



Anne-Nelly Perret-Clermont (Editor)

With the collaboration of Jean-Paul Bronckart · August Flammer ·  
Sophie Lambolez · Denis Miéville · Jean-François Perret · Walter J. Perrig

# Thinking Time



A Multidisciplinary  
Perspective on Time

HOGREFE



Swiss Monographs  
in Psychology

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*For Jean-Marc Barrelet,  
Chairman of the Scientific Council of the Institut l'Homme et le Temps,  
La Chaux-de-Fonds, Switzerland  
who innocently sowed the seeds of this adventure*

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# Time, Mind, and Otherness

Anne-Nelly Perret-Clermont and Sophie Lambolez<sup>1</sup>

*"The future that death brings, the future of the event, is still not time. For the future that belongs to no-one, the future that man cannot assume, still has to enter into a relationship with the present in order to become an element of time."*  
(E. Levinas, 1946/1994, p. 68)

*"Is now today?" "Mommy, were you there when I was born?"*  
(K. Helkama, 1981, p. 41)

**Starting point: The "Mind and Time" conference in homage to Jean Piaget, to celebrate the centenary of his birth in Neuchâtel**

This work grew out of the "Mind and Time" conference held in Neuchâtel on 8-10 September 1996, by the Institut l'Homme et le Temps, Chaux-de-Fonds and the Institut de Psychologie de l'Université de Neuchâtel to celebrate the centenary of Jean Piaget's birth there (Liengme Bessire, Barrelet, Perret-Clermont & Zittoun, 1996; Barrelet & Perret-Clermont, 1997).

The conference consisted of a presentation of current research into time, particularly the relationships between time and awareness; this book is not a report of the conference, but rather an opportunity to develop the subjects discussed during those three days. The project has taken several years to come to fruition, partly because of its ambitious scope – authors from different countries, speaking different languages, different areas of scientific thought, etc. – and partly because of the illness of the main editor, which was beyond our control and which meant that the work has taken a very long time to produce ... we hope that, like good wine, it is all the better for maturing slowly.

This time for reconfiguring a multidisciplinary dialogue seems like only an instant in

relation to the many thousands of years of debate on the subject, for in this book the reader will not only meet writers who were Piaget's contemporaries or influenced by his work, but also echoes of older philosophers such as Socrates and Plato, Lucretius, Aristotle, St. Augustine, Thomas Aquinas, Descartes, Locke, Leibniz, Rousseau, as well as other more recent philosophers, such as Janet.

In choosing this theme, the organizers and co-editors were aware of the humorous side – though the subject itself is a serious one – of situating the work firmly within the region where Piaget grew up, and in particular within its regional tradition of clockmaking (Liengme, 1994; Chollet & al., 1977; Cardinal & al., 1991), as well as in a field that is sometimes regarded as one of the most difficult in human science. In psychology, for example, there is comparatively little research concerned explicitly with the concept of time, although time is of central importance to it. We felt it might be useful to start by reviewing research projects, from many different disciplines, that have studied time. Even though the authors are well aware that they are neither the first nor the only ones<sup>2</sup> to take a fresh look at the concept of time as central to their discipline, they felt that a consideration of this multidisciplinary perspective might be an original way of honoring Piaget, because even though his writ-

<sup>1</sup> We would like to thank Valérie Tartas (University of Toulouse), a specialist in the relationship between children and time, for her assistance with this introduction. We would also like to thank Pippa Sandford for the translation.

<sup>2</sup> In particular, from the same publisher: Helfrich, H.E. (1996). *Time & Mind*. Seattle, Toronto, Göttingen & Bern: Hogrefe & Huber Publishers, and from our colleagues: McGrath, J.E. & Tschan, F. (2004). *Temporal Matters in Social Psychology. Examining the Role of Time in the Lives of Groups and Individuals*. Washington: American Psychological Association.

ings explicitly concerned with the concept of time are not central to his work, his “genetic” approach was indirectly instrumental in introducing a new relationship to time in cognitive psychology and epistemology, so paving the way for crucial advances in the field.

### Jean Piaget

Jean Piaget was born in Neuchâtel on 9 August 1896, and died in Geneva on 16 September 1980. Throughout his life he demonstrated a passion for intellectual enquiry (Ducret, 1990; Vidal, 1994; Barrelet & Perret-Clermont, 1996). From a very young age he was interested in natural science, with a particular passion for molluscs, and he became a member of the *Club des Jeunes Amis de la Nature*. When he left school he enrolled in the Faculty of Science at Neuchâtel University; in 1921 he obtained his doctorate in natural science with a thesis on molluscs in the Valais, written at a time when new theories were situating the study of biology within a new temporal perspective, following on from Darwin’s ideas of evolution. At the same time, Piaget was interested in the disciplines taught in the Faculty of Arts, such as philosophy, epistemology, and logic. He attended lectures by Arnold Reymond, who invited his students to study scientific thought within its historical context (Piaget, 1931); he read Aristotle, Kant and Bergson, and decided to devote himself more specifically to a question he believed to be fundamental: “How is knowledge possible?” This led him to psychology, particularly child psychology. In 1919 he spent six months in Zurich, where he studied psychology and psychoanalysis, followed by a year in Alfred Binet’s laboratory in Paris, where he worked with Théodore Simon on his research into the development of intelligence and intelligence testing.

Piaget became a professor at the University of Neuchâtel; between 1925 and 1929 he taught psychology, sociology and philosophy of science. He was then invited by Edouard Claparède and Pierre Bovet (founder of the *Club des Jeunes Amis de la Nature* that Piaget had attended as an adolescent) to become Director of Studies at the *Institut Jean-Jacques Rousseau* at the University of Geneva, to conduct research on child psychology to provide a scien-

tific basis for developments in the “New Education” movement. Piaget taught the history of scientific thought and experimental psychology there until 1971, and for the rest of his life was director of the International Centre for Genetic Epistemology. He was also professor of psychology and sociology at the University of Lausanne from 1938 to 1951. He was invited to teach in Paris, first at the *Collège de France* in 1942, and then at the Sorbonne from 1952 to 1963.

### Piaget and time

At the end of this Introduction there is a list of publications (books and articles) in which Piaget explicitly dealt with the concept of time. They have been studied and have sometimes generated significant research (notably by Grize et al., 1966; Bovet & al., 1967; Fraisse, 1967, 1979; Cromer, 1971; Ferreiro, 1971; Friedman, 1977, 1978, 1982, 1992; Levin, 1977; Montangero, 1977, 1984, 1996; Montangero et al, 1995; Crépault, 1989; Weist, 1989; Pouthas & al., 1995 and others), but it has to be admitted that the concept of time is not the best-known part of his work and he does not seem to have spent much time on it. Piaget treated time as a category of thought – “How does the individual think about time?” – and he was particularly interested in how children perceive and understand time at different stages of their development, particularly its duration (in terms of start and finish). He studied and described the mental structures that make it possible to acquire the concept of time and the interdependent concepts of speed and acceleration. The questions Piaget posed echo the problems of the ancient Greek philosophers in thinking about speed, as Gardies describes (this volume). Most of all, Piaget studied time by constructing ways of measuring it. This may seem surprising. Why did Piaget regard measuring time as being so important to its relationship with psychology? In the tasks he used for his investigations, Piaget suggests the time of work accomplished (which recalls the world of workers and manufacturers) and the displacement time of moving things (which brings to mind trains going through tunnels or coming into a station). The cultural and clockmaking heritage may have come not only from within the region, but also from within the

family<sup>3</sup>. Piaget seems to have had little interest in the social, pragmatic, or existential dimension of time. Later in this book, Bruno Latour invites us to return to this question, in time-spaces where the mind is seen to be wrestling with work, instruments, representations, and measurements.

But if Piaget's contribution to the subject were limited to time as a category of thought, we would lose sight of his most important work. In his writing he tackled the question from other perspectives.

His second approach, the most fruitful and most promising in his work, is the introduction of a temporal perspective into the study of psychological processes. Piaget considered and conceptualized the development of thought in its deployment in time, and instituted the so-called "genetic" approach. Inspired by biology, he transposed to psychology the time inherited from natural sciences, reinterpreted the concept of evolution, and imported the concepts of assimilation, accommodation, and equilibration, investing them with an explanatory function.

His third approach is that of historical time. It appears that Piaget only wrote one paper on the subject (Piaget, 1933) but he was probably profoundly influenced by the relationship to time that he learnt from his teachers at the University of Neuchâtel, particularly Arnold Reymond (Piaget, 1925) who studied the history of logical thought, and also from his father, Arthur Piaget, professor of medieval literature, first rector of the University of Neuchâtel founder and first director of the *Institut d'Histoire de la Réforme*. Arthur Piaget trained in Paris when the critical-historical method was at its height; Zumstein (1995) referred to this method as the preferred approach for liberal theology. The Piagets grew up in a social environment marked by bitter controversy and tension (Thomann, 1996; Perret, 2003) between the proponents of liberal theology and the scientific role of history on one side, and the proponents of a simultaneously more pietist and more social form of Christianity on the other; apparently Piaget's mother belonged to the latter group. Both camps had their prominent intellectuals, but the proponents of liberal theology seemed to put their confidence more in Reason, a position that Piaget praised in the book he published when very young, "la Mission de

l'Idée" (1916), while their opponents concentrated more on the psychological experience of people facing difficult times in their lives. Piaget seems to have learnt some important lessons from the critical-historical approach, such as being wary of emotion, the moment, the social pressure of the group, and dogma; he used the critical-historical method as an instrument, originally designed for the critical interpretation of texts and applied by him to analysis of the oral discourse of children, in which he tried to make a "critical interpretation" of their thought. In line with the critical-historical method, Piaget tried to establish the primary sense of what was said within the "historical" context in which it was stated (in the psychological sense, the context is provided by the child's stage of development and the task it is presented with). Piaget wanted to make a critical analysis of what was said (in practice, with the child, through a game of counter-arguments), to examine the forms (in this case, the logical forms) and the concepts brought into play, but rather than applying a historical approach to documents reflecting ideas from the past, he applied it to children's thoughts in the present, restoring them to their place in the micro-history, i.e. to their genesis. In doing this, Piaget used the term "critical method" to describe his method, before describing it as a "clinical" approach to the children's thought.

Our aim in this collective work has been not to retrace Piaget's thoughts on time step by step, nor to examine how they were received, but rather to try to capture the spirit of his work, to take the same "adventurous" approach as our illustrious predecessor, who had no qualms about crossing theoretical and methodological boundaries between disciplines when exploring a subject. So without losing sight of the difficulty of our task, we will look at *time* from a number of different viewpoints.

### Can time be an object of thought?

Can time be conceptualized? People have always been interested in time as something that passes, that seems to run away from them, and brings them closer to death. What is time? Can time be an object of thought? Time has a physical, bio-

<sup>3</sup> We should add that it was Piaget's maternal grandfather (so not a Piaget) who was a clockmaker ... as the name Piaget says something about you in Switzerland!

logical effect on us; is it possible for it to be simultaneously familiar and unimaginable? It is a paradox that time, with its biological effect on us, can simultaneously be so difficult to represent with our minds.

It seems that we are prisoners of time and completely powerless when faced with it; we cannot speed it up, slow it down or stop it, much less go backwards in it; it imposes its own pace on us, and we cannot change it. As a Chinese proverb puts it, "money can buy clocks, but not time." The subjective duration of a time of absence is longer and more fully experienced than a time during which things happen. We live in a world which is not an abstract universe made up of concepts, including the concept of "time", but one which is made up of generations and networks of people and mediations whose actions, interactions and words not only make up the contents of our memory, but are also the means that make remembering possible. A relationship with time is simultaneously biological, psychological, social, and technical.

Following Piaget's example, the authors' intention is to invite the reader to start from the biological facts and the irreversible effect of what time does to us: neuropsychology will show us the problems of perceiving time; psychology will help us to glimpse the meaning of our very different ways of thinking about time (through observing the time of growth in childhood, through the phenomenological experience of time, the problems of memory transmission, time for learning time, etc.). Throughout this exploration, it must also be remembered that any discussion of time is based on language and logic which themselves bear the marks of their own sometimes interdependent development.

### Internal biological timers

*Françoise Macar's* contribution (this volume) discusses the understanding of time from a neuropsychological viewpoint, and shows that perception of duration involves primary processes that might be underestimated in Piaget's theory. She focuses in particular on the mechanisms by which we process durations of seconds or minutes, and presents the current state of basic research in this field. In addition, human and animal studies show that although certain areas of the brain are involved in understanding time,

some (the frontal and prefrontal regions) are more involved than others in processing short durations, although none is specific; however, this does not nullify the hypothesis that they might have specific roles in time processing functions. Macar shows that humans have mechanisms for measuring time that allow them to measure, remember and reproduce the durations of events and actions lasting for a short time, and they can do this without using any instruments. What happens with longer durations?

The rest of the book will examine these longer durations, in relation to the questions raised by *Françoise Macar*. We will find ourselves at the heart of an interactive network of biological processes, human technical and discursive actions, undergoing transformations whose traceability is itself the result of these very interactions.

### Memory in time

How does our memory function in relation to these durations and their content? How are our memories of reality established?

Walter J. Perrig (this volume) recalls that even though Piaget concentrated on the genesis of intelligence and mental functions and did not therefore regard memory as particularly important, his work on memory is still renowned, as it demonstrated that memory cannot be dissociated from other cognitive functions and more generally, from the functioning of intelligence. There is more to memory than just remembering. As a specialist in contemporary experimental psychological research into memory, Perrig reviews Piaget's insights, which are still of interest today despite their limitations in terms of design and empiricism. There is still much in his work to be explored and built on.

Timothy A. Salthouse (this volume) considers time as a transformable resource that degrades with age; actual time decreases while age increases, which appears to have repercussions on many types of cognitive functioning. While Piaget focuses on the positive role of the development of cognitive operations on memory, Salthouse takes the opposite view and shows that higher order cognitive functioning suffers an age-related decline (though not in infants or children, of course) that can be accounted for by a reduction in the rate of information remaining

available for processing and in other time-related mechanisms to time. This is a resource-based conceptualization of time.

Elizabeth F. Loftus (this volume) is interested in the processes by which memory becomes distorted in the long-term, and in particular, how false memories are created. Her interest dates back to the famous story that Piaget used to tell about the so-called kidnapping attempt on him when he was a child. Loftus has developed a set of paradigms for experimental study of these false memories created in individuals who have not experienced the events in question. Her research has very important implications, e.g., in the case of false memories of sexual abuse during childhood, when the abuse did not in fact take place. Her studies also demonstrate the limitations of the influence of suggestion in creating false memories, which opens up the way for empirical methods to distinguish between memory and events created by the imagination, and to discover the effects of the latter in both the long- and short-term.

Werner Wippich (this volume) puts Piaget's work into perspective, along with the contributions of Perrig, Salthouse, and Loftus, by examining the explanatory value of time in research into memory. His understanding of the field offers an explanation for Piaget's relative lack of success in dealing with thought in terms of "time"; indeed, in his efforts to build an interactive theory, Piaget was completely committed to the idea that thought is constructed by abstraction. In Piaget's eyes, abstraction is a process that extends the biological processes of equilibration, albeit on another level, by detaching the mind from contents, forms, social dependence, and emotional experiences. But Wippich shows us that in the current state of research, the most recent hypothesis in the field of memory for time is, on the contrary, that associated contextual information and a knowledge of social, natural and personal time patterns are essential ingredients in any reconstruction of the time of remembered events. Memory may result from interplay between general cognitive processes and episodic memory processes. Contextual associations of particular memories may be used in constructing temporal memories. Piaget could not arrive at this conclusion by pursuing his central concern with mental development as a process whereby structures are abstracted from sensorimotor and concrete situations.

### Logic, language, and time

The articles in the third part of this book examine logic, linguistics, and psychology, to propose a new approach to the formalization of the concept of time. As Denis Miéville emphasizes in his introduction, with reference to St. Augustine, it seems that there is an awareness of time and yet major problems become apparent as soon as any attempt is made to represent it or analyze it. These articles will try to clarify this question.

Denis Miéville (this volume) writes as a logician, following Lesniewski and others in examining the conditions under which a developmental logic could be capable of describing the stages of its own progression in time, preserving the traces of its successive conceptual expansions.

Jean-Louis Gardies (this volume) looks at the vocabulary and grammar of time in the vernacular (particularly Indo-European) languages, and at what logicians borrow from them. He gives examples to show that logicians cannot for their part be satisfied with these grammatical resources, which refer only by implication to the constituent functions of the temporal rationality of discourse, as their role is to make an inventory of truth functions. In a stimulating exploration of the history of the understanding of "speed," Gardies shows how, in turn, grammatical resources perfected by scientific procedures can influence natural language. This example of "speed" is taken up again by Bruno Latour (this volume), who also considers how natural resources other than language are transformed by scientific distancing procedures into technological objects, which in turn intrude into human interactions and discourse.

Jean-Blaise Grize (this volume) recalls Piaget's pre-eminent role, which restores the subject to its position as centre of functioning in the study of knowledge. The Piagetian approach is structuralist, but within a constructivist perspective. The author also demonstrates the importance of this approach and draws the conclusion that if the subject is a participant in the development of knowledge, it becomes essential to consider the way in which he or she communicates knowledge, also using natural language and its various mechanisms such as tenses, ideas ("soft ideas", not to be confused with concepts), and schematizations of causes (not the modeling of reasons).

As humans can only be studied in the context of their history, human science must be able to represent an event as a single whole, which cannot be done with models in which the subject is abstracted, but rather using ideas and schematizations, within situations of communication and of the constant effort of interpretation required of the person being spoken to; so this is a process which takes place within time and cannot be abstracted from it. Grize feels encouraged by this approach to revisit the epistemology of the space-time of contemporary physics and the Big Bang.

Piaget held that cognitive development “is a linear, incremental and refining construction,” or to put it another way, that there is development when a rational structure replaces another structure that is less rational, or not rational at all. However, in contrast, Olivier Houdé (this volume) advances a concept of the development of non-regular rationality that progresses by a tortuous path. He refers to Michel Serres, who felt that scientific development follows a timeline that folds and twists and resembles a “crumpled-up handkerchief.” Houdé uses four examples (construction of the object, number, categorization and reasoning) to show how his vision of time in the genesis of knowledge makes it possible to describe observations of babies, children, and even adults. The author demonstrates “steps backwards” which follow “obvious” competencies: “an individual’s development also implies knowing how to inhibit a competitive structure,” and this competition between constructs is what makes time in knowledge development take on the shape of a “crumpled up handkerchief full of folds.” Perhaps one day it will be possible to describe the different stages of this crumpled development? In any case, Houdé says, they won’t be the same as Piaget’s!

Jean-Paul Bronckart (this volume) takes a sociodiscursive interactionistic perspective and considers that the central objective of human and social sciences is activity, while the role of psychology is to account for the action of the individual. Activity is closely related to language, as it is through discourse and evaluation of discourse that it is interpreted, reconfigured, negotiated, etc. The construction of temporality has a crucial role in this general process of reconfiguration. Narratives, in particular, are known for their role in turning events into meaningful actions. Through a detailed analysis of

different forms of speech and texts, Bronckart demonstrates the many ways in which speakers construct their timeline, locate the actions described, and construct their discursive worlds. One hypothesis that Bronckart draws from his survey is that the interest in narrative has led to an underestimation of the contribution of other forms of discourse to the clarification of actions, but that “primary” temporality actually has its roots in leisure – the leisure to narrate.

In these chapters, we have been jumping from language to logic and back, following the processes by which humans think about time. There seems to be a sort of dialectic move between the quest for abstraction out of time towards some kind of universal statements, and an ever present need to embed the frame of reference of ideas in the *here and now* of experience in order to achieve communication. But in both approaches it can be seen that thinking about time is a dynamic, constructive process that leaves its mark on the devices (including the formal devices) it develops. This process is inherent to humans’ efforts to communicate and it is not a solitary activity. Social interactions between participants in a conversation configuring their common tasks, between speaker and audience, as well as the shared intentions and expectations between writers and readers, all contribute to the existence and institutionalization of discursive spaces in which it is possible to reflect on the (multiple, folded and twisted?) timeline.

### Developmental timing

August Flammer (this volume) introduces the fourth part of this work with an invitation to think about the way the various stages of developmental psychology are related to time. Time (or age) is seen as an independent variable. But this approach with time seen as a “variable” has limitations, and leads to an invitation to seriously reconsider the historical nature of development as well as the historical nature of developmental psychology and its social marking. It is only recently that researchers have become interested in how children and adolescents use and think about time, not in terms of Piagetian categories but as a function of their relationship with the “use” of time. This research has led to a demonstration of the existential choices of young people in prioritizing their activities.

Françoise D. Alsaker, August Flammer and Urs Tschanz (this volume) want to understand the values and priorities of the individual and society, by looking at the way in which individuals organize their everyday lives (what they do, when, and for how long). It is very clear that personal management of time is to a very great extent governed by social demands (particularly by schools, which require levels of investment in time that vary greatly from one country to another, and which also impose very different structures on their days) and traditions (including gender stereotypes and expectations).

Carsten Wrosch and Jutta Heckhausen (this volume) feel that human life offers different but constraining approaches to development, with deadlines which affect the adaptive processes that regulate development at a number of timepoints or ages, depending on whether or not they are complied with. Their model is based on a set of constraints and opportunities in relation to which the individual must actively and constantly situate themselves, e.g., in choosing and achieving their goals, managing the consequences of success or failure, etc. Finding one's place in relation to this biological and social time would appear to be an essential engine of development.

But what is biological and social time? Is it a progression? Willem Koops (this volume) describes historical changes in the theory of child development. Like Locke and Rousseau, Piaget is anchored in a firm belief in "natural development" and "objective progress" from the "primitive" to the "civilized." Although it was not these authors' intention, we now know how far this belief has also generated occasionally dramatic prejudices from advocates of eugenics. However, modern research has demonstrated the existence of much more advanced levels of cognitive ability and social understanding in children and even in babies than were demonstrated by the philosophers, psychologists, and educators of the last three hundred years. They are already beings endowed with rationality, and unwarranted "infantilization" could have disastrous effects on education. Reading Koops, one wonders whether, rather than confining young people within a timeline (assumed to be that of growth from incompetence towards the "advanced state" that will be the Adult), psychologists and educators would find it useful to rediscover them by trying to achieve the best possible

communication between human beings in a more horizontal relationship. Its post-modern appeal, yet still inheriting some of the values of the Enlightenment, is echoed in current educational science research, which is aware of the crucial role of social interaction and discourse in the framing of thinking, time perspectives, and agency (Perret-Clermont & al., 2004).

### Time for learning

If cognitive, social and emotional development, is not just the mature fruit of time, as if time were the water irrigating the good seeds of the garden – then what kind of relationships to time can educators and learners establish? Is *development* too abstract a concept that should be more realistically replaced by *learning*, as post-Vygotskians tend to tell post-Piagetians? Or are there biologically-induced patterns of activity and of auto-equilibration that have to be respected if the child is to be an active participant of his or her own learning – as Piaget would reply? Instead of entering into this theoretical debate, already addressed to some extent by Koops and others in this volume, Jean-François Perret introduces the reader to empirical studies of existing teaching and learning situations embedded in their complex sociocultural environments in order to understand how institutions and social life frame specific times for formal learning. Of course, in some ways, children and adults "learn" from experience all day long. Yet some kinds of learning require a retreat from reality, some kind of reflections and abstraction. How are the times for these types of learning organized at the public and individual levels?

Alain Mercier, Maria Luisa Schubauer Leoni, Elisabeth Donck et René Amigues (this volume) set out to study the temporal dynamics connecting learning and teaching within the "didactic contracts" which implicitly manage academic situations. Social time is not a single entity providing a framework for the efforts made by both sides. On the contrary, careful observation of academic work shows that there are different patterns of time, such as that of "teaching and learning time", which is managed by the teacher to ensure progress in the text that has to be made known to the student (it could be said that the teacher "reads" the knowledge to the student).

So this time is linear and almost cumulative (except that it has to succeed in linking the new knowledge to the old knowledge *and* succeed in seeing that old knowledge that has become obsolete is forgotten in the face of new knowledge). And there is learning time, which is the student's time, which has two aspects – there is a private dimension, in the form of a spiral when the student goes back over the knowledge already learnt to study it, revise it, understand it anew and interpret it for his or her own purposes (particularly the purpose of responding to the present task); and there is a public dimension, a time which could be said to be derived from the teacher's time: in the appropriate way, at the right time, students must give evidence of their his participation in the life of the class and of their ability to demonstrate their knowledge, or more precisely, to demonstrate that it can be thought that they know what they need to – as they have given the right answers, their adequate responses can make it thought that they know the knowledge. Here again is the “folded,” “twisted,” or even “crumpled” time of Serres and Houdé, along with Bronckart's multiple forms of discourse. But what does the subject learn?

Jacques Perriault (this volume) observes the relationship to time involved in distance learning situations (through interactive video conferencing, in the case of a university course in law). This way of communicating knowledge raises a crucial issue, the question of time – time to understand, to manage, to anticipate. This is all the more important as distance learning is new, and students interpret it on the basis of their experience of other situations with media (radio, television and video), or traditional teaching situations. This “hybridization” of traditional learning with episodes of distance learning can be disruptive, as these types of working have different or even opposite constraints. For example, its very nature means that videoconferencing creates a larger number of items of information to be processed on different levels (content of the knowledge, as well as managing exchanges, operating the technology, etc); it has its own internal clock which changes the dynamics of learning, and causes students to use time in a different way from a traditional course. Time needs to be re-examined in new teaching situations. And the student has to find a new way of organizing their

time for internalizing the knowledge, for personal study, and for making their knowledge their own.

We have been accustomed to thinking of learning as taking place within a chain of cultural transmissions from generation to generation, and as a task specific to young people supported by their parents and educators. Pierre Dominicé (this volume) takes his turn in questioning our traditional understanding of time as a predetermined arrow pointing in one direction. This very specific cultural representation of time, and consequently of personal biography, cannot withstand the pressures of today's transformations of society. Changes in health and life expectancy, in the labor market, technology, gender relationships, etc. lead to changes in the rules of the game of social life which have to be relearned all over again each time. From the viewpoint of an educational specialist, Dominicé questions the concept of development; he says that adults “will have to learn to adapt to breaking and breaching as transitional stages in their biography.” Learning is not only about formal or scientific knowledge and preparation for work, but also about learning at a personal level to face a more complex social life. But then, in this complex world, what is the role of formal adult education programs? Dominicé has observed adults who enrol on a course, and paradoxically by doing so lose the time to learn anything other than the prescribed content of formal knowledge and techniques that they are being taught. The learning process cannot be isolated from the wider processes in society that transform reality. The complex tasks of lifelong development described in this volume by Wrosch and Heckhausen need special support to be achieved. Where will this support come from? Perhaps from looking again at the concatenations of the generations, and the relationships between them, the dialogue between generations might be a clue to discovering the cultural resources available. “Perhaps the time has come to consider adults and young people as partners in the same adventure (...) of the same emerging world,” says Dominicé, reminding us of Koops' comment; and, he adds with a fresh (but still traditional) look at the timeline, “the creative dimension of adulthood will have to be found by the right mix of cultural legacy and fabrication of the future.”

### Pluritemporality of humans and artefacts

Does time leave traces, or is it because an event becomes an object of attention that its trace creates time? A teacher deliberately establishes traces of what has been worked on in class, traces and notes that students must rework in order to be able to demonstrate that they have learnt them, i.e. that they have become capable (according to a certain number of standards) of taking account of the knowledge learnt in their social relationships and scientific discourse; this is how *memory* of the knowledge is transmitted. But is it really knowledge that is involved here? And where does this transmission and memory fit on the timeline? Does time – or the timeline of memory – exist as a shared construction of the mind or is it a “folded and twisted” reality that only has the appearance of being shared? In this book, we have seen how individuals make great mental efforts, through language and reason, to locate themselves – and locate other people – along timelines. But these timelines seem to multiply, crumple up, run alongside each other, or cross. Bruno Latour (this volume) asks us to think much more seriously than the Western philosophical tradition tends to do about the *manufacturing* of time.

Certainly the psychological efforts mentioned above are based on mediations that displace and transform their objects according to procedures whose ingeniousness is explored in relation to the linguistic dimensions, in part 3 of this book; but we should also study the ingeniousness of other technical and scientific dimensions. Tartas (2000, 2001) has shown, in an extension of Vygotskian research into the role of symbolic tools and mediations in the structuring of thought, the importance of the instruments made available to the child so that it can situate itself within time. Time experienced is time marked by the culture within a social framework which itself is marked by a philosophy, taking shape through narratives (Halbwachs, 1925, 1949; Hall, 1984; Valsiner, 1993; Brockmeier, 1995). Latour (this volume) takes as his basis numerous studies of the history of science, techniques and philosophy, not forgetting the distancing and poetic process of humor, and takes us into a sort of scanner producing images in five rather than three dimensions: time-space is then perceived as enriched by the *agency* of human beings subtly weaving together interactions from many places, times and types of material.

We are now a long way from the hypothesis of “pure spirits” (“pure” because foreign to all places, historical events and bodies). We are a long way from the position of a Master Clockmaker, set in an unhistorical world, out of space and time, in a position that might be the location of the axes of the coordinates, and able to see (and to foresee – the terms have become synonymous) human development as the unfolding of potentialities, and all scientific efforts as the mere unfolding of determinations made visible step by step. God – but which god? – on his balcony. We are back to Piaget! For it seems that this was the question he started with (Perret-Clermont, 1996). In his first book, written when he was still very young (“La Mission de l’Idée”, 1916), a spirited pamphlet addressed to the pastors of the Protestant church in Neuchâtel, Piaget revolted against dogmatism and pietism, in a sort of “pre-immanentism,” calls in it for Christ’s mission to be seen as an *Idea*. For Piaget, the Messiah is an *Idea* made incarnate to save the world from its barbarism by developing Reason, the guiding intelligence that inhabits every human being. Reason is universal. It certainly seems to have come down from that balcony. If we have understood the young Piaget’s act of faith correctly, it confirms Latour’s hypothesis that sees in Piaget’s inability to think of time as having been “manufactured” the mark of a secularized theological heritage, the fruit of a theology constructed with categories of thought taken from a modernity that is trying to make the world intelligible through formalisms and unchanging doctrines, without seeing the creative work that produces and marks them, and without seeing the organizations and institutions that create the regularities observed. A world where everything is so well ordered, scheduled and “understood” that there is no longer any place for a novel interweaving of new interactions and inventions, for surprise and the unknown, for otherness. A world where there is nothing more to be thought about. And if there is nothing more to think about, nothing more to wait for ... perhaps there is no more *time* either.

The reader will have understood that this work is an invitation to revisit in their relation to time the very foundations of different (and yet inter-related) disciplines such as psychology, philosophy, logic, linguistics, the history of science and techniques, and theology. This revisiting may be *poetic*, in the etymological sense, in

other words, creating sense for our time, a visitation as a quest fully embedded in this supposedly "known world," but with a passionate expectation of nevertheless discovering something unknown, something new, a surprise! A longing for otherness... a sense of time...

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## **Part I.**

### **Internal Timers**



# Time Passing, Attention, and Internal Timers

Françoise Macar

## Introduction: Time measurement by clocks

Human beings have always been ingenious watchmakers. Across centuries, many different methods have been used to measure time with more and more accuracy. Water flow inspired the first designers in 3000 B.C., giving birth to various types of clepsydrae. Hourglasses based on sand flow also have far-off origins. Much later, mechanical clocks generated intense interest with many examples of extant throughout Europe in the 14th century. Three hundred years later, the pendulum clock appeared, with greatly improved control of movement regularity. It was built in 1656 by the Dutch mathematician and astronomer Christiaan Huygens. Galileo had worked on the idea of a pendulum some twenty years before, and Leonardo da Vinci gave us several drawings of such a mechanism in the late fifteenth century.

Eighty years ago, accuracy in time measurement took a giant step forward with the piezoelectrical clock. This mechanism is based on the vibrations of quartz crystal (that reaches a frequency of 5 millions Hertz). A further revolution came with atomic clocks, one consequence of which was a new definition of our fundamental chronometric unit, the second. It is now derived from properties of the Cesium 133 atom, rather than from the movements of the stars as in the past. Can no measurement of time be considered accurate enough today? The NIST-7 clock recently elaborated in USA will have error of 1 second ... in 3 millions years.

Even though our current clocks and watches do not attain this level of excellence, these devices have become so commonplace that we can hardly imagine measuring time without them. Many tools in our everyday life include digital clocks: microwave ovens, electric coffeepots, televisions, video recorders ... Time measurement is undoubtedly useful to human societies whose members need to synchronize their activities, as well as to individuals who wish to boil an egg or to cook spaghetti *al dente* ... In

fact, even though watches and hourglasses are available for this particular purpose, many cooks prefer to forget them and rely instead on their own ability to estimate time. Many similar situations show that target durations can be memorized through repetitive training, as are various other properties of the environment.

## Piaget's research on time

A usual matter of debate is whether it is the duration by itself that is memorized, or events elapsing in the course of that duration. This question evokes recurrent philosophical inquiries such as: What is time? Is it an *a priori* form of our perception, like space, as Kant believed? Does it exist beyond the elapsing events? Do we apprehend duration through intuition as proposed by Bergson, or is it constructed on the basis of other dimensions?

Piaget's position in this debate was clear. For him, duration cannot be perceived; rather, it derives from the relations between speed and space. The development of the idea of time during childhood is grounded in a cinematic context, and several years are needed to elaborate temporal concepts and acquire stable temporal notions. No intuition, or perception of time exists. Piaget defines his straight views in the first lines of the book entitled *Le développement de la notion de temps chez l'enfant*:

"We are far too readily tempted to speak of intuitive ideas of time, as if time, or for that matter space, could be perceived and conceived apart from the entities or the events that fill it" (Piaget, 1946/1969, p. 1).

Following Piaget, space and speed are primary notions that must be correctly connected before the temporal dimension can be deduced. This kind of learning implies the existence of successive stages. It is not until the age of 8 that a child is able fully to understand temporal concepts (post-Piagetian studies have generally re-

ported successful answers at an earlier age, since children are known to be more and more precocious in many domains ...). To demonstrate this development, Piaget designed a series of ingenious tests. Little puppets, for example, were shown walking on parallel tracks at different speeds, different starting or ending points, and covering various distances in certain amounts of time ... A great many combinations of the parameters involved were used, and questions concerning these parameters were posed to children 5–12 years old.

Many other approaches to temporal concepts are brilliantly explored in Piaget's book. For example, the manner in which children understand time as measured by clocks is another fascinating chapter that produces somewhat surprising data. Children aged 4–5 do not consider time stable; they view it as varying with the speed of their own activity. When it comes to people's age, the book reveals that the youngest children establish strong connections between age and height; they also sometimes believe that grandparents have always been old ... As on so many other topics, Piaget's seminal research on time has opened a rich and far-reaching field that has continued to provide a wealth of exciting results (see e.g., Crepault, 1989; Levin, 1992; Montangero, 1977, 1996).

#### **Another approach to temporal processes**

Speed plays a key role in Piaget's research on time. A central place is given to cinematic situations and to the development of reasoning in human beings. The present article describes a different approach that focuses on duration outside cinematic framework, and on primitive temporal mechanisms shared by numerous animal species. Speed is irrelevant in the evaluation of whether an egg has spent enough time in boiling water, or in the decision of whether an auditory Morse code signal was a dot or a dash. Long before being able to reason about time, children can distinguish the duration of two otherwise similar signals and control some temporal features in their own behavior. Babies a few weeks old are able to discriminate different auditory rhythms (Demany, 1979) and to modify their own sucking rate if some reinforcing consequences ensue (Pouthas, 1990). As Fraisse (1957) emphasized, newborns have a very pre-

cocious experience of time because before their needs are satisfied, waiting is often necessary. The existence of inescapable delays is probably a frustrating discovery ... Complying with such constraints is one of the means by which living organisms adapt to their environment.

The mechanisms involved in estimating and producing time periods are not yet entirely understood. Obviously, the problem is quite different depending on which duration range is involved: seconds, hours, weeks, years ... Research on neural mechanisms basic to time processing in different species typically focus on brief durations. For long durations, memory processes, time cues such as are provided by calendars, and reasoning on past, present, and future concepts are prevalent factors to consider, most of which restrict the scope of the research to human beings. In this brief review, neural mechanisms in the range of brief durations, on the order of a few minutes at the maximum, are considered.

#### **Champions of brief durations and other instances in everyday life**

In looking for multifaceted illustrations of time processing, the stupendous performance of animals such as bats, barn owls or electric fishes deserve special mention (see Carr, 1993 for review). Bats discriminate between tens of nanosecond-delays. To localize their prey in the dark, they emit biosonar pulses: The delay between the outgoing pulse and the returning echo determines the distance of the prey. Barn owls are other champions of time processing, able to detect microsecond differences in the phase of a sound reaching one and the other ear. Electric fishes exhibit comparable temporal performances by detecting phase differences between electric signals on different parts of their body surface.

Other animals are sensitive to longer delays, but still, delays that are of central relevance to their everyday life. Interesting observations have been made on humming birds living in the lowland rainforests of Central and South America (Gill, 1988). These birds feed on nectar from various flower species scattered at various places, and adapt their foraging behavior to elapsed time: Because the nectar replenishes gradually in flowers after being harvested, the optimum moment to revisit a flower can be pre-

dicted. Most visits are seen to take place at this moment. The birds can also be trained to visit artificial feeders after fixed delays (e.g., 10 or 15 minutes). To reach the right place at the right time is critical in this case, as it is in many other types of foraging behavior (Gallistel, 1989).

Human beings are also pretty good at processing durations that are significant in their own behavioral repertoire. In verbal communication the duration of vowels is crucial to differentiate certain words (e.g., "lip" and "leap"). Pauses in spoken sentences structure the delivery and may also denote the speaker's particular intents, doubts or expressive purposes. The latter use is obvious in music playing too, by way of the duration of notes and silences.

Such examples point out the fact that certain durations need to be accurately processed. Obviously, this is not true for any temporal dimension. In many situations time is not a significant feature and, therefore, needs not be directly controlled. Similar considerations apply to space, since every event or action takes place in space whereas solely some of them elicit spatial processing. In the temporal field, a commonplace distinction exists between the prospective and retrospective situations. The former implies that one's attention is directed to temporal parameters whereas it is not in the latter. Practically, in laboratory experiments, human participants may, for instance, be required to estimate the duration of a target period (i.e. 10 seconds) signaled by an auditory cue. If they are informed before the cue starts that they will have to judge time, their judgment will be prospective. In contrast, their judgment is retrospective if required only after the target duration has elapsed without any previous mention of the relevant cue parameter. This distinction is essential in the study of psychological time, because the mechanisms at play in the prospective and retrospective cases seem to be different. A great number of experimental studies have established that duration judgments reflect opposite trends in those cases (see e.g., Block, 1992; Hicks et al., 1976).

### **A central stopwatch?**

It is for prospective judgments on brief durations, when accurate timing is clearly a key aspect of performance, that the existence of a central control of timing is to be considered. Various

types of mechanisms may possibly intervene depending on the particular conditions of performance and on the species concerned. Many questions are still pending in the field of time processing, and further research will certainly bring new clarifications in near future, given the multidisciplinary approaches that are increasingly used and the precious contribution of brain imagery methods. Today one type of time-counter mechanism is pointed out by converging evidence obtained with temporal conditioning schedules in animals (mostly rats and pigeons) and with psychophysical procedures in humans. "Internal clock", "pacemaker" or "interval timer" are current names used to designate the time processor, which in fact seems to act as a stopwatch with definite starting and ending points.

A core feature lies in the cumulative properties of the timer. The prevalent hypothesis nowadays is that some internal "pulses," the nature of which is still unclear, accumulate during the to-be-estimated period (Gibbon et al., 1984; Thomas & Weaver, 1975). Pulse accumulation starts when the target period begins and stops with its end, such that pulse number increases regularly as a function of time. The judgment of time is thought to depend on pulse number. This number, however, does not depend only upon objective time, but is sensitive to various factors that may induce systematic errors. Description of the error trends and investigation of the error sources are major goals of psychological time research. It has been demonstrated that important sources of errors are due, first, to the amount of attention that one devotes to temporal parameters while performing the timing task, and secondly, to activation factors.

### **The effects of attention**

We are all aware that our feelings on time passing may vary depending on whether we pay attention to it or not. Everybody, some day, has been occupied with an absorbing task and, when the task was over, hardly believed that time could have passed so fast! The elapsed period was thus felt much shorter than it was according to clocks. This commonplace experience has been confirmed in a great number of laboratory studies designed to strictly control the factors at work. Many of these studies are based on dual-

task requirements. An example of this corpus of data is worth describing, since it is one of the arguments used to validate the existence of a cumulative internal timer.

The principle of the dual-task procedure is, obviously, to perform two different tasks simultaneously. For instance, the participants, tested individually, may be required both to estimate the duration of a target period, and during this period, to read words appearing on a video screen. They are carefully explained that both tasks are important. When the experiment starts, a brief auditory cue is delivered, signaling that the target period begins. Then, one by one, various words are briefly presented on the screen. These words belong to different semantic categories (vegetables, fruits, animals, ...). The participant, who has been given a digital board, must indicate how many animal names were delivered during the target period by pressing on the appropriate digit at the end of this period (signaled by another auditory cue). In addition, the duration of the press is important, since the participant is required to make it equal to the duration of the target period. The participants, evidently, are not told how long the target period actually lasts (for instance, 10 to 20 s).

In this type of experiment, the results show that the temporal judgment is strongly affected by the level of attention paid to each concurrent task. One way to bring this effect to light is to present either difficult or easy words during the target period in different trials. With difficult words, the participants will devote more attention to the linguistic task, and, as a result, less attention will be left to the target duration. Focused attention is, indeed, known to be capacity-limited. The fascinating consequence of such decreased attention to the target duration is that this duration is felt to be shorter. For instance, a duration of 15 s may be judged to be 14 s long with easy words and 12 s long with difficult words. Another way to pinpoint the effect of attention in the dual-task situation explained above is to ask participants to focus either on the target duration or on the presented words, depending on trials. Surprisingly enough, fairly precise modulations in the level of attention devoted to each task can be obtained. The outcome is straight: the less attention is attributed to time, the shorter it is judged. A great number of dual-task studies yielding consistent results have been carried out in the past fifteen years (see e.g.,

Block and Zakay, 1996; Macar, 1996; Macar et al., 1994; Zakay, 1992).

These data are surprising at first sight. It is admittedly reasonable to expect larger errors as a result of decreased attention, but why are the errors in one direction only, rather than reflecting both temporal underestimation and overestimation? The result obtained suggests that something is lost when attention to time is reduced. Coming back to the idea of a cumulative timer, it means that some pulses might be lost during the target period. A possible interpretation is that pulse accumulation is momentarily interrupted each time attention is detracted from time (for instance, in the dual-task described above, it would be interrupted each time a word is presented, and the break would be longer for difficult than easy words because the former ones need more processing time). Consequently, the number of pulses accumulated at the end of the target period would be the lower the lesser attention has been paid to time, thus inducing large temporal underestimation.

So far, dual-task studies have been run with durations comprised between half a second and a few minutes. Whether longer periods obey the same laws, pointing out the critical role of attention in time judgments, is unclear. Our current feelings that the more we are occupied, the faster time passes, seem to concern rather long periods as well ... Such feelings are not sufficient, however, to demonstrate that identical mechanisms are involved. Further research will tell us more.

### Activation factors

In addition to the effects of focused attention, the role of activation factors in time estimates is well known. An amusing anecdote is illustrative in this respect. In the thirties, the physiologist Hoagland (1935) reported observations concerning his own wife. One day as she was ill and feverish, she complained that he had been gone for a long time when he came back from the drugstore after an actually short trip. Very perplexed, he requested from her various time judgments, such as counting at the rate of one per second, what she did ... in less than 40 seconds. After recovery, her counting rate was more accurate. This story led Hoagland to postulate the existence of a temperature-dependent chemical clock in the brain.

A number of experiments were readily designed to test this idea. Various means were used to raise or lower volunteers' body temperature (hot clothes or rooms and cold baths, among others) and the expected effect on subjective time was generally obtained: The duration of external signals seemed to be longer when temperature increased, as if the hypothetical internal clock ran faster (for review, see Macar, 1980 or Wearden & Penton-Voak, 1995). In terms of pulse accumulation, it is as if more pulses were produced in a constant period. Even though the exact mechanism of this effect is still unclear, it is typically interpreted as reflecting the influence of the organism's level of activation on temporal processes.

Another argument in favor of this interpretation derives from the effects of drugs on time judgments (see e.g., Meck, 1996). Stimulants such as amphetamines entail overestimation of the duration of external signals, whereas sedative drugs have opposite effects. These findings have been repeatedly confirmed in animals as well as in humans. They suggest that our internal timer is influenced by certain factors acting on brain metabolism or on the conduction speed of nervous impulses.

### Specialized brain structures?

An important question is whether certain brain structures are more involved than others in the processing of brief durations. Several research teams, considering together the data brought by behavioral experiments, the consequences of brain lesions and the outcome of brain imagery techniques, now answer this question positively.

First, the effects of attention on time estimation are believed to be mediated by prefrontal regions. Frontal lesions are known to provoke marked attentional deficits in humans (review in Furster, 1989). These deficits are not limited to temporal tasks; rather, they are visible in many different conditions. For instance, frontal patients may pay little attention to questions and be unable to answer if these are not repeated. They may also draw low benefit from the information provided to correct their performance in certain motor tasks. In addition to neuropsychological studies on patients, the recording of electrophysiological brain indices in healthy humans or animals also provides interesting information.

Definite changes in the activity of prefrontal neurons have been found in monkeys that accurately controlled the duration of a motor response. As the monkeys had to hold a key pressed for a fixed period, the temporal course of their neuronal firing patterns appeared to be related to their temporal performance (Niki & Watanabe, 1979). Other electrophysiological indices, reflecting more global changes in brain activity (such as slow changes in surface brain potentials) have been recorded in human subjects. They confirm that frontal regions are most active when one is engaged in the estimation of brief durations (Elbert et al., 1991). In addition, they show that modulations in the level of prefrontal activation may be related to the participant's degree of accuracy (Casini & Macar, 1996). Finally, more recent brain imaging techniques, such as positron emission tomography and functional magnetic resonance imaging, offer congruent data concerning the involvement of frontal and medial central areas in various timing procedures (Coull et al., 2004; review in Macar et al., 2002).

The role of subcortical structures in time processing is also more and more documented nowadays. Parkinson's disease seems to include some timing problems (for review, see Harrington & Haaland, 1999) among the various deficits, essentially of motor nature, that it induces. This disease is known to depend on defects of the *substantia nigra*, a small subcortical structure connected to the *striatum* and to other nuclei of fundamental importance in sensorimotor integration. Neurons in the *substantia nigra* secrete dopamine, a chemical neuromediator whose key function in the temporal accumulator mechanism is suggested, among others, by pharmacological studies (Meck, 1996).

In sum, several brain structures seem to intervene together in time processing. Fronto-striatal loops are of major importance, and inspire much current research. Such loops might account both for the temporal accumulator and for its dependency on attention factors (Meck, 1996). Other brain structures critical to time processing must also be mentioned, such as the cerebellum (Braitenberg, 1967; Ivry, 1993). This structure plays a major role in motor mechanisms, and probably also in higher order cognitive processing, as suggested by recent evidence (Ito, 1992).

All these brain structures, obviously, underlie a vast array of behaviors, and thus cannot be said

to be specific to time processing. Nevertheless, they might play a definite role in one feature of this processing, among their other functions. Is it reasonable to imagine, in particular, that the accumulator function, pointed out by so numerous data, depends on one limited system or on one neuronal network within one particular brain structure? Several specialists of time processing consider this problem. It should soon be clarified by the multidisciplinary research in progress.

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## Part II.

### Memory in Time



# Piaget's View on Memory in Relation to the Passage of Time

Walter J. Perrig

## Introduction

Memory is not a prominent concept in the work of Piaget, even though he and Bärbel Inhelder published a voluminous work on "mémoire et intelligence" (Piaget, Inhelder & Sinclair, 1968). If I refer here to *Piaget's work*, this is just for simplicity and we should not forget that his collaborators also made substantial contributions. It is beyond the scope of this paper to identify all the individual contributors. But there is one person, Bärbel Inhelder, who needs to be mentioned, especially for what she has contributed to the topic of this paper.

Piagetian research focused on the genesis of intelligence or the genesis of the operations of thought. This happened at a time when a long tradition of research had already been devoted to the laws of memory. Nowadays, memory research commands a dominant place in cognitive research. For this reason, and in the context of the 100th anniversary of Piaget, it is timely and appropriate to review his contributions on memory. This is a both fascinating and challenging task, as Piaget is not among those authors cited when the basic insights about memory functions are discussed. To approach this task we will start with a general outline of Piaget's work on memory. These insights will then be related to the current research on how memory functions are conceptualized. Needless to say owing to the special dedication of this book I will also pay close attention to the role "time" plays in Piaget's memory research.

## Memory and intelligence

The Geneva group considered their approach to studying memory, in contrast to the long tradition of memory research, as somewhat unusual. However, their work does not include extended discussions of the literature that would have been available at that time. There are only short references to Ebbinghaus (1885) and Bartlett

(1932). Against this background they labeled their work as that of "subjective behaviorists" (Inhelder, 1969). According to their view, their thinking should be much more than "subjective mentalism," given that previous studies should already have demonstrated that it is possible to study the results of thinking activities in an objective fashion. In contrast to the strict behavioristic tradition, they were mainly interested in the internal mechanisms of transformations between stimulus and response. Piaget did not follow the experimental tradition of manipulating the spatio-temporal and meaning constellations of the stimuli to discover new laws or conditions for optimal memory performance, rather he focused upon the operations and transformations of internal and unobservable events. More specifically Piaget was interested in the relations between memory and schemes of intelligence. And it goes without saying that his analyses were restricted to observation and experimentation with children.

There are different sources for studying Piaget's research and thinking on memory: Piaget, Inhelder & Sinclair (1968) and Inhelder (1969) concentrate directly on the topic of memory. But of course this research on memory was related and influenced by criteria and laws of development in line with the cognitive structures that were known to them from previous research (Inhelder & Piaget, 1964). Thus, Piaget's memory research is closely related to his concepts of the development of thinking in classification, seriation, and conservation, to the representation of space (Piaget & Inhelder, 1956), numerical and geometric notions (Piaget, Inhelder & Szeminska, 1960), and to the study of mental images (Piaget & Inhelder, 1966).

The question concerning the relationship between memory and intelligence poses first the problem of terminology and conceptual distinction between what is meant by "memory" and what are to be considered as schemes of intelligence. When Piaget compared memory with perception, as a taking up of available facts, he

reasoned that memory could be considered as a direct image of what has been taken up or experienced in the past. Recognition could simply consist of two parts: perception on the one hand and an analogue remembering on the other. But this view is rejected already at the outset by Piaget as he takes into consideration the fact that perception is not a passive perceptive function but embraces organizational processes that are mediated by a schematization allowing interpretation or assimilation. However, the schemes themselves also have to be stored in memory. Should we then call everything that is responsible for the conservation of the past memory?

Piaget's answer is yes and no! He argues that everything that constitutes an individual's past might be called memory, including genetic information. But clearly this phylogenetic "memory" is quite different from an individual's act of recognition or evocation (free recall). He distinguishes different meanings in the use of the term "memory": Firstly he refers to the broad meaning of memory in a biological sense, if one uses memory for the conservation of every learned reaction, even e.g., for the production of antigens in the process of immunization. From a perspective closer to psychological processes, he argues that even inborn functional mechanisms might well be responsible for the memory of special perceptive forms of simple geometric types of figures.

Secondly, Piaget interprets memory at a behavioral level, as the term memory can be used for all conservations of habits, products of learning, recognition phenomena and evocations of memory images. In this context, the use of a habit implies sensomotoric schemes that are activated by some proprio-receptive and extero-receptive cues that are themselves parts of recognition processes, as well as all schemes themselves can be grouped under the concept of memory.

But Piaget also argues for a more distinctive use of the term memory: He uses the term of "memory in a broad sense" for the conservation of schemes. This is the ability of a subject to reproduce what is in a sensomotoric, conceptual or operative scheme. In this context, it is important to distinguish between a scheme and a schema in Piaget's terminology. A *scheme* indicates the general structure of actions and operations (e.g., the organization of actions that allows for the arrangement of structured series). A *schema*, in contrast, refers to an imagined representation of

the result of an action. For Piaget "memory in the strict sense" is every reaction that is based on recognition, if an object is present, or reactions that rely on evocation, if the object is absent. When Piaget studied memory, his observations were limited to types of behavior such as recognition, reconstruction, and particularly evocation of particular events located in the past. These particular memory images, which contain situations or events that are unique and located in the past, have clearly to be distinguished from acquired knowledge such as schemes that are general. There is a clear distinction between memory (in the strict sense) and conservation of schemes. Schemes can be actualized in the present without reference to the past. Recollections can accompany the activation or the use of schemes, but this is not necessary. So, a habit, for example, or the scheme of a seriation, can be applied without any remembering. From a developmental perspective the assumption is important that, until the age of 12 to 18 months, children have already acquired a whole set of schemes before there is a memory that allows evocation of the past.

But in turn what is necessary for the application of a scheme is some sort of recognition of analogies of situations. Thus recognition comes before evocation. Piaget distinguishes two types of recognition. The first type is strictly mnemonic and is shown in the perception of an individual object. This type of recognition is realized, e.g., in the case where a baby recognizes his mother and distinguishes her from other persons. The second type of recognition is on a precategorical level and is in any case schematic: It is the assimilation of a situation to a scheme, e.g., if a child cognates an object that is suspended as other objects that he has seen before which can be put in a swinging movement. This process of assimilation is continually reproducing and generalizing. Piaget always distinguishes this process of schematization from the memory process. Schematization represents the internal organization and dynamics of behavior. The conservation of this organization is just the expression of its activity, while memory is a figurative or symbolic reading, or a reconstruction of the results of this activity.

If I pause here to evaluate Piaget's conception of memory, presented so far, I have to admit to a deep respect for his excellent demonstration of how important analytical thinking can be as a

basis for or the beginning of empirical work. His analytical approach could be taken as exemplary in undertaking memory research. This is perhaps exactly what makes Piaget's work so fascinating compared to the main procedures known and established in experimental psychology.

If we compare his argumentation with current thinking in experimental memory research, we realize that actual research contributions are not characterized by these kind of elaborated terminological distinctions. Unfortunately, I would like to add, as it is clear to me that this kind of reflective thinking is not only a question of semantics, but it demonstrates the intense will to adopt a system of definition that points out problems rather than hides them. To mention just one example of a problem, to me it would not only be a question of semantics if we asked ourselves whether we should use the term memory for priming effects as well, or whether it would be more helpful in conceptual terms to spare memory for more specific functions or phenomena of remembering.

To make this point clearer we should now ask how Piaget's view of memory relates to the actual theoretical discussion about memory functions. From what has been said above, many distinctions that are important in theories of memory today are laid out and can be identified in Piaget's theory. For example:

- (1) the distinction of episodic and semantic memory (Tulving, 1972) that can be rephrased as: *memory images, that contain situations or events that are unique and located in the past versus acquired knowledge as schemes that are general* (in Piaget's terminology),
- (2) the distinction of explicit and implicit memory, or declarative and procedural memory (Squire, Knowlton and Musen, 1993), *recollections with clear reference to the past versus application of a scheme without any remembering* (in Piaget's terminology),
- (3) the distinction between memory recognition and other forms of recognition (Jacoby & Dallas, 1981), *mnemonic recognition of an individual object versus activation of habits or schemes by some proprio-receptive and extero-receptive cues* (in Piaget's terminology).

The impact of a theoretical approach cannot be conclusively evaluated at the level of termi-

nology. We have to ask what the verbal description is referring to, and whether differences are located only at the level of naming, lexicality, or whether there is a deeper conceptual difference that can be identified and contrasted. It would be quite easy, e.g., to accumulate statements of other scientists, maybe back to the Greek philosophers, referring possibly to a similar, or a common, phenomenon. But again the question is, what do we gain from the insight that "Aristotle already said..."? Certainly such references never make actual research activities negligible. However, progress in science is not determined by whether a phenomenon is known or not to somebody else – or even to everybody else – out there. Progress has to be measured by whether and to what extent a phenomenon can be explained. To return to Piaget's work on memory, it is necessary to look now at the operational level and ask how he studied memory, and to what kind of more specific conclusions he came.

### The investigation of memory

In outlining Piaget's experimental approach I will present just one typical procedure to investigate memory of a serial configuration. Other domains of investigations included: memory of horizontal levels of liquid, for numerical and spatial correspondences, for situations involving causal relationships, of configurations involving arbitrary combinations, of classifications, geometric transformations, and of transition of movements. The general feature of Piaget's method was a visual presentation of the stimulus setting at the beginning of the investigation. An intentional learning instruction made sure that the children looked at the scenes in order to be able to report later on what they had perceived. Memory was then measured immediately and/or after one week, and again after several months. Memory performance is then reported by age groups or operational levels, which had been measured for each individual on different tasks.

The procedure to investigate memory of a serial configuration was as follows: Children of three to eight years were shown a configuration consisting of ten sticks of 9 cm to 15 cm in length. The sticks were arranged in a series from the shortest to the longest. The children were told to look carefully at the sticks and remember

them later. No time limit was given. After one week they were asked to indicate by gesture (draw with the finger on the table) what they had seen a week before, and then were asked to draw from memory what they had seen previously. Six to eight months later the children were again asked to draw from memory what they had seen previously. Some children were asked to describe the series verbally. After the children finished their memory drawings, they were given sticks and asked to make the seriation themselves. This task was used to determine the level of operativity of every child.

### Findings and theoretical integration

The data of these investigations on memory of a serial configuration is presented as a distribution of the children's performance (in percentages) in a 3x4-table where 4 operational stages (preoperational, transitional, empirical seriation and operational seriation) are combined with 3 types of memory. The drawings from memory were divided into a sequence of types of organizations. The types of drawings corresponded closely to what the children did when they were asked to make a series with the sticks, and of course the children's performance correlated with age. The youngest subjects, three to four years old, drew a number of sticks lined up that were of equal length (type 1). The drawings of children in the next age group, four to five years, showed different features (type 2: e.g., all the sticks were divided into two classes, one big, one small), which distinguished them from the drawings of the third group of the six to seven years old, which showed correct serial configurations (type 3). It was also noted that the verbal descriptions fell into four distinct groups. So, e.g., one child said "This one is short, this one is long, this one is short, this one is long," obviously describing two classes of sticks, which relates to a feature of drawings of the second type, that is found most frequently in the transitional stage of operational development.

A second finding, reported in several investigations using different stimulus settings, is important for the characteristics Piaget attributes to memory: After an interval of six to eight months, most of the children (90% of children between five and eight years) made drawings that showed progress relative to the first draw-

ing. This progress was always gradual. Subjects progressed from one substage to the next on the operational level. Finally we have to mention a further fact, which Piaget has found repeatedly: That is the clear advance of reconstruction or recognition over evocation. In his total sample he observed improvement for 50 percent of the subjects, and on relearning this rose to 70%.

### *Schemes as memory codes and their influence over time*

From Piaget's data it seems clear that memory images are linked to operational schemes and that these schemes control the images and dominate the perceived model. Piaget's interpretation of the results is straightforward: It is clear that the memory image is not a simple residue of the perception of the model, but rather a symbol that corresponds to the schemes of the child. What seems to happen is that the child interprets the seriation as a possible result of his own actions. During the interval between the first and the second evocation, the schemes themselves evolve as a result of their own inherent functioning through the spontaneous experience and actions of the child. Thus, the action schemes - in this particular case, the schemes of seriation - constitute the code for memorizing. This code is modified during the interval and the modified version is used as a new code for the next evocation. This means that at each stage, the memory image is symbolized according to the constraints of the corresponding code. So far, Piaget's memory research demonstrates that memory images, measured in evocation and reconstruction, are not copies of reality, that reconstruction and recognition allows more accurate performance, and that the structure of the mnemonic code varies with the passage of time.

In the light of the available findings in memory research Piaget's results do not surprise, nor would they win prizes for novelty. Knowledge regarding the constructivity of memory is well established and corroborated by hundreds of experiments. The same is true for the better memory performances in recognition or reconstruction compared to performance in free recall. What stands - at first glance, in contrast - with well known decay functions, described as memory laws, are the reported improvements of memory performance over long time intervals. In this context it has to be men-

tioned that today many excellent studies are available on reminiscence (better overall recall in a later test) and hypermnnesia (recall on a later test of previously unrecalled items). A review of this research area is given by Roediger (1994). Retesting in these studies in general happens after short intervals. Correspondingly the theoretical frame differs from Piaget's, who observes developmental changes.

The improvements in memory found by Piaget come from the development of the operational stages of the children. These effects have to be positive if the original presentation setting corresponds to the schematic structure, and there will be distortions, and thus a loss of memory, if the original presentations contained divergent features. If the code were fixed, one might suppose that the memory would show greater deterioration the greater the interval of time. From the developmental perspective we have to assume that these action schemes that represent the memory code become more and more fixed in adulthood.

What then is the special contribution of Piaget's work on memory? The most prominent feature of his memory research is the intention to localize the function of memory in the context of the whole system of cognitive functions. Thus, the design of the experiments as well as the results are related to the general structure of intelligence and thinking and its development. His findings demonstrate that, in the context of development and learning, memory is not simply a conservation of what has been learned. Memory itself and memory performance is also ruled by the very same organizational principles that constitute actions, thinking and intelligence. From this perspective, the schemes, these organizational units, have to be considered not simply as the product of learning. Although they do adapt to demands of the environment continuously (accommodation), they do this only within the constraints of inner organizational principles and processes. Piaget demonstrated how these principles become memory codes that control memory performance. This schematization is the basis for the constructive plasticity of memory performance, and thus only a part of what is considered a memory image belongs, strictly speaking, to memory. But still the interesting question remains, what is the unique function of memory? Memory images conserve a number of unique, concrete, and experienced

situations in which schemes functioned successfully or not successfully. Because schemes are general, it is memory that allows differentiation. Although the coexistence and interactions of operative elements of schemes (in their generalizing function) and the figurative elements of memory (in its individualization of past experience) are discussed in Piaget's conclusions in a convincing overall view, much remains speculative as many assumptions – or rather convictions – lack concrete experimental demonstration.

### *Memory and recollective experience in remembering*

How does Piaget's view relate to modern theories of memory? Memory research has demonstrated that past experience affects us in many ways. For example, it influences the ease of identifying stimuli, changes the probability that we will have certain thoughts, affects emotional responses such as preferences, manifests itself as expert or semantic knowledge, and creates the potential for what we suppose to be memories of autobiographical events from our personal past. Concerning performance controlled by recollective experience, today we have theoretical frameworks that mirror the view on how memory performance can be influenced by different factors. Tulving (1983) describes a process called *ecphory* by which cues combine with trace information to yield a combined product called *ecphoric information*. Tulving suggested that recollective experience may range from clear and precise to vague and fuzzy, and that subjective feelings of pastness and truthfulness of memory must be provided by intrinsic properties of *ecphoric information*. Thus, Tulving has emphasized the idea that information is not simply accessed, but combines with cue information in a joint product that is the input to further processing. Also in Tulving's theory, considering recollective experience raises the issue of the distinction between memory and decision processes.

There is another approach, the source-monitoring framework (Johnson, Hashtroudi & Lindsay, 1993), that takes Tulving's notion as axiomatic and that further attempts to characterize the qualitative nature of this *ecphoric product* and the factors that enter into its conversion into a feeling of pastness, veridicality, and belief in source. Identified cues thus far are classified as

sensory/perceptual information, contextual (spatial and temporal) information, semantic detail, affect, and cognitive operations. These insights are highly relevant for theoretical and practical reasons in domains like eyewitness testimony, and false or repressed memories (Ceci & Bruck, 1993; Loftus, Coan, and Pickrell, 1996), which are hotly debated topics, even outside the research domain. Concerning children's memory Piaget's conception is very valuable and it would be worthwhile to follow and to investigate it further. His experimental approach of repeatedly interviewing subjects after varying delays, and especially longer ones, could be a paradigm that would shed new light on different memory phenomena. This research strategy has been used in the older tradition by Bartlett (1932) and newer studies on the misinformation effects (Loftus, 1979). This paradigm, combined with the *ecphory*, or the source-monitoring approach, would, for example, allow the relationship between time and memory performance to be studied precisely. The misinformation effects demonstrate the influences of extero-receptive information that comes in between the original perception and later recall. While the schema theories of Bartlett and Piaget concentrate on the organization and function of information packages within the subjects, the theory about the misinformation effect does not primarily focus on the structure and function of some special type of knowledge structures. That is not to say that the misinformation effects wouldn't allow inferences on the representational characteristics of the experienced past to be drawn. In fact the assumption is made that memory structures are changing as time passes, as in the view of Piaget, although for different reasons.

### *Schema theory in progress*

Where do the differences in Piaget's work compared to Bartlett's approach and to the misinformation paradigm lie? Certainly Piaget's investigation is closely related to Bartlett's thinking, at the operational as well as on the theoretical level. Both had an informal way of conducting and reporting their experiments. Both were concerned that the experimental conditions should be as natural as possible and did not worry much about replicable, stable experimental conditions. There are few statistics and little data aggregation. Their studies reflect features of memory

that are of real importance in everyday life. They explore these features with original tasks, great skill, and sensitivity. From these explorations they derive their notions about effort after meaning, use of inference and intelligence, reconstruction and schema that helped to form our understanding of cognitive functions. Concerning the notion of schema, Bartlett's term does not coincide either with Piaget's terms *scheme* or *schema*, though it comes closer to *scheme*. There, Piaget is unique in showing how the genetic characteristic of schemes in children goes together with their memory performance.

There is another difference between Piaget and Bartlett. Bartlett mainly demonstrates distortions or impairment brought about by schematic knowledge while Piaget shows memory improvement mediated by developing schemes. Interestingly there is an English researcher, Ballard (1913), whose finding clearly contradicts Bartlett's result and anticipates Piaget's observations. As far as I can see, and astonishingly, neither Bartlett nor Piaget made reference to these studies although both could have known of them. Ballard used poetry with schoolchildren as subjects. He found that the children in later trials recalled material they could not recall before. It would be challenging to study the exact relationship between effects of reminiscence or hypermnesia and Piaget's memory improvements. But certainly there would have to be more systematic experimentation devoted to the influence of schemes, in Piaget's sense, and of other forms of episodic memory or semantic-knowledge activation processes. There is also the question of how much extero-receptive information contributes towards improved performance.

In the last few years, schema theory has attracted a certain amount of criticism, as researchers from psychology and artificial intelligence have come to realize its limitations. Schemata as fixed memory structures or codes that are pulled out for use on demand are not very helpful for understanding human cognition and intelligence. What they lack is flexibility and context sensitivity, without which neither memory nor intelligence functions well. Meanwhile approaches are available that relate memory performance to knowledge structures. Kintsch's construction-integration model (1988), for example, assumes that understanding text can be considered in terms of a knowledge activation

model, where the initial processing is strictly bottom-up. That is: Text meanings are activated, associations are build up, and inferences and elaborations are produced without regard to context. Dependent on the context, however, a network of interrelated items is created in this manner, which can be integrated into a coherent structure through a spreading activation and a context-sensitive integration process (Kintsch, 1988) by strengthening adequate meaning and inhibiting irrelevant information. We can expect that the organization of the underlying semantic net as well as the context-sensitive integration process is highly relevant for memory processes. This is a way of studying the construction of schemata afresh.

From this we learn once again that memory cannot be dissociated as a separate ability from other cognitive functions, or, as Piaget would have stated, from the functioning of intelligence as a whole. We would all agree that the problem regarding the relationship between memory and intelligence remains to be analyzed in greater depth and with greater precision than in these, what Piaget calls, preliminary investigations. And we all also agree that there is more to memory than just remembering. Personal experience and general knowledge, reproduction and reconstruction are all aspects of memory but require their own methods of study and analysis. In this endeavor – as I hope I have shown – Piaget's terminological analyses, as well as his thinking on memory, memory images and schematization, and his retest-procedure, combined with the parallel measurement of cognitive functions outside of memory in the strict sense, provide valuable hints and ideas that are far from being fully exploited yet.

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# Time as a Factor in the Development and Decline of Mental Processes

Timothy A. Salthouse

The theme of this chapter is that it is meaningful to think of time as increasing and then decreasing as a function of age. Of course I am not referring to time in an objective physical sense, but rather functional time in the sense of the amount needed required to carry out many cognitive operations. Several years ago Robert Kail and I (Kail & Salthouse, 1994) suggested that time can be viewed as a processing resource that alters with age if changes occur in the time needed to execute operations since fewer operations will be able to be completed in a given period of time. In this chapter I will elaborate on this perspective, and will summarize some relevant empirical research concentrated on the adult portion of the lifespan.

I will begin by documenting the lifespan growth and decline of this resource-based conceptualization of time. For this purpose I will use several measures from tasks that are so simple that accuracy is nearly perfect, and consequently virtually all of the variation across people can be assumed to be in terms of how quickly the items can be performed. The first figure portrays results of measures from two perceptual speed tasks from the Woodcock-Johnson Test of Cognitive Abilities (Woodcock & Johnson, 1989, 1990) expressed in standardized units. Notice that there is a rapid increase in the period of childhood, followed by a gradual decrease across the adult years. This phenomenon is evident with a variety of different tasks, and strongly suggests that there are substantial age-related differences in measures that might be hypothesized to reflect the time required to execute elementary cognitive operations.

An immediate obvious question is why are measures of time important? Many other lifespan changes presumably have no consequences for cognition, such as running speed, bicep diameter, lung capacity, and the color of one's hair, and thus it is reasonable to ask what is special about measures reflecting speed of processing.

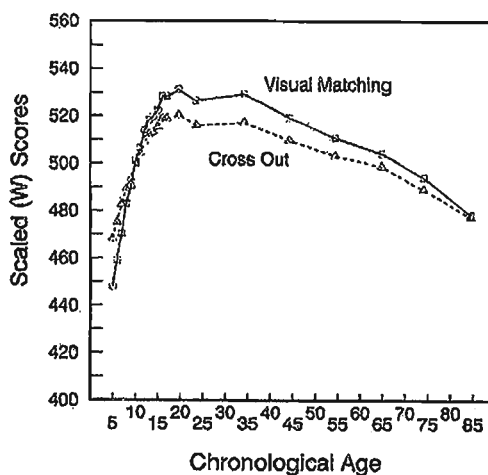


Figure 1: Mean performance between 5 and 95 years of age on two perceptual speed tests from the standardization sample in the Woodcock-Johnson Psycho-Educational Battery.

I have two responses to this question. First, I will argue that time is unique because plausible theoretical mechanisms have been proposed by which slower processing can affect cognitive functioning. And second, I will describe empirical evidence indicating that measures of processing time are actually involved in the age-related differences in many measures of cognitive functioning. The empirical evidence will be described first because discussions of hypothesized mechanisms are more meaningful when the to-be-explained relations have been established to exist.

The primary empirical question of interest is whether there is evidence for an influence of time or speed on the relations between age and various measures of cognitive functioning. The simple answer to this question is yes, but in order to understand the reasons for this answer it is important to briefly describe the types of analytical methods that have led to this conclusion.

Consider the general case of a potential mediator,  $X$ . In the present context  $X$  corresponds to an index of speed of processing, but it could be virtually any variable hypothesized to contribute to at least some of the age-related differences in cognition. How can one determine that age-related changes in  $X$  might be responsible for age-related changes in  $Y$ ? Several sets of relations could be investigated, such as those between age and  $X$ , between age and  $Y$ , and between  $X$  and  $Y$ .

But how can one determine whether, and to what extent, the relations involving  $X$  actually contribute to the observed relations between age and  $Y$ ? The mere existence of each relation is not sufficient because a great many variables are related to age, but it is unlikely that they are all involved in the relations between age and variables reflecting cognitive functioning. For example, both gray hair and poor memory are often related to increased age in adulthood, and in an age-heterogeneous sample they might be found to be related to each other merely because both are associated with increased age. However one could not conclude that gray hair mediates the decline in memory that often accompanies increased age because all of the relevant relations need to be considered simultaneously. That is, evidence is needed to establish that the combination of relations between age and  $X$  and between  $X$  and  $Y$  do in fact contribute to the observed relation between age and  $Y$ .

Three major techniques could be used to investigate the hypothesized linkages (see Figure 2). All involve examining the relation between age and  $Y$  after eliminating or controlling the relation between age and  $X$ . In each case the expectation is that the relation between age and  $Y$  will be greatly reduced or eliminated if much of it is mediated through  $X$ .

One possible strategy consists of some type of experimental intervention to alter the level of  $X$ . Ideally the intervention would operate by improving  $X$  in older adults to the level of young adults, and thereby eliminate the relations between age and  $X$ . Experimental manipulation is clearly the most convincing way to establish the existence of a causal relation because if  $X$  is the only variable that has been altered then it must be responsible for the observed differences. Unfortunately, intervention approaches may not be feasible in the present context if the  $X$  variable changed slowly over a period of many decades. Not only might

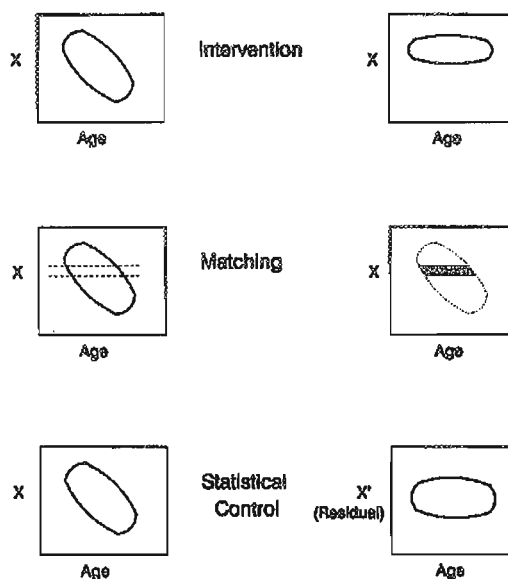


Figure 2: Schematic illustration of three techniques that could be used to eliminate the variation between age and some variable  $X$ .

interventions be ineffective in reversing changes that were slow and gradual, but if the change in  $X$  occurred gradually, it may have been accompanied by numerous adaptations that might not be easy to eliminate even if it were possible to restore the level of  $X$  to the earlier state.

A second possible strategy involves the use of matching by attempting to find people of different ages who have similar values of  $X$ . Although seemingly straightforward, this procedure also has at least two major limitations. First, when trying to match on a variable that has moderate to large relations with age, as is expected to be the case with  $X$ , the matched samples will likely be small and the range of ages probably restricted relative to the entire sample. Both of these factors will lead to low statistical power to detect relations between age and  $Y$ , and consequently the hypothesis of attenuated relations between age and  $Y$  might be supported for artifactual reasons. The second limitation of the matching procedure is that there is no assurance that the matching is only on the intended variable  $X$  because several variables may vary concomitantly with  $X$ , and one or more of them may influence  $Y$  in addition to, or instead of,  $X$ . To the extent that this is the case, one could not be certain that  $X$  was the critical variable responsible for the changes in  $Y$ .

The third strategy that could be used to investigate the role of a variable  $X$  in the relations between age and another variable  $Y$  relies on some type of statistical control. That is, statistical control procedures could be used to equate people of different ages on  $X$  by partialing out the linear relation between age and  $X$ . An advantage of equating with statistical procedures rather than through direct matching is that all of the available data can be used in the analyses, and thus there is minimal reduction in statistical power relative to the entire sample. Statistical control procedures also allow the influence of other measured variables to be examined and eliminated by similar partialing techniques. The primary assumption of statistical control procedures is that the relations between age and  $X$ , and between  $X$  and  $Y$ , are mostly linear, or that the variables can be transformed to yield linear relations. Once the linear relation is determined, it can then be used to adjust the values of  $Y$  to remove the influence of  $X$ , and allow examination of the relation between age and the portion of  $Y$  that is independent of  $X$ .

Because interventions do not yet appear feasible, and since matching leads to substantial reductions in power, statistical control procedures may be the most practical method for eliminating the influence of a hypothesized mediating variable at the current time. Two different statistical control methods can be used, both of which are based on related types of correlational procedures.

One method is known as commonality analysis, and it is useful for determining how much of the variance in  $Y$  is unique to  $X$ , how much is unique to age, and how much is shared between  $X$  and age. This technique is particularly helpful when partitioning the age-related variance because it can indicate how much of the age-related variance in the criterion variable ( $Y$ ) is shared with the hypothesized mediator variable ( $X$ ).

Various types of path analysis can function as the second statistical control procedure because they provide estimates of the relative strengths of paths from age to  $X$ , from  $X$  to  $Y$ , and from age to  $Y$ . The latter path is especially informative because it represents the influence of age on  $Y$  that is not mediated through  $X$ , and thus it can be used to estimate how much of the age-related variance in  $Y$  is not explained by the mediator ( $X$ ). Ideally the path analyses should be conducted with latent constructs and structural

equation modeling to reduce measurement error and minimize biases in the estimates of the magnitude of the relations. However, the analyses are still meaningful with observed or manifest variables, particularly if reliabilities are available to allow the estimates of the relations to be adjusted for measurement error.

In both commonality analyses and path analyses the methods are relevant to time-based interpretations if measures of processing speed are used as  $X$ , and measures of cognitive functioning are used as  $Y$ . Results from these procedures will be illustrated with perceptual comparison speed measures serving as the  $X$  variable, and measures of performance from three different cognitive tasks serving as the  $Y$  variable.

As mentioned earlier, perceptual speed measures are assumed to reflect how quickly elementary cognitive operations can be performed. That is, the tasks are so simple that few people make mistakes, and consequently virtually all of the variation across normal adults is reflected in the time needed to perform the tasks. Administration time for the measures can be as brief as 60 seconds, but estimates of reliability are often .8 or higher. Although I will be describing results based on paper-and-pencil procedures, it should be noted that similar patterns of results in commonality analyses and path analyses have been obtained with reaction time speed measures, and thus the conclusions do not seem to be specific to a particular method of assessing processing speed.

Results with three different criterion measures will be illustrated, and in each case the data were based on samples of 200 or more adults ranging from 18 to over 80 years of age. One of the criterion variables is the score on the Raven's Progressive Matrices, which is a popular test of inductive reasoning in which 8 of 9 cells in a matrix contain geometric patterns and the respondent is required to select the best completion of the missing cell in the matrix. A second criterion variable is the sum of the number of items recalled across the first five trials in the Rey Auditory Verbal Learning Test. In this test the same list of 15 unrelated words is read aloud five times, with the respondent attempting to recall as many words as possible after each presentation. A measure reflecting time and accuracy on the Block Design test from the Wechsler Adult Intelligence Scale – Revised is the third criterion variable I will describe. This test in-

volves the respondent attempting to assemble blocks to match a target pattern.

These three tests are obviously quite different, and they are generally assumed to reflect distinct psychometric factors (i.e., inductive reasoning, episodic or short-term memory, and spatial visualization). Each of the tests has been established to have good reliability, and scores on the tests typically exhibit moderately large age differences. The next figure illustrates results from studies conducted in my laboratory, with the scores in each test converted to standard deviation units from the entire sample to facilitate comparisons across variables. Notice that the range of performance from the youngest to the oldest age groups is almost two standard deviations with each variable.

The next figure illustrates results with commonality analyses (in the form of a pie chart depicting variance accounted for in the criterion variable) and path analyses (in the form of a path diagram with estimates of the relevant coefficients). Results from both sets of analyses are consistent with the interpretation that time to execute simple operations is an important factor in the age-related differences in cognitive functioning. This is apparent in the commonality analyses because estimates of the percentages of the total age-related variance shared with speed (i.e., the ratio of shared to the sum of shared plus unique-to-age multiplied by 100) were 98.1 for the Raven's variable, 73.2 for the Rey Verbal Learning variable, and 86.3 for the Block Design variable. The path analysis results are also

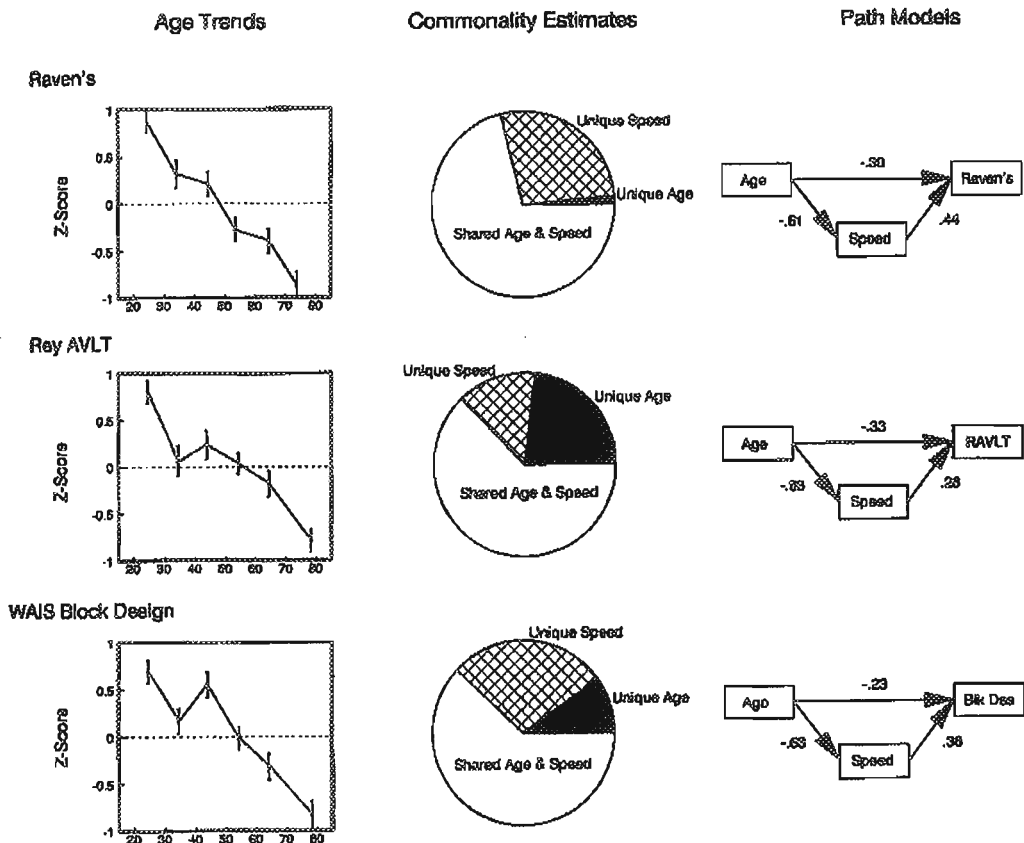


Figure 3: Mean standard scores (and standard errors) as a function of age for the Raven's Progressive Matrices (Salthouse, 1993), and the Rey Auditory Verbal Learning Test and Wechsler Block Design Test (Salthouse, Fristoe & Rhee, 1996). Also portrayed are results from commonality analyses and path analyses with these variables as criterion variables.

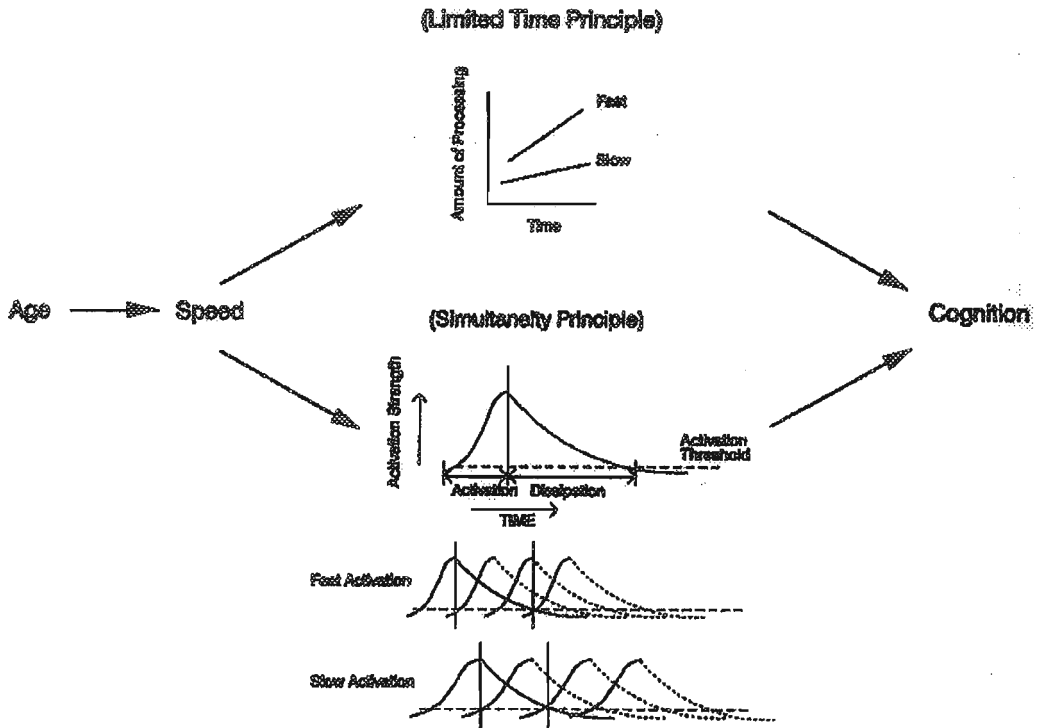


Figure 4: Schematic illustration of two hypothesized mechanisms that might account for the influence of speed on the relations between age and measures of cognitive performance.

consistent with the hypothesized speed mediation because moderately large coefficients were evident for the paths from age to the speed variable and from the speed variable to the cognitive variable. Moreover, in each case the direct or unmediated relation between age and the cognitive variable was substantially smaller than the corresponding correlation (e.g., for Ravens,  $-.30$  vs.  $-.57$ ; for RAVLT,  $-.33$  vs.  $-.50$ ; and for Block Design,  $r = -.23$  vs.  $-.47$ ).

The results just described clearly indicate that a substantial proportion of the age-related variance in several complex cognitive measures is shared with simple measures that are hypothesized to reflect how quickly simple processing operations can be executed. However, it is important to emphasize that not all age-related effects on complex cognitive measures are shared with simple speed measures. Results such as those I have just described are sometimes misinterpreted as implying that a single monolithic factor is responsible for all of the age differences observed in measures of cognition. In fact, an advantage of these types of correlational proce-

dures is that they allow the relative contribution of different types of influences to be determined, instead of focusing exclusively on whether the influence of a particular variable is different from zero, as is often the case with other analytical procedures. The results of these analyses, and of similar analyses of other data, suggest that measures of simple processing efficiency share large proportions of age-related variance with several different types of complex cognitive variables. They are thus consistent with the interpretation that factors related to processing speed contribute to *some* of the observed age differences in variables representing higher-order cognitive functioning.

Now that the relations involving processing speed have been established to exist, it is appropriate to ask about the mechanisms that might be responsible for those relations. I believe that at least two speed-based mechanisms, which are schematically illustrated in the next figure, are involved in the age-related effects on cognition (Salthouse, 1996). I refer to one mechanism as the *limited time* mechanism because if elemen-

tary processing operations take longer to be performed, then fewer of them can be completed in a given period. This mechanism is likely to be very important in timed tests, and especially those with low levels of difficulty in which performance is primarily assessed in terms of the number of items completed in the specified time. However, the limited time mechanism could also affect performance in more complex situations where a sequence of operations must be performed and slow execution of the early operations means that later, and possibly higher-order, operations are not successfully completed. A relevant metaphor for the limited time mechanism might be an assembly line in which if early operations are not completed rapidly, the products at subsequent stages may be defective.

Considerable evidence indicates that with increasing age less processing can be accomplished in the same amount of time. For example, this phenomenon is evident with manipulations of stimulus presentation time, with post-hoc analyses of the level of accuracy obtained at specified reaction times, or with functions relating reaction time to the amount of completed processing or to the number of operations that must be performed.

The second mechanism by which slower processing could lead to impairments in the quality of cognitive functioning is known as the *simultaneity* mechanism, and it may operate even when there are no external time limits. The critical assumption in this mechanism is that in order to be successful many higher-level cognitive operations such as association, integration and abstraction require that all of the relevant information is simultaneously available. If it is not all accessible when needed, then the operations may not be completed successfully, and the quality of the relevant performance will be impaired. Several factors probably affect the amount of simultaneously available information, but the time to activate the information is postulated to be a particularly important determinant.

It could be argued that if information remains in the same state of availability indefinitely then the completion of processing will merely be delayed when the speed of activation is slower. However, if information is lost through decay or displacement then there will be a limited period when all relevant information is available, with the duration of that period dependent on the dynamics of the speed of activation and the rate of

loss or forgetting. Moreover, because it is unrealistic to expect information to remain in a high state of availability indefinitely, speed of activation is likely to be a critical variable affecting the amount of information that is simultaneously available.

It might still be possible to achieve the same eventual level of higher-order products if the rate of loss of information was slowed to the same extent as the rate of activation. However, in order for this to occur the information must not be lost as rapidly in older adults compared to young adults, and there is no evidence to suggest that the rate of forgetting is slower with increased age. Instead most of the relevant research suggests that the rate of forgetting for older adults is either the same as that of young adults, or possibly even faster, but certainly not slower (see Salthouse, 1992).

Because it is difficult to obtain precise measures of the time course of information availability, very little evidence directly relevant to the simultaneity mechanism is currently available. Although this mechanism is largely speculative at the present time, it seems plausible as a mechanism by which slower speed of processing could lead to lower levels of cognitive performance.

### Summary and Implications

I will now summarize the major points of this chapter. First, I suggested that effective or functional time decreases with increasing age, and that it seems likely that this decrease has consequences for many types of cognitive functioning. Second, results from two correlational procedures were described that indicate that measures of processing speed are closely involved in the relations between age and several types of cognitive functioning. And third, two mechanisms hypothesized to contribute to the role of speed on cognition, limited time and simultaneity, were discussed. I believe that the combination of plausible argument together with relevant empirical evidence lends credibility to the time-based interpretation of developmental differences in cognition. However, much more research is clearly needed before this interpretation would be completely convincing. For example, more analytical research is desirable on the mechanisms that are responsible for the speed

mediation that has been established to exist. Finally, it is important to capitalize on the strengths of different methodological approaches, because both correlational and experimental procedures provide valuable information. For example, correlational procedures are useful to estimate the strength of relevant relations, and experimental procedures are useful to explore the nature of the mechanisms responsible for the relations.

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# Distortions of Memory and the Role of Time

Elizabeth F. Loftus

A famous story told by Piaget about his own memory distortion has long captured the attention of American psychologists, has inspired further research, and so it seems fitting to begin a chapter for a book celebrating the 100th year of his birth with a reminder of that story. I am referring to Piaget's classic childhood memory of an attempted kidnapping that had allegedly happened to him early in his childhood (Piaget, 1945/1962). The false memories appear to have stayed with him for at least a decade:

"... one of my first memories would date, if it were true, from my second year. I can still see, most clearly, the following scene, in which I believed until I was about fifteen. I was sitting in my pram, which my nurse was pushing in the Champs Elysées, when a man tried to kidnap me. I was held in by the strap fastened round me while my nurse bravely tried to stand between me and the thief. She received various scratches, and I can still see vaguely those on her face ... When I was about fifteen, my parent received a letter from my former nurse ... she wanted to confess her past faults, and in particular to return the watch she had been given as a reward ... She had made up the whole story ... I, therefore, must have heard, as a child, the account of this story, which my parents believed, and projected into the past in the form of a visual memory."

Piaget's story illustrates that it is possible to create a vivid memory in the mind of a child, which is why I found it useful to include in an early analysis of the controversy over repressed memories (Loftus, 1993). In Piaget's example, the false memory appears to have been created through a story told at that time, and perhaps through subsequent family retellings. It raises a question about the extent to which we are all prone to forming vivid but untrue images about things that happened in our past. Some researchers, who also have used the Piaget story in their

writings, have suggested that "All of us are prone to these types of confusions." (Ceci & Bruck, 1995, p. 201).

## Piaget's story inspires new research

The point at which Piaget's story took on special significance for me in terms of inspiring new research was when I began to ask whether one could plant a false memory in the minds of adults for entire events that had not in fact happened in the past. Piaget's illustration was one of an "implantation" that had begun in childhood, and had presumably stayed with him through his childhood until he was told of its untruth. This is different from taking an adult and injecting into that adult's mind a memory for something that had not happened in childhood, or that had not happened at an earlier point in the adult's life. I began to search for ways to do this, and developed a number of paradigms for false memory implantation.

## Ways of inducing false memories

In one line of work, we tried to plant memories for having seen an event on videotape that subjects had not seen. We induced subjects, via the technique of asking leading questions, to believe that they had seen a drugbust, and to provide a sometimes rather detailed description of it. Unlike the Piaget illustration, our subjects were all adults at the time that they received their suggestion about the drug bust, and the memory was suggested to have occurred two weeks earlier. Nearly 2/3 of our subjects appeared to buy into the false suggestions and claimed to have seen the nonexistent drug bust (see Loftus, 1997, for a brief description of this work).

In another line of work, we tried to plant memories for nonexistent childhood experiences. We induced subjects, via the technique of supplying them with information ostensibly ob-

tained from a trusted family member, to believe that they had been lost in a shopping mall or other public place, that they had been frightened and were crying, and were ultimately rescued by an elderly person and reunited with their family. Again, these subjects were all adults at the time that they received their suggestion about being lost, and the memory was suggested to have occurred to them when they were about five years old. Approximately one-quarter of the subjects appeared to buy into the false memory of being lost in this way, and to provide a complete or partial report of their created experience (see Loftus & Pickrell, 1995 for a description of this line of work).

One should not make the mistake of assuming that because more subjects bought into the false memory of seeing a recent drug bust than bought into the distant false memory of being lost that it is easier to plant a recent memory. The type of event was different, the method of suggestion was different, and the absolute levels of assenting to the suggestion can be influenced by all of these manipulations. Ideally, to reach firm conclusions about the ease of planting memories in the recent or distant past, all of these features should be held constant, and only the alleged time of the false event should change. In a somewhat different paradigm, one involving imagination exercises as a means of suggestion, this is exactly what was done, so I turn to the discussion of that work now.

### Imagination inflation

In one paradigm we required that our subjects imagine a counterfactual past, to see if the mere act of imagination could lead people to false memories. We showed that one simple act of imagining a childhood event increases a person's subjective confidence that the event happened to them in the past – a phenomenon that we called "Imagination Inflation" (Garry, Manning, Loftus & Sherman, 1996). In this study, subjects were asked about a long list of possible childhood events (e.g., broke a window with your hand) and they told us the likelihood that these events had happened to them as a child. We called this the Life Events Inventory (LEI). Two weeks later, subjects were instructed to imagine that some of these events had actually happened to them. And, finally, they responded for a sec-

ond time about the likelihood of that long list of possible childhood events, that is they took the LEI test again.

Consider one of the critical items on the LEI "broke a window with your hand." Some subjects imagined this experience in childhood. If they participated in the imagination condition, they were told: "Imagine that it's after school and you are playing in the house. You hear a strange noise outside, so you run to the window to see what made the noise. As you are running, your feet catch on something and you trip and fall." While imagining themselves in this position, subjects answer some questions such as "What did you trip on?" They were further instructed to imagine: "As you're falling you reach out to catch yourself and your hand goes through the window. As the window breaks you get cut and there's some blood." While imagining themselves in this predicament, they answer further questions such as: "What are you likely to do next?" and "How did you feel?"

We confined their analysis to items that subjects explicitly said were unlikely to have happened in the first place. We found that a one-minute act of counterfactual imagination led to positive changes in a significant minority of subjects. After engaging in this act of imagination, 24% of subjects increased their subjective confidence that something like this actually happened to them. For those who had not imagined the event, only 12% showed a corresponding increase. The other seven critical items used in this study similarly showed increased subjective confidence after imagination. These other critical items included negative experiences like getting in trouble for calling 911 (the telephone emergency number) and being pulled out of the water by a lifeguard, and positive experiences like finding a \$10 bill in a parking lot. Across the eight critical events that some subjects were asked to imagine, we found that there were more positive changes in imagined scenarios (34%) than in non-imagined ones (25%).

These findings show that even a single act of imagining a known counterfactual event can increase the subjective likelihood that the event happened in the past. Why does this occur? There are many possible explanations. One reason might be that an act of imagination might remind some subjects of a true experience, although post-hoc analyses suggest that this is not a very likely explanation for most of the

changed reports. A more likely explanation is that an act of imagination simply made an event more familiar when the second assessment was made, and that familiarity was mistakenly related to childhood memories, rather than to the act of imagination.

One question we next asked about imagination inflation was about the role of time. If one is induced to imagine a counterfactual past, how long does that imagination exercise persist in its influence over a person's assessment of his or her autobiography? Obviously you would not expect that this single simple exercise would persist forever.

### The timing of imagination

How long lasting is the Imagination exercise? In collaboration with Marcos Nunes-Ueno and Chuck Manning, we explored this question. One possibility is that imagination has its strongest influence when it immediately precedes the second LEI since the image would be the strongest, compared to imagination in the distant past. After all, the image would begin by being relatively clear but would be expected to fade over time – a simple forgetting phenomenon. Inflation might be strongest immediately. On the other hand when imagination immediately precedes the second LEI and the image is strong, it might be relatively easy for subjects to attribute any familiarity they feel about the LEI item to the image, and not to their earlier childhood. Inflation might be less strong immediately after Imagination than after some time has passed. Our study exploring these issues involved three time intervals. In one condition subjects had the imagining session immediately prior to the final LEI test. In another condition, subjects had the imagining session one week prior to the final LEI test. In the third condition, subjects had the imagining session two weeks prior to the final LEI test.

We found a non-monotonic relationship between timing and inflation. The greatest inflation effect occurred when the imagination session and the final test were separated by one week. The least inflation occurred when the imagination session was immediately followed by the final test. An intermediate amount of inflation occurred when the imagination session and the final test were separated by two weeks.

This makes sense if we think about the inflation mechanism in the following way. Immediately after imagining that you broke a window with your hand you may find it relatively easy to respond to the LEI item concerning this scene as you did before. Any enhanced familiarity you may experience over the item can be understood to be due to the recent image. On the other hand when a bit of time has passed (a week in this case), you may not remember as well that you imagined breaking a window, and you may be more likely to relate feelings of familiarity for the item to your childhood rather than to the imagination exercise. Finally, when more time passes, the impact of the single image will, at some point begin to fade, and should eventually completely fade. In an extreme case, one probably would not expect a single image of breaking a window in an experimental setting to influence childhood memories assessed over a year later. Imagination might conceivably have rather long-ranging effects if the subject were to repeatedly rehearse the image, or the imagination experience were to change other aspects of the subject's information processing. But in the absence of such happenings, one might not expect such a long-range result for such a simple manipulation.

Time also played a role in a different line of work in which imagination was used to influence past memory, but this time past memory for recent experiences. In this line of work, imagination instructions were used to make people believe that they have done things in the recent past that they did not in fact do (Goff, 1996; Goff & Roediger, 1996). The subjects took part in research that took place over several sessions. During the initial "encoding session," subjects listened to a list of action statements as they were read aloud. For each statement subjects were instructed to do the stated action, to imagine doing it, or simply to listen to the statement but do nothing else. The actions were simple ones such as these: Knock on the table, lift the stapler, break the toothpick, cross your fingers, roll your eyes. During a second "imagination session," subjects had to imagine various actions. Finally during a "test session," they had to answer questions about what they actually did during the initial session. The investigators found that, after imagination, subjects sometimes claimed that they had actually performed an action on the first occasion when they had

not. The more times they imagined an unperformed action, the more often they made this mistake. So, for example, in one study, after five imaginings, subjects claimed they had performed a non-performed action 13% of the time.

As for the impact of time, Goff and Roediger found that if the imagination session was very close to the test session, subjects were not very likely to claim that imagined experiences were previously performed. Presumably if subjects were trying to make a source monitoring judgment (did I do it or did I just imagine doing it?), they would have an easier time knowing that they imagined it if the imaginings had very recently been performed. They could readily attribute any experienced familiarity to the recent imagination rather than to a real experience from weeks earlier. As in our work on imagination inflation, the power of imagination was greatest when some time separated the imagination exercises from the final test session. It was then that the subjects could more readily be led to find the critical item familiar, and mistakenly relate that familiarity to a past act of performance, rather than to a past act of imagination.

One useful feature of the Goff/Roediger paradigm is worth emphasizing. In some of the studies that have used imagination to induce false childhood memories, one cannot be certain that the imagination exercise did not tap into a genuine memory and pull it forth. However, in the studies in which people are led to imagine that they performed some acts a week earlier, records show that these events were not performed, and any subsequent claims that they were had to, necessarily, be false.

#### Remarks about memory distortion and time

Taken together these newer studies add to our understanding of memory distortion and how it happens. They take us beyond the story of Piaget which illustrated so vividly the possibility that a repeated family story might lead a young childhood to have a persisting false memory. They reveal that it is possible to plant false memories in the minds of people for events that never happened to them in the recent past and for events that never happened to them in childhood. And, even in the absence of a direct suggestion from a trusted external source, we also see that by merely inducing people to imagine a counter-

factual past, we can also influence their beliefs that they had personal experiences that they never had.

Elsewhere I have discussed the important implications of these findings for the interactions of patients and their psychotherapists (Loftus, 1993; Loftus, 1997). The concern is that direct and subtle suggestion about the past might sometimes be leading some patients to develop false autobiographical memories that can be harmful to the patients and to their families.

But importance of these findings may extend to other life activities and have far-reaching consequence for those who are not involved in psychotherapy. Take writers for example. Consider the case of the American writer, Kathryn Harrison who published a memoir called *The Kiss*, about a lengthy sexual affair she entered into with her own father when she was about 20 years old (Harrison, 1997). As the memoir unfolds, it turns out that Harrison's parents conceived her soon after meeting at age 17 as virgins, and a hasty marriage was arranged. The father left the family when Harrison was only six months old, and she saw him only a couple of times until she was 10, and then not again until she was 20 when he visited while she was home from college. It was then that he kissed her passionately on the mouth as she was driving him to the airport, later called her constantly, and ultimately began the affair. It lasted until her mother's dying days, at which time Harrison broke off the relationship. A controversy erupted over the memoir long before it actually appeared in print (Shnayerson, 1997). Why did Harrison write about an affair she had as a consenting adult with her father? The author's publicist suggested that it was something that had haunted the author and that she needed to come to terms with it in this way.

But there is more to the story. Just a few years earlier, in 1991, Harrison published a novel called *Thicker than Water*. In the novel she tells the same story of the incestuous affair that she would recount in her later memoir. In both places, recounted identically, is the initial meeting of the parents at a particular theater. In both places is the story of the marriage, the childbirth and the divorce. In both there is a visit from the father when the child is 10. In both places there is the story of the affair that begins with the kiss at the airport. Only in the earlier novel does she give the detail that she and her father had inter-

course 41 times. In both places the dying mother plays a role in ending the affair.

At the time of the earlier novel, Harrison was asked explicitly whether this was a memoir in disguise and she denied this emphatically to several writers: "The author says the incestuous relationship forced upon the main character, Isabel, in that novel is completely a product of her imagination." (Shnayerson, 1997, p. 58). The writer who exposed this "wholesale lift," was clearly disturbed by it, and posed a number of questions.

If the author were haunted by the story, and needed to tell it in her memoir, why did she tell the story in so much less detail in the memoir than she had in the earlier novel? Why was the author not worried about reviewers discovering and being troubled by the double use? Was Harrison re-experiencing her victimization, and offering herself up to the world, as she had to her father, to get attention at any cost? The exposé writer posed another possible answer to his questions: Perhaps the author was troubled by the modest sales of her earlier books and was looking for a way to create something more appealing than the usual half-life memoir could hope for: A work that would stand as testimony for those similarly afflicted with similar experiences as the one she would be telling now. Today's readers, the exposé writer suggests, clearly want story tellers who feel as naked and alone as they do. In all of this discussion, however provocative, the writer seems to presume that the story is true. But is it not possible that the effort that Harrison put into imagining the story as it was being constructed for the 1991 novel led to some alterations in Harrison's own personal past memories that then found their way into her 1997 memoir?

#### A final note about Piaget's story

In 1996 I had the honor of giving a talk in Neuchâtel, Switzerland at a conference in celebration of the life and work of Piaget. The evening before the talk, the conferees were treated to a trip to the famous Watch Museum<sup>1</sup>. In the midst of my talk, as I spoke of Piaget's story, I was momentarily struck with one question that I could not get out of my mind and felt compelled to share with the audience. "What

happened to the watch? The watch that the nurse had received as a reward? Wouldn't it make a remarkable contribution to the collection at the Watch Museum?" Although Piaget's now-grown children were in the audience of my talk, and I hoped to discuss these questions with them during a conference break, time prevented that from occurring. However, Dr. Eduard Marbach, the Swiss philosopher, graciously agreed to contact the family and pose my questions to them. Here is his report (Marbach, 1996):

"... I have also attended the Centennial of Jean Piaget's birth Conference, The Growing Mind, in Geneva, and I have just come back. There, I had several times the chance to talk to the two daughters of Piaget, his son was not there as he had to go to France. Lucienne actually said to me, when I had explained to her what you would like to know, especially also what had become of the watch, that she only knew about this whole story from the film in which Piaget relates the story! You can imagine that I expressed some surprise at that, not only in my face, but by using (French) speech acts of the sort 'oh! is this so, I thought it might have been a subject of discussion in the family every now and then, but you think you only know about this from the film ...?!' Thereupon – you are the memory specialist and will know how to evaluate such a shift! – Lucienne appeared like making up her mind and then said something to the effect of 'actually, the story about the watch, as it so much amused my father, may well have been told by himself in the family so that I really learnt about it there ... And you know, my grandmother was a person of quite some standing and at that time, 1898, in Paris she was certainly very concerned about what had happened to her son (Jean Piaget at the age of two) and so – that's what I think Lucienne was getting at – my grandparents may well have offered that watch to the nurse. But they would certainly not have taken the watch back when the nurse offered to do so. You know, the nurse became a member of (signs of some hesitation, but fi-

<sup>1</sup> In the city of La Chaux-de-Fonds : Musée International de l'Horlogerie.

nally pretty assured that that is what it was) the Salvation Army ... and my grandparents no doubt let her have the watch for some other good purpose but not take it back themselves.'

... Well, Elizabeth, what I have just related to you is of course by no means a verbatim report of what Lucienne told me. You know, we were somewhere on a stairs, not far away from the crowd, i.e. there was much background distraction, and on top of it my own memory, alas, is not infallible either! But I think sincerely to have given you the gist and something of the tone of what she said to me. Let me add that at the beginning of our conversation about the childhood memory story of her father, Lucienne also clearly expressed her being aware that her father had related the story precisely as an example of how one can have a memory of something that really did not happen!''.

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# Comments on the Concept of Time and Its Explanational Value in Memory Research

Werner Wippich

## Overview

Before I briefly comment on the three selected contributions of this part 2 that deal with "Memory in time" I would like to mention an incomplete list of empirical and theoretical aspects of the topic memory *and* time as viewed from the standpoint of general psychology. Next, as a kind of framework, I present some selected viewpoints of the topic memory *for* time.

## Memory and time

Concerning the topic memory and time, time has been used at an operational level as an independent variable (for example, in research of the classical forgetting curve) as well as a dependent variable (for example, in analyzing reaction times in recognition judgments). Similarly, the time-aspect of aging research may be subordinated to this operational level.

At a more task-oriented level, the use of temporal information has become somewhat important in so-called source monitoring tasks (Johnson, Hashtroudi, & Lindsay, 1993). Time has been viewed as an attribute of predominantly externally derived information as opposed to internally generated information (such as thoughts or dreams). Thus, a memory of temporal information may be used to attribute the event to an external rather than to an internal source. Similarly, time has become important not only in retrospective memory tasks but in prospective memory tasks, too. In the latter tasks, one must be prepared to do the right (and mostly trivial) thing at the right time in the more or less near future.

At a more theoretical level, time had been viewed as a possible cause of forgetting (for example, in decay theories of short-term memory). Furthermore, and more actually, the storage of temporal information has been interpreted as an

automatic consequence of encoding external events (Hasher & Zacks, 1979). According to this view, the storage of temporal information may have become pre-wired in an evolutionary sense and cannot be improved by strategic encoding devices. Most importantly, temporal information has been used as a marker in order to distinguish certain memory systems. For example, Tulving (1972) favored the distinction between episodic and semantic memory as two information processing systems. The two systems differ from one another in terms of the nature of stored information, and in terms of autobiographical versus cognitive reference, for example. According to this view, episodic memory receives and stores information about temporally dated episodes or events, and temporal-spatial relations among these events. An event is always stored in terms of its autobiographical reference to the already existing contents of the store. On the other hand, semantic memory is seen as a decontextualized form of memory. It may represent organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, and about relations among them.

In a similar vein, the more recent distinction between implicit and explicit uses of memory may be based at least partly on a different role of temporal information at retrieval. At first, the distinction between implicit (or indirect) and explicit (or direct) memory is to be placed at a task-oriented level. Explicit memory tests, such as recall or recognition, require the subjects to recollect a prior episode. Implicit memory tests are defined as tests that do not require conscious recollection of a prior study episode for their successful completion (Schacter, 1987); nevertheless, they show a benefit in performance from the previously studied episode. The implicit nature of these tests is operationalized through instructions at testing. For example, on an implicit word-stem completion test, subjects

are instructed to complete a word stem with the first response that comes to mind. Memory is revealed when subjects produce more words that had previously been studied than could be expected by chance. Interest in the distinction between explicit and implicit tests of memory has increased because the two classes of tests exhibit different patterns of results as a function of certain independent and subject variables. These functional dissociations have led some researchers to conclude that the tests are tapping different memory systems (Tulving & Schacter, 1990). At a theoretical level, then, implicit or unintentional uses of memory may reveal specific and long-lasting experiences but at the same time experiences that are more or less timeless or at least used without any reference to time. An explicit use of memory, on the other hand, presupposes a temporal orientation and may be based on the retrieval of temporal cues. The fact that amnesic subjects have great problems in explicit test conditions but may show normal performances in implicit test conditions is consistent with this view.

Still from another theoretical perspective, time may be viewed as a processing resource in memory research, allowing, for example, only shallow or more elaborate encoding activities. At retrieval, functional time may determine whether memories are based on the impression of familiarity or result from extensive search and retrieval attempts.

Finally, at a conceptual as well as at a more subjectively oriented level of analysis and experience time may be seen as a necessary ingredient in the construction of consciousness and, thus, in conscious recollection. For example, memory-impaired people are typically disturbed in their time experience. Psychophysical measurements have led to the estimate that H. M., a famous amnesic patient, has the experience of three minutes for one hour. Many clinical disorders can be characterized by a temporal memory disorientation. Temporal confusion may contribute to an inadequate account of reality as well as of the self in constructing consciousness from actually perceived, remembered as well as planned or monitored information. In fact, time may play an important ordering role in constructing and reconstructing an autobiography and a concomitant sense of personal identity.

In sum, if one looks at this rather incomplete list, concerning the topic memory *and* time, it

may come as no surprise that the field has been plagued with vagueness. There is some loose and mostly heterogeneous association between the concepts of memory and time at different levels of analysis. A somewhat unified and structured research program has not been developed. Most researchers are still reluctant to use unifying terms like consciousness in a constructive way. Diversity in the research attempts and even arbitrariness seems to be the rule.

### Memory for time

In combining memory and time, one may distinguish two research traditions that have been developed somewhat separately. On the one hand it has been asked in what way memory may influence the registration and experience of time. According to Fraisse (1984), the estimation of time outside of the psychological present (i.e., 2–3 seconds) involves memory. In a storage size hypothesis (Ornstein, 1969), for example, it was supposed that time estimates are based on the number and complexity of encoded information. I will not discuss this research tradition. On the other hand, *memory for time* has been investigated in posing the question how memory is infused with temporal information (see Friedman, 1993, for review).

Suppose, for a moment, if you can, that all of your memories would be free-floating, unattached to any time. I think that you may feel like an amnesic patient, and perhaps such a simulation may prove to be impossible. Normally, we have a clear sense that each memory belongs to a unique place in our past. Thus, our life is experienced as if it unfolds in time. There is a sense of chronology and the experience of a true autobiography.

What processes and representations may underlie our chronological sense of the past? How the autobiography came to be infused with time? Our intuition may tell us that a linear chronology of events is somehow coded in memory. Indeed, as mentioned earlier, there has been the hypothesis that temporal information may be encoded automatically (Hasher & Zacks, 1979) and that such an encoding may not require much of the limited processing resource. So-called time-tagging theories, however, which assume that each event is coded and represented with a time signal, have not fared well in current research.

(Friedman, 1993). To the contrary, there is some evidence that it is a chronological illusion to assume that the linear chronology of past events is directly represented in memory. Some replica of linear time does not seem to be coded in memory. A specialized system for coding linear chronology has never been detected. Memory for time is not built on special temporal codes or a chronologically organized memory store.

Instead, there is more evidence in favor of a position that assumes that our chronological sense of the past is the product of an ongoing constructive process. We draw on, interpret, and integrate information from our stored knowledge of time patterns and other general knowledge about time in order to reconstruct temporal information of remembered events. Thus, in the sense of Tulving (1972), temporal information "recall" may result from an interplay of semantic memory and episodic memory processes. Besides, the contextual associates of particular memories may be used in constructing temporal memories. Finally, so-called order codes linking related events can be a basis for reconstructing temporal information. It is only occasional and rather exceptional that direct associations between events and time names are formed and retrieved. In fact, dates have been proven to be very poor retrieval cues.

In sum, associated context information of a remembered event and, even more importantly, a general knowledge of patterns of time, including social, natural, and personal time patterns may be the most important basis in order to reconstruct the time of remembered events. Order codes may be relevant for relative time judgments. These codes are assumed to be built up when a new event causes the retrieval of an old one, thus constituting a before – after relation. Memory for time, thus, may have several different bases. It is mostly a constructive result, and this may explain its approximate nature. It is normally more accurate than chance but seldom totally exact. One of the most convincing results demonstrating the importance of a general knowledge of patterns of time in constructing the time of remembered events has been so-called "scale-effects" (Friedman, 1993). It has been shown repeatedly that memory for time can be very accurate on a fine temporal scale (say, the time of the day of an event) and at the same time very inaccurate on a gross scale (say, the month of a year).

### Comments on the selected chapter contributions

In his reconstruction of the Piagetian view of memory and memory development, Walter Perrig (this volume) has made it clear that many distinctions that are important in modern theories of memory are laid out and can be identified in Piaget's theory. For example, the distinction between implicit (or indirect) and explicit (or direct) memory has been foreshadowed by Piaget's analysis and work. I would like to underline once more that an implicit or unintentional use of memory may reveal specific experiences that are more or less timeless or at least used without any reference to time. On the other hand, an explicit use of memory presupposes a temporal orientation and involves a subjective sense of pastness.

More importantly, and as described by Perrig, Piaget has insisted that memory cannot be dissociated as a separate ability from other cognitive functions. Thus, in the context of developmental research, he has shown that improvements of memory performance are possible over long time intervals as a consequence of developing schemes. In a similar vein, research on memory for time has demonstrated that the recollection of temporal information is mostly a constructive result based on the general knowledge of patterns of time. It would be interesting to see whether a developing knowledge of patterns of time corresponds to a different recollection of temporal information and whether improvements or deteriorations of memory performance over long time intervals are correlated with a changing knowledge of patterns of time.

In the contribution of Timothy Salthouse (this volume), time is viewed as a processing resource. Salthouse and others have shown convincingly that there are substantial age-related differences in measures that might be hypothesized to reflect the time requirements to execute elementary cognitive operations. More importantly, a substantial proportion of the age-related variance in several complex cognitive measures is shared with measures that reflect how quickly simple processing operations can be performed. The differentiation between a limited-time mechanism and a simultaneity mechanism may be a fruitful one and can contribute to the analysis of qualitative as well as of quantitative differences in aging research. In this sense, then, the

processing resource account may be reconciled with another approach according to which older adults have a broader range of information active in working memory than do younger adults (Zacks & Hasher, 1994). According to this research tradition, inhibition may be considerably less effective for older adults than for young adults. In fact, there is some evidence that specific information, and not more time, is required for older adults to clear the recent and now irrelevant past from memory.

The research on false memories, reported by Elizabeth Loftus (this volume), may profit also from the consideration and assessment of the knowledge of patterns of time and of other types of knowledge (e.g., so-called scripts). It may be impossible to plant or to create a false memory given that the subject does not have an adequate schema, or timetable, in order to incorporate the new and false information.

In general, the evidence presented by Loftus in favor of false memories is very convincing. This evidence has, of course, important implications for the evaluation of reports by patients of childhood memories about sexual abuse. As has been mentioned by Loftus, direct or subtle suggestions about the past might sometimes be leading some patients to develop false autobiographical memories that can be harmful to them.

At a theoretical level, it seems to be fruitful to analyze false memories as failures of source monitoring. In this sense, it may be useful to analyze false memories at different levels of representation. Furthermore, it may be interesting to find out whether the subjective experience of a false memory is totally indistinguishable from the experience of a correct memory. Does a false memory "feel" like a true memory? Is it experienced with a true sense of pastness, for ex-

ample? Finally, and within another research tradition, it may be instructive to investigate false memories with implicit measures of memory. Given that implicit measures may reveal experiences that are used without any reference to time it may be possible to detect false memories even more frequently with implicit measures. In fact, an implicit use of a false memory may be one basis for the formulation or construction of a "true" false memory in a time-structured autobiography of the subjects.

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## **Part III.**

# **Logic, Language, and Time**

# Logic, Language, and Time\*

Denis Miéville

Time does not exist outside the soul or, if it does, it is a result of motion, and then there are many times, just as there are many motions; or else it is the consequence of a single unique motion, and in that case whoever does not perceive this motion has no sensation of time. All of this is impossible.  
(Averroes)

## Introduction

Major difficulties are inevitably involved in thinking about time. No one will be surprised at this. But what is time? The search for an answer goes back at least as far as the African bishop who struggled with the question and revealed how perplexing it could be.

What, then, is time? If no one asks me, I know; if I want to explain it to someone who does ask me, I do not know. Yet I state confidently that I know this: if nothing were passing away, there would be no past time, and if nothing were coming, there would be no future time, and if nothing existed, there would be no present time. How, then, can these two kinds of time, the past and the future, be, when the past no longer is and the future as yet does not be? But if the present were always present, and would not pass into the past, it would no longer be time, but eternity. Therefore, if the present, so as to be time, must be so constituted that it passes into the past, how can we say that it is, since the cause of its being is the fact that it will cease to be? Does it follow that we can truly say that it is time, only because it tends towards non-being?

(St Augustine, 397 / 1960: 287-288.)

Despite what one might be led to expect by this beginning, we shall not be treating the notion of time in terms of logical grammar. Nor shall we compare temporal logic and modal log-

ics, or reflect on the classical parallel between space and time.

Our intention with the following contributions of this part 3 will be to consider first the problem from epistemological, psychological and linguistic points of view, as was done in the Time, Logic and Language symposium as part of the conference that took place at Neuchâtel to mark the centenary of Piaget's birth. We shall be referring to research presented by Jean-Blaise Grize, Olivier Houdé, Jean-Louis Gardies, and Jean-Paul Bronckart, and hereafter developed. These works have been first published in French in *Travaux du Centre de Recherches Sémiologiques* 65 by the University of Neuchâtel (1997):

- In his presentation on *Language of time and logic of time* (this volume), Jean-Louis Gardies raises the issue of the vocabulary and grammar of time from a comparative point of view. His interest centers on the way in which such a vocabulary and grammar appear in Indo-European vernacular languages as well as in temporal systems of logic and mathematics influenced by lexical and grammatical forms borrowed from these languages.
- In *The time of soft ideas* (this volume), Jean-Blaise Grize follows Piaget's analysis of the role of the subject in epistemology and draws the appropriate conclusions concerning the analysis of time and of ideas.
- In *The time of rationality* (this volume), Olivier Houdé investigates time in his capacity as a developmental psychologist. His purpose is to follow Piaget in reconsidering the time of rationality from the point of view of cognitive epistemology.

\* Translated by James Gasser.

- In *Temporality of discourses: a contribution to the reshaping of human actions* (this volume), Jean-Paul Bronckart develops ideas in the general framework of socio-discursive interactionism. He defends the view that the central object of human and social sciences is activity, such as it occurs in the historical constructs we call social groups. Language is necessarily involved as a process of negotiation and also as an instrument of evaluation of the activity.

And now, in our own contribution here, the problem of time is considered from the point of view of a purely developmental logic, some indications of which were given at the symposium. We shall treat of the progressive development of activities of logical thought, which is based on primitive meanings and various steps involved in the introduction of new meanings. A logic capable of indicating the steps of its own progressive development would provide an explicit record of the time of its expansion in terms of new ideas. Such a logic would thus be unlike a classical formal logic, which is given all at once, wholly and completely, once its basic principles have been made explicit. Such a logic as we are considering would be a system that effectively preserves traces of its successive conceptual expansions. From such a logic it would thus be possible to read back the chronology of its development and articulate the history of its construction. This work was inspired by the meeting at Neuchâtel in memory of Piaget.

### Time and developmental logic

As mentioned in the introduction to this article, the object of our own interest is developmental logic, i.e., a logic that reflects the steps of one's cognitive development. Such a logic, despite having no truth-functional connectives associated with temporality, can reveal the chronology of its development. It can be characterized as being (1) truth-functional and extensional, (2) different from classical logics due to the large number of logical connectives it can contain, and (3) designed in such a way as to be gradually extended so as to include new connectives. This, of course, demands clarification and justification, which we shall begin to provide by means of the following considerations:

#### *First consideration*

First-order classical logic is not the be-all and end-all of extensional logic. This would of course go without saying were it not sometimes easily forgotten. For first-order classical logic is first and foremost mathematical logic. It was developed for specific reasons explicitly related to the construction of foundations for arithmetic. The conceptual objects that it involves are just those that are needed for achieving this aim. One consequence of this is that the resulting logic contains a relatively modest number of syntaxico-semantical categories and uses a limited number of logical operations.

#### *Second consideration*

In order to undertake a logical analysis of the reasoned procedures of deductive sciences under their extensional and truth-functional aspects, the syntaxico-semantical categories of names [N] and sentences [S] are absolutely essential. The category of sentences is indispensable to whatever involves truth values, and names are intimately connected to the objects that make up the universes that logics are concerned with.

#### *Third consideration*

Every syntaxico-semantical category other than S and N is definable in terms of these two basic categories. In classical propositional logic, for example, two categories are necessary in addition to S and N. On one hand there is the category of functions on one sentence yielding a sentence [S/S], to which negation belongs; on the other, there is the category of functions on two sentences yielding a sentence [S/SS], of which conjunction and disjunction are examples.

On the basis of these considerations, it is appropriate to pose the question of the number of syntaxico-semantical categories that a system of logic contains – and consequently of the number of functional connectives associated with them – in order to fulfill its role with respect to the whole of deductive knowledge. This question is not new; indeed, Tarski posed it as early as 1933.

The language of a complete system of logic should contain – actually or potentially – all possible semantical categories which occur in the languages of the de-

ductive sciences. Just this fact gives to the language mentioned a certain “universal” character, and it is one of the factors to which logic owes its fundamental importance for the whole of deductive knowledge. In various fragmentary systems of logic, as well as in other deductive sciences, the multiplicity of the semantical categories may undergo a significant restriction in both their number and their order.

(Tarski 1983: 220.)

As Tarski points out, the variety of semantic categories can be limited in certain (fragmentary) systems of logic. The best example of this limitation is once again classical first-order logic, in which only the following categories are found: N, S, S/S, and S/SS (as well as the quantifiers, which yield sentences when applied to propositional functions with nominal arguments: S/propositional function).

This is a recognition that many different languages are associated with various systems of logic; Tarski even proposes to classify them in the following way:

[...] we can distinguish four kinds of languages: (1) languages in which all the variables belong to one and the same semantical category; (2) languages in which the number of categories in which the variables are included is greater than 1 but finite; (3) languages in which the variables belong to infinitely many different categories but the order of these variables does not exceed a previously given natural number  $n$ ; and finally (4) languages which contain variables of arbitrarily high order.

(Tarski 1983: 220.)

Given that language of a complete system of logic must contain variables of arbitrarily high order, it is necessary to consider the form that such a project would have to take. Before giving some elements of response, we shall pose the following:

#### *Fourth consideration*

In a complete system of logic, there are an infinite number of syntaxico-semantical categories. For it is indeed possible to conceive of a denumerably infinite number of categories given the basic categories of names and sentences. Any

such category can eventually be specified by means of the following inductive definition:

- i. N and S are categories.
- ii. If  $C, C_1, C_2, \dots, C_n$  are categories, then  $C/C_1C_2\dots C_n$  is a category; it is the category of functions that yield expressions of the category C with  $n$  arguments, the first of which is the category  $C_1$ , the  $n^{\text{th}}$  of which is  $C_n$ .
- iii. Nothing is a category except by i–ii.

#### *Fifth consideration*

Even though all the categories obtainable from the two basic categories might potentially be conceived of, the actual number of known logical operators – and therefore of the categories that correspond to them in the language of deductive sciences – is, at any given moment, finite.

Given the impossibility of a logical theory actually comprising the infinity of logical operators, it is necessary to create a logical system capable of being gradually enriched with new categories and new connectives. The considerations that we have set forth compel us to concern ourselves with the following questions.

Since the set of logical operators related to the language of deductive sciences is not known all at once, and once and for all, but only gradually, in connection with the problems that logic succeeds in solving,

- (1) How are the meanings of new connectives to be gradually recorded?
- (2) From what primitive meanings are new connectives to be derived?
- (3) What sort of system can be given in this gradual, progressive, incremental way?
- (4) What are the consequences of this way of doing things?
- (5) Is a purely distributive semantics adequate for representing logical operations of increasing complexity?

We shall respond to the third question first. Given a logical system capable of progressively taking in new ideas, we must consider the choice of the axiomatic basis of the logical edifice being constructed as well as the nature of the procedure that brings about such a progression of logical ideas. It is necessary, then, first of all, to justify a possible choice of initial primitive meanings from which new meanings are to be obtained. Now the construction of new mean-

ings from other previously recorded meanings presupposes a procedure of definition. It is of interest, then, to consider the conditions that govern every well-formed explicit definition, which are well known and will not be repeated here (see however Miéville 1984). For now, it will be sufficient for our purposes to recall only one of these conditions: a well-formed definition establishes an equivalence relation between a sentential expression A that contains the new constant or function to be defined, and another sentential expression B that does the defining. Now two sentential entities are truth-functionally equivalent if and only if the result of applying a biconditional to the two is a logically valid sentence:

$A \leftrightarrow B$  if and only if  $\vdash A \equiv B$

This information is important in two different ways: on one hand, it shows that the biconditional is a serious candidate for the role of a primitive meaning in the axiomatic basis of a constantly evolving system and, on the other, it is suggestive of the nature of definitions in a system progressively enriched with new logical ideas. Traditionally, an explicit definition is taken to be a mere linguistic convenience. Subjectively, we may grant it some cognitive function, but formally it is nothing but an abbreviation, which is indeed the case in classical systems where every definition is introduced by means of a metalinguistic symbol,

$A =_{df} B$

To limit the status of definition to abbreviation is not only intellectually unsatisfying but useless as regards the construction of a system, which it should always be possible to enrich with new logical ideas. Russell himself, already at the beginning of the 20th century, was conscious of this.

It is a curious paradox, puzzling to the symbolic mind, that definitions, theoretically, are nothing but statements of symbolic abbreviations, irrelevant to the reasoning and inserted only for practical convenience, while yet, in the development of a subject, they always require a very large amount of thought, and often embody some of the greatest achievements of analysis. (Russell 1956: 63; originally published 1903.)

In order to substitute the quasi-creative role that ought to belong to definition for the practical function associated with abbreviation, it is necessary to think of the activity of defining as an inference rule that introduces expressions (definitions) as theorems of the system. The price to be paid is a break with the purely abbreviative role of definitions. Such a rule must be devised in such a way as to determine the criteria of admission of new expressions (definitions) as a function of meanings previously recorded in the system. These expressions (definitions) would appear in the system as the biconditional expressions having the status of theorems:

$\vdash A \equiv B$

On the basis of these remarks having to do with the realization of a developmental logic, it is appropriate to determine the axioms that are necessary to provide a basis for the meaning of the biconditional operator. The inferential conditions authorizing the introduction into the constantly evolving system of new biconditional expressions – bearing new logical concepts and having the status of theorems – should also be specified. Before taking up these issues, however, there is a major obstacle that must be removed, since this way of considering the development of a logical theory in no way presupposes an order of access to categories and logical operations, nor an exhaustive limit circumscribing them. To this semantic indetermination related to the set of known logical operators corresponds a syntactical indetermination: as it is not known beforehand what will be defined, it is simply not possible to propose a list of symbols fixed in advance according to a semantic plan that is closed with respect to categories and functions. A developmental system thus cannot have one of the essential characteristics belonging to any formal system in the classic sense of the term, namely that of being “*given completely and all at once*” (Chazal 1995: 73). At the initial stage of a developmental logic, only the indispensable initial meanings are present; every other meaning must be given by a definition that is internal to the system and unconnected with any previously recorded syntactical object. Besides what is given in the axiomatic basis, no other symbol is specified a priori. The choice of new symbols bearing new meanings, and recog-

tion of their categories and functions, must then take place by means of an identification procedure that uses other criteria than those of "one form, one meaning". The solution consists of using a determination that is contextual in nature.

Contextual determination is nothing new. Anyone who has thought about the grammatical category of the English word "and", for example, is aware that this word, taken by itself, belongs to no uniquely determined category. In order to assign it to a category, it is necessary to take into account the nature of the linguistic objects that it acts on. In the sentence "Peter reads the newspaper and John laughs," "and" belongs to the category of functions on two sentences yielding a sentence, because it acts on the two sentences "Peter reads the newspaper" and "John laughs." In the example "The Swiss flag is red and white," on the other hand, "and" belongs to the category of functions on two names yielding a name, because it acts on the two names "red" and "white." The preferred way to overcome the semantic, and therefore the syntactic, indeterminateness proper to developmental logics is to use the contextual determination that will be presented here. From now on, we shall accept that any (constant or variable) connective, whatever its category, will precede a pair of symmetric parentheses – the shape of which will not be important to begin with – that enclose a finite number of arguments. Thus, in the following, "\*" and "+" are connectives:

\* $(\text{ay}\%)$  and  $+\{x\text{cvj}\}$

The first acts on three arguments, the second on four. As we shall explain more fully later on, the category of a connective is thus determinable on the basis of the shape of the parentheses and the number of arguments.

But how can it be known whether "\*" or "+" is a variable or a constant? The question is perfectly natural given that no previously agreed-upon list of symbols for variables or constants is available. The answer once again has to do with a contextual mode of determination, such as the following:

- (1) Every well-formed formula of a constantly evolving system must be quantified.
- (2) A quantified expression consists of two concatenated sub-parts: the first is non-

empty and within parentheses of the shapes  $[$  and  $]$ ; the second is also non-empty and within parentheses of the shapes  $\{$  and  $\}$ . The first part is called a quantifier, the second a subquantifier.

A well-formed formula is thus of the following general form:

$$[\dots e\beta\alpha\dots]\{ \dots \alpha\nu\mu e4\dots \}$$

(The meaning and the shapes of the elements contained in this expression are not important for the moment.)

Now it is possible to define, in an expression, which symbols are variables and which are constants:

- (3) A symbol in a subquantifier is a variable if and only if:
  - it is not a symmetrical parenthesis
  - it is different from the symbols chosen to define the quantifier and subquantifier parts of a well-formed formula
  - there is a symbol of the same shape in the quantifier

Hence it is possible to determine the status of each symbol in a contextual way with no list of previously semantically determined symbols available.

We know then that the symbols "e" and "α" in the subquantifier  $\{ \dots \alpha\nu\mu e4\dots \}$  are variables because for each of them there is a sign of the same shape in the quantifier  $[\dots e\beta\alpha\dots]$ .

The symbols "ν", "μ" and "4" in the subquantifier  $\{ \dots \alpha\nu\mu e4\dots \}$  are constants because they are not symmetrical parentheses, they are not symbols of the same shape as parentheses used for the quantifiers and subquantifiers, and because there are no signs of the same shape in the quantifier  $[\dots e\beta\alpha\dots]$ .

We now have all that we need to achieve our aims:

- we know how to distinguish constants and variables
- we know how to recognize functional connectives and the general form of a functional expression
- we know that recognizing the category of a symbol has to do with the shape of the symmetrical parentheses of the parenthetical expression that follows, as well as the number of arguments contained in that expression
- the procedure used for giving definitions that makes it possible to obtain new mean-



introduction of complex expressions corresponding to the following schema:

$$\lfloor v_1 v_2 \dots v_n \rfloor \equiv (f \langle v_1 v_2 \dots v_n \rangle E_{v_1 v_2 \dots v_n})$$

The corresponding expression in more familiar notation is given here:

$$(\forall pqr)(f \langle v_1 v_2 \dots v_n \rangle \equiv E_{v_1 v_2 \dots v_n})$$

In this expression, the symbol “f” represents a constant function on  $n$  variables of a new category. The expression “ $f \langle v_1 v_2 \dots v_n \rangle$ ” is the *definiendum* of the definition; the expression “ $E_{v_1 v_2 \dots v_n}$ ” is the *definiens*. The latter must be formed from what has already been constructed in the system and contain the variables  $v_1, v_2, \dots, v_n$ . It will be noted that the *definiendum* and *definiens* are indeed given, as intended, in a biconditional expression:

$$\equiv (f \langle v_1 v_2 \dots v_n \rangle E_{v_1 v_2 \dots v_n})$$

The following considerations will be sufficient to specify the application of the inferential rule of definition:

- i. If the new constant function  $f$  that is to be introduced belongs to a syntaxico-semantic category already in the system, the context characterizing this category must be formally respected. For example, if a new constant function of the category  $S/SS$  is to be introduced, then the context already chosen, namely “ $(-)$ ”, must be respected.
- ii. If the new constant function  $f$  that is to be introduced belongs to a category that is not yet in the system, a context must be chosen that assigns to it a new categorical identity; care must be taken to choose parentheses that will create no confusion. Consider for example the situation in which a binary constant function yielding sentences with two arguments, each belonging to the category of functions yielding two sentential arguments,  $S/(S/SS)/(S/SS)$ , is to be introduced. In this case, parentheses of the shapes “ $($ ” and “ $)$ ” may not be used, for as the new function is binary, and as these parentheses have already been used to identify another category in another binary context, using these same ones again would make the

category of the new function totally ambiguous. Apart from these parentheses and others already used in the system in binary contexts, any pair of parentheses may be used.

Finally, the thesis-definition expression must respect the fundamental conditions that apply to every explicit definition:

- (1) An equivalence relation must exist between the *definiendum* (which includes the defined term) and the *definiens* (the defining expression).
- (2) The *definiens* must be composed exclusively of previously introduced primitive or defined terms.
- (3) The *definiendum* must include exactly one new constant term, which must not be of the same shape as any other term of the same syntaxico-semantic category.
- (4) Care must be taken to ensure that any and all variables in the *definiens* occur in the *definiendum* as well. (Failure to respect this condition could lead to contradictory constructions.)
- (5) Care must be taken to ensure that any and all variables of the *definiendum* occur in the *definiens* as well. (This condition is purely for the sake of esthetics.)
- (6) No sign of the *definiendum* should be repeated. (Failure to respect this condition could lead to problems using the rule of substitution.)

The definition procedure based on the biconditional and proposed by Lesniewski satisfies these conditions.

Considerable emphasis has been placed on Lesniewski’s rule of inferential definition. With this rule, it is possible to develop incrementally all conceivable logical categories on the basis of the initial and primitive category of sentences, “ $S$ ”. But this will still not be enough to satisfy the logician, for the potentially infinite set of sentential operations still needs to be put to use in order to obtain the set of logical theorems of the system, whatever its stage of development. A developmental logic will therefore need additional rules of inference such as biconditional detachment, substitution, and extensionality. The logic outlined here includes these rules, but as we intend above all to insist on the temporal definition associated with the syntaxico-semantic development of such a logic, we shall restrict ourselves here to the mere mention of

the existence of these other rules of inference.

In order to characterize the spirit of a developmental logic in which temporal progression is dominant, we have until now confined our remarks to purely sentential logic. But this assuredly basic part of logic is only one among many; it is incomplete. We have of course been concerned above all with time, but truth values are also an important factor in problems of reference and relational structures. From this point of view, the syntaxico-semantic category of names is fundamental, and added to that of sentences it is possible, with combinations, to obtain all syntaxico-semantic categories that a complete and ideal logic should possess. Here again, we borrow from Lesniewski an expanded system of higher-order predicates endowed with the dynamics of a developmental construction indicating time.

#### A glimpse at Lesniewski's "ontology"

A pre-semantic approach shall be adopted with respect to Lesniewski's "ontology," a higher-order calculus of nominal terms. This will be given by a naive, natural understanding of the world and of how we talk about it. We believe in the material existence or non-existence of things such as Socrates, this page, the moon; all these belong to our reality. We know how to reason with such objects and in order to do so we give them names. These are *individual names* that denote things considered to be entities. There are of course also *general names*, such as "Nicolas Bourbaki," the name of the polycephalic mathematician. And there is yet another kind of name, well known to logicians who never tire of reasoning about Pegasus, the present king of France, and square circles: these *empty names* denote no objects. Finally, there are objects that have no names, which prevents us from talking about them. Lesniewski includes these under the category of names.

Whenever we speak and whenever we reason, we never cease to use – in Indo-European languages at least – the copula "is". This copula plays a logical role of considerable importance, even if it does not appear explicitly in the predicate calculus, where it is in a way consolidated into predicates. Lesniewski's interest in the copula results from practical considerations connected with the fact that he used natural lan-

guage to present his collective set theory. The copula "jest" – "is" in Polish – abounds in natural-language formulations of his axioms and theorems. It is associated with the names it uses to organize the objects of his theory. His interest, then, is in the meaning of the copula when it articulates names. The result is a theory of terms that is capable of representing a calculus of names.

The genius of Lesniewski is to have insisted on uncommon standards of rigor while at the same time being aware that a formal language ought, as far as is possible, to inherit the richness of discursive thought and particularly its potential for creativity. This attitude explains in part his refusal to work with systems of the Russell tradition. He was led to construct a logical system that fixes axiomatically the meaning of the copula, and this system, like all his others, is of a conceptual and developmental nature. It follows that this system too can be developed progressively, on the basis of what has been previously assumed or defined. This is done by a rule of definition of an ontological character that authorizes the introduction of internal theses-definitions into the system. The freedom of definition, which makes it possible to represent new ideas as they are added to the system, results from the fact that every syntaxico-semantic category is determined contextually rather than by depending on a predetermined set of symbols.

On the basis of these ideas, Lesniewski establishes unequivocally the meaning of the copula he uses in discursive expressions of his logical deductions. A first formal version was given in 1930 in the form of a single axiom containing only one primitive term, the epsilon "ε." This is *not* the symbol of the membership relation from classical set theory. This term appears in so-called *singular* sentences of the form "a ε b," which can be read pre-semantically as follows:

a ε b: a is the (or one of the) b

The terms "a" and "b" represent formal objects of the syntaxico-semantic category of names. The epsilon "ε" is thus a function on two names yielding a sentence: S/NN.

A singular sentence of the form "a ε b" is true if and only if all the following conditions are satisfied:

- (1) The term "a" does not represent a name that has no denotation.

- (2) The term “a” represents an individual name. This name may not denote more than one individual.
- (3) If a term is associated with a name having the same denotation as that associated with “a,” then it is related to the objects – or to the object – the name of which is associated with the term “b.”

This formulation is inelegant. The first clause stipulates the existence of *a*, the second specifies the uniqueness of *a* and the third makes explicit a principle of convergence (all that could be *a* is also one of the *bs*).

This meaning of Lesniewski’s epsilon is expressed formally as follows (“ $\lceil a \rceil$ ” can be read “for all *a*”; “ $\lceil \exists b \rceil$ ” “there is a *b*”).

Axiom:

$$\lceil ab \rceil \lceil a \in b \equiv \lceil \exists c \rceil \lceil c \in a \rceil \wedge$$

(existence)

$$\lceil dc \rceil \lceil (c \in a \wedge d \in a) \supset d \in c \rceil \wedge$$

(uniqueness)

$$\lceil c \rceil \lceil c \in a \supset c \in b \rceil \rceil$$

(convergence)

If this meaning of the copula *be* is used, and if commonly shared, “naïve” knowledge be taken as the semantic domain, truth values can then be assigned to the following sentences:

“Aristotle is an ancient philosopher”: TRUE

“John Paul II is a famous mathematician”: FALSE (he exists and is unique, but he is not a mathematician)

“Pegasus is a winged horse”: FALSE (Pegasus does not exist and denotes no object)

“Man is mortal”: FALSE (in this context, “man” is a general name and denotes more than one object; the sentence is in fact a contraction of a universal affirmative, which may be written  $\lceil c \rceil \lceil c \in a \supset c \in b \rceil$  and which is true)

The representation of quantification adopted here differs from that in general use. This is not a mere matter of style, but a necessity in that, in Lesniewski’s theories, quantification does not have the existential character implicit in classical logics and explicit in standard free logics. In view of an interpretation on a semantic domain, quantification can not be objectual. In this theory, existence and quantification remain two distinct notions.

Like protothetic, Lesniewski’s ontology is a logical theory and contains inference rules. There are seven rules in the ontology: detach-

ment, substitution, a quantification rule, two rules of extensionality, and two of definition. For reasons already given, only the definition rules will be considered here.

On the basis of the rules and using the four primitive syntaxico-semantic categories given by the axiom (S, N, S/NN, S/SS), as well as the constants associated with some of them ( $\epsilon, \equiv, \wedge, \supset$ ), new constants of any syntaxico-semantic category can be obtained progressively.

Elsewhere, we have defined a nominal negation of the category N/N (Miéville 1991), a logical operation of category subordination N/SN as well as other higher-order operations (Miéville 1993).

This syntaxico-semantic generosity has a particularly attractive consequence in that it pushes back the elementary limits of classic extensional descriptions. The availability of constants of the categories N/N or N/S, for example, causes concern about the subtlety of the description of the semantic model. From this point of view, there is a natural desire to have a semantics capable of representing the organization of the various relations of part to whole. Once again, we turn to Lesniewski to borrow and interpret his definition of the collective class (Lesniewski 1916; Miéville 1984). The collective interpretation of class has the advantage of taking into account the pluridimensional aspect of objects. On this interpretation, it is possible to consider as a whole an entity of even the highest degree of complexity, without accepting just anything at all as an ingredient. Our interest in this model will thus be easily understood. Lesniewski’s collective model is also of considerable use when it comes to speaking of the same object of discourse in different respects, as we so often do. We shall turn, then, to its basic properties.

### The collective class

Let us first give an illustration. In Figure 1 is given a class of squares. On the distributive interpretation, this class is made up of exactly six elements: the squares ACEG, BDFH, ABIH, HIFG, BCDI, and IDEF.

All these elements are of the same kind. They all possess the characteristic property of the class, namely the concept that has created it: to be a square of the geometric figure given in Figure 1.

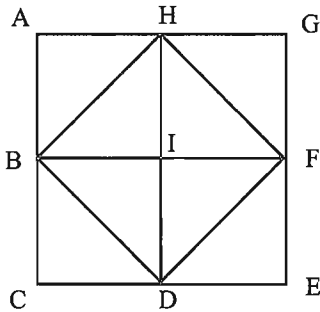


Figure 1

On the collective interpretation, this class also includes these six elements, and many other things as well. The following elements, for example, also belong to the class:

- the triangles ABH, BIH, HIF, HFG, BCD, BDI, IDF, DEF, BFH, BDF, BDH, and HDF;
- the polygon ABIDEF as well as other polygons;
- the line segments AB, AC, BC; every segment contained in AC; the points A, B, C, D; every point contained in CD; every imaginable collection of points and/or of segments and/or of other elements.

All of these belong to the collective class of the squares of Figure 1. The cardinality of the distributive class of squares of Figure 1 is six, whereas that of the collective class is the continuum.

The collective class of the squares of Figure 1 is moreover the very same object as the class of triangles of Figure 1. The same elements are given, then, by very different conceptual means.

It was in an axiomatic theory of the part-whole relation that Lesniewski defined the concept of collective class. The ingredience relation that he proposes is reflexive, antisymmetrical, and transitive. Although the model of his construction is pluriextensional, it remains extensional. Lesniewski was probably guided in this by his perception of geometrical space, but his definition of collective class can be given more precisely, as follows.

Lesniewski began his reflections on the notion of class by refusing to accept that it be considered a mere symbolic or linguistic convenience. He refused in particular the sense attached to it by Russell (Whitehead & Russell 1910, I: 71-72):

The symbols for classes, like those for descriptions, are, in our system, incomplete symbols: their uses are defined, but they themselves are not assumed to mean anything at all. That is to say, the uses of such symbols are so defined that, when the definiens is substituted for the *definiendum*, there no longer remains any symbol that could be supposed to represent a class. Thus classes, so far as we introduce them, are merely symbolic or linguistic conveniences, not genuine objects as their members are if they are individuals.

For Lesniewski, however, a class is a “thing.” Intuitively, a pile of sand exists, just as the grains of sand exist of which it is made up. These thoughts lead Lesniewski both to attach a collective meaning to the term “class” and to present a general theory of sets, called “mereology,” in which the collective class is defined.

Mereology has the following axiomatic basis:

- Axiom I For all A and for all B, if A is part of B, then B is not part of A.
- Axiom II For all A, for all B and for all C, if A is part of B and B part of C, then A is part of C.
- Definition I For all A and for all B, A is an ingredient of B if and only if:
- A exists and
  - A is identical to B or A is part of B
- Definition II For all A and for all  $a$ , A is the class of  $a$ s if and only if:
- A exists and
  - there is a B such that B is one of the  $a$ s and
  - for all B, if B is one of the  $a$ s, then B is an ingredient of A and
  - for all B, if B is an ingredient of A, then there is a C and a D such that C is one of the  $a$ s, D is an ingredient of C and D is an ingredient of B
- Axiom III For all A, for all B and for all  $a$ , if A is the class of the  $a$ s and B the class of the  $a$ s, then A is identical to B.
- Axiom IV For all A and for all  $a$ , if A is one of the  $a$ s, then there is a B such that B is the class of the  $a$ s.

The following comments should be added:

- The only primitive term of this axiomatic basis is “part of.” This term is understood as a relation that is irreflexive, asymmetrical, and transitive.
- The defined term “ingredient of” is a partially ordered relation.
- If  $A$  is a class of  $as$ , then  $A$  is an ingredient of itself.
- One and the same collective class  $A$  can be obtained from the distinct elements  $a$  and  $b$  without there being a relation of sameness between them; this aspect is of direct interest to us.
- From the collective point of view, the empty class does not exist.
- Mereology does not limit itself to the primitive meanings that are necessary in order to define the concept of collective class; it also includes a whole set of possible operations that are involved in computations on and with collective entities.
- As in the cases of protothetic and ontology, it is possible to indicate in mereology the stages of its own development.

## Epilogue

We have presented above the basic elements characterizing a developmental logic that preserves the principles of bivalence and extensionality. We have also given the primitive meanings required to found such a logic, as well as the inferential means to expansion in terms of new constants and therefore of new categories.

We do not have before us, in form or in content, a unique logical theory having the property of being progressively developed. Instead, we have an axiomatic basis, modest in terms of primitive meanings, from which a multitude of logical systems can be obtained. This results in at least two important epistemological consequences. The first is directly concerned with a whole new way of understanding formalization; the freedom to expand the system implies indeterminate syntax, which leads in turn to a contextual determination of the meaning of the components of an expression. The second consequence is concerned with the progression in space and time involved in the development of these systems. The time involved is that of the increase in operational knowledge of the devel-

oping system. It indicates the stages of the important changes occurring in the system by means of creative definitions, which make it possible to demonstrate new theorems that do not contain the defined new term but that would be impossible to demonstrate without this new meaning.

The expression of time that results from these systems is related not to truth-functional operations but rather to the idea of expansion and growth; it is growth that adds new potentials to those of previous stages. This genetic movement is adequate to represent an entire filiation of structures. One possible application of a developmental system would be to use the definition rule so as to indicate the progressive construction of the transformation ‘group’ INRC that specifies the stage of hypothetico-deductive operations as revealed by Piaget and his school (Piaget 1949). Work on such a project is currently under way.

A plunge into developmental logic thus leads to new intellectual adventures where time is prominently involved in the development of logical knowledge. These adventures also lead to more and more investigations of the structure of formal semantics. For considering and recording the time of cognitive development creates interest in semantic structures that are more specialized even than the levels of complexity and specialization revealed by new logical operations. The need for a clearly defined collective class is a sufficient proof of this.

To Jean Piaget, we should like to pose the following question: what would such a logic, which records the stages in development, have inspired in you today? What function would you have attributed to this perception of the collective class that can be understood as the ultimate step in the ever-increasing complexity of logical operations? To us it belongs to find a response.

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# Language of Time and Logic of Time\*

Jean-Louis Gardies†

Here I shall content myself with tackling a problem of vocabulary and grammar of time. Using some specific examples, I would like to draw a rough comparison between

- on the one hand, the vocabulary and grammar of time proper to vernacular languages, more particularly to Indo-European languages,
- and on the other, the vocabulary and grammar of time that mathematicians and logicians, they themselves more or less taking inspiration from these vernacular languages, have been led to elaborate and place at the foundations of the concepts or systems that they set out to construct.

Firstly, I shall compare the manner in which Indo-European languages mark time with the way in which time was expressed by the first logicians in modern times to concern themselves with the setting up of specifically temporal systems, namely logicians of the Prior school.

Amongst the numerous ways in which they express time, Indo-European languages make privileged use of:

- on the one hand, grammatical inflections, which we call verb *tenses*, the most fundamental being the *past*, the *present* and the *future*,
- on the other hand, adverbs, amongst others the two adverbs *always* and *sometimes* which allow a quantification of instants in the same way as the use of classical quantifiers allows *predicate calculus* to quantify the arguments of predicates.

It is characteristic of the preoccupation of logicians that, while taking inspiration from the way in which time is expressed in natural languages, they are generally keen to reform it, in particular to reduce the modes of expression that can be found to a minimum of forms retained as fundamental and from which they set out to define the others.

Firstly, whilst our Indo-European languages

distinguish *at least* between a present, a future, and a past (generally they even have several pasts), most logical languages renounce the expression of the present tense as such. In fact, Thomas Aquinas has already made the observation that the present is itself presupposed in the expression of all the other tenses: “the past, he wrote, is that which has been present, the future that which will be present.” With reference to the present thus finding itself in all other tenses, any mention of it becomes pointless; it is pointless to say that *it has been the case that p is present*; it is sufficient to say that *it has been the case that p*, which logicians will write:

Pp;

It is pointless to say that *it will be the case that p is present*; it is sufficient to say that *it will be the case that p*:

Fp;

in the same vein, it is pointless to say that *p is present*; it is sufficient to say that:

p.

Furthermore, from the only two indefinite terms:

Pp and Fp

it will be easy to construct equivalents, in the past and future, for the adverbs *always* or *never*: *it has not been the case that not p*, that is to say that *it has always been the case that p*; *it will never be the case that not p*, that is to say that *it will always be the case that p*. On this basis the use of the conjunction *and* will allow us to obtain the *always* of our vernacular languages, oriented as much towards the past as towards the future: *it has always been the case that p & p & it will always be the case that p*, that is to say *always p*.

Thus, although taking inspiration from the way in which vernacular languages express time, instead of taking this as it stands, the grammar of temporal logic systems proceeds firstly to tidy things up with the aim of reducing to a minimum the number of primary indefinite terms, a starting point from which we shall then introduce other terms by the simple route of definition.

\*Translated by Anne-Marie Rifai.

This first example has therefore shown us that logicians, having to establish the grammatical basis of their logic systems, could doubtless have found inspiration in natural languages, however this only on condition that a reorganization could be carried out with a view to bringing out the character of truth functions which should from then on clothe the temporal functors so that a logic can be founded upon them.

My second example will lead us towards the same sorts of conclusions: it will again show how logicians' borrowings from the grammars of natural languages are prone to freeing up from them possible *functions* (in the logico-mathematical sense of the word), underlying what essentially presented itself primarily as a simple *means of communication*. However, this example is already more complex than the preceding one, in so far as the borrowing of logical language from the vernacular language which provides its inspiration, is here far more removed from a literal imitation. If we take, one after the other, words as they appear in a dictionary and in their number we consider only the verbs, we will notice that amongst them we can distinguish two mutually exclusive types according to the following principle:

- certain verbs express *states*: if I say that *it is raining*, that *Marie is beautiful*, that *Jack loves Marie*, that *he prefers Marie to Susanne*, I describe a *state* of rain, of beauty, of love, or of preference; the term of state that I am using implies no notion of passivity whatsoever; I rank among these *verbs of state* those which Gilbert Ryle (in *The Concept of Mind*) called *task verbs* like, for example, the verbs *to walk* or *to run*,
- certain verbs, on the other hand, radically distinguish themselves from the preceding ones in so much as, far from describing a singular state, they express *advents*, *ruptures*, *passages*, *completions*; hence Gilbert Ryle referred to them as *achievement verbs*.

The difference between these two categories of verbs lies in the fact that, while the first verbs refer to the reality of a single state which they describe, the truth of the second verbs is a function of several states, most of the time in our Indo-European languages of two or three states. If I say that *Peter is recovering*, my assertion is true on the double condition

- (1) that Peter was ill in a first state

- (2) that Peter will be in good health in a second state.

If I say that Peter kills Paul, my assertion is true on the triple condition

- (1) that Paul was alive in an immediately previous real state,
  - (2) that Paul will not be alive in an immediately subsequent real state,
- furthermore (as it is not enough that Paul be dead for Pierre to have killed him)
- (3) that Paul would have been alive in a subsequent unreal state had Peter not intervened and killed him.

It is on the basis of an analysis of this sort that one can build up in particular, a logic of the change or of the action, the foundations of which we will already find in the work of von Wright.

Let us note that our Indo-European grammars do not establish any morphological difference between verbs of state and verbs of achievement; they treat both groups in the same way, as if they all engender assertions which have uniformly the same status. Our Indo-European grammars do not in fact concern themselves with justifying, in terms of truth functions, propositions as simple as:

- *if Peter has recovered, then Peter is in good health,*
- *if Peter has killed Paul, then Paul is dead.*

However, it is on the contrary, the duty of the logician to be concerned with matters of this sort, that is to say, to account for this adjustment in time and states, to clarify the temporal *logos* cloaked in inferences of this genre, which vernacular languages off load as simply a matter of common sense.

However, this difference between verbs, according to whether they are a function of one or of several states, can not only indicate itself in natural languages by the choice of verbs themselves, some especially dedicated to the designation of states, others to achievements; it can also be expressed in the choice of grammatical tenses that can be applied to the same verb, since it is not without good reason that our grammars, when having to express a tense like the past, have at their disposal several forms.

It is thus that in French the neighboring of the *imperfect* with the *past historic* or the *past perfect* often indicates a contrast between the state described by the first and the event or achievement which arises in the middle of this state as indicated by the second two. Writers such as

Flaubert knew how to play with this supremely well in order to underline, in their descriptions or their narratives, the distinction between what served as background or decor and, on the contrary, the means by which the change or the action takes place. The *Port-Royal Grammar* (*La Grammaire de Port-Royal*) gives the example of the statement:

*Je soupais lorsqu'il est entré*  
(I was dining when he entered)

where the imperfect "Je soupais" ("I was dining") refers to a state ("I was in the process of dining"), during which the *event* took place, passage from the state of absence to the state of presence of the person who suddenly entered.

Thus, in our Indo-European languages, can the lack of explicitly morphological distinctions between verbs which express a single state and those whose truth value is, on the contrary, a function of several states, be partially compensated for by the use of grammatical forms like the one I have just revealed as existing in French. Forms which storytellers and novelists pay much attention to given that they enrich the resources of expressiveness available to them.

If we had taken our examples from the English language, we could have come up with the example of the *present continuous*, the function of which is generally to transform an *achievement verb* into a *verb of state of affairs*.

Logicians cannot for their part be content with these grammatical means which refer only in an implicit way to the constituent functions of the temporal rationality of discourse. Their role is to make an inventory of the truth functions, some of which can be present virtually in natural discourse, whereas others can add themselves to the simple means that vernacular languages already place at our disposal.

My last example regards precisely a case of this sort where the grammatical means perfected by scientific procedures have distanced themselves from the means proper to natural language to the point where this natural language itself finishes by making its own these grammatical means the invention of which initially proceeded purely from a scientific process. This example will be more complex than the preceding ones in so far as it no longer concerns the simple notion of *time*, but a compound form of this notion, that is, the notion of *speed*.

Historians of the sciences have at times pointed out that the Greeks of the 4th and 3th

centuries B.C. did not have our notion of speed. In Plato's *Laches*, it is effectively characteristic that Socrates, setting himself the task of giving an example of the definition of a concept taken in itself, independently of all the forms that it can assume and all the domains to which it can be applied, chooses this example of *speed* of which he states (192 a9-b2):

If therefore someone were to ask me: "Socrates, what is this object that you call speed, the presence of which you acknowledge in all these things?", I would reply to him that I call speed the *faculty of accomplishing many things in little time* through the voice, when running, in a race or for everything else.

"The faculty of accomplishing many things in little time," that is to say what we call more exactly today *rapidity* or *celerity*, a property which is opposite to *slowness*, and which is something altogether different from this rapport between space traveled and the time taken to travel it, which corresponds to the second meaning that our contemporary dictionaries give to the word *speed*, and which is so different from the first, the only one known to the Greeks, that we do not hesitate to qualify this speed itself as *more or less rapid* or *more or less slow*.

If the Greeks did not have what I call here *our notion of speed*, it is not simply because they did not think, by virtue of some form sort of blindness or timidity, of taking the step that more recent authors have thought of. It is in fact a case of outright refusal, the reason for which was much more fundamental.

*Speed*, as we understand it today, we have just said, is a ratio, or, as it was said in the past, a *reason* or *logos* (the ratio between space traveled and the time taken to travel it). The theory of *ratios*, from magnitude to magnitude, plays a considerable role in Greek mathematics; all the more considerable given that these ratios occupy the place occupied by what we call in today's mathematics *positive real numbers*. It therefore enables the Greeks to envisage all magnitudes be they rational or irrational. We know that this theory of ratios, upon which all Greek geometry leans, in particular that of Archimedes, is the subject of book V of Euclid's *Elements*. Now this book stipulates straightaway that there is only *ratio* between two terms if these two terms designate homogeneous magnitudes, which is, I shall add, a phenomenological evidence: two heterogeneous magnitudes, on the one hand the

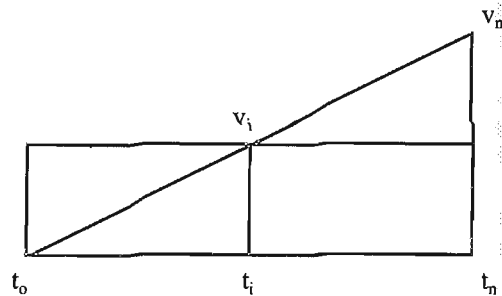
distance from one point to another and on the other the time taken to travel it, can have no ratio between them. This is why speed, as we understand it today, is essentially unthinkable for a Greek.

We should not however be too quick to draw conclusions from this remark. The Greeks may not have the notion of *speed*, but have nevertheless the notion of *superior*, *inferior*, or *equal speed* to another speed. Aristotle, in book IV of his *Physics*, in his discussion on the existence of emptiness, is thus lead to envisage moving bodies of unequal speeds. A short time later, Archimedes calls upon the notion of equal speed for the construction of his spiral, using the Greek adverb  $\upsilon\phi\sigma\sigma\tau\alpha\chi\epsilon\tau\omega$ , which does indeed mean "at equal speed". In effect nothing disallowed the Greeks from thinking a speed higher or lower than another, because there is indeed homogeneity between *the distance* traveled by a body during a given time and the longer, equal or shorter *distance* traveled by another body during the same space of time. Only is *speed* in itself, as in our supposed ratio between distance traveled and time, inconceivable for the Greeks.

Not only a higher or lower speed, but also a speed double or triple another are *naturally* thought of: a triple speed is the ratio between these two homogeneous magnitudes which are a triple distance to a single distance traveled in the same time by two moving bodies respectively, a ratio whose value is independent of the unit which is used for measuring these distances. On the contrary, *speed* in itself has no natural existence that permits the proposal of a definition of it in the Socratic tradition, all the more so since, even if one allowed oneself to think of it as the ratio between the distance traveled and the time taken to travel it, there would then be as many speeds as pairs of units conventionally chosen to measure this distance and this time respectively.

The specifically logical difficulty in thinking of speed as the ratio between a distance and a time, was not to be overcome until much later, when it became understood that this arbitrary double inherent in the choice of the unit of measurement does not stop us from being able to confer upon what we designate as speed certain properties like, for example, the one expressed in what we call *Merton's rule* or *theorem*, as it seems to have been expressed for the first time towards 1330 at Oxford by the *Fellows of Merton College*. This theorem states that a mov-

ing body, of a *uniformly difform* speed (*uniformiter difformis*, today we say of *uniform acceleration*), travels in a given time over the same distance that it should cover, if its speed at half way was its *uniform* speed. A property which Galileo would generalize three centuries later and which the authors of the 14th century were already representing in the following diagram which anticipates the representation of Cartesian co-ordinates, as the times are on the abscissa, the instantaneous speeds in ordinates, whilst the distance covered is expressed, as the sum of all instantaneous speeds, in the area of the triangle  $t_0 t_n v_n$ , clearly equivalent to the rectangle of length  $t_0 t_n$  and width  $t_i v_i$ .



It was probably not until the 17th century that this innovation from the physicists of Oxford experienced the developments it deserved and the idea of instantaneous speed was fully extricated, represented here by simple lines, i.e., the limit of the ratio of the space traveled to the time taken to cover it when the latter tends towards zero, in other words a *derivative*. It will above all be necessary to characterize the *acceleration* of this speed, a case of recognizing the nature of a *second derivative*.

Perhaps the objection will be raised that the terms designating *acceleration* already existed in Greek and Latin. In the classical era *acceleratio* was an accepted Latin substantive and the Greeks designated the same thing by the work *epeixis*. However, *acceleratio*, as well as its Greek equivalent, if we consult the texts to which our dictionaries refer, means the simple act of hurrying oneself, of going more quickly than at a normal pace, as would a troop of soldiers going to the aid of another troop in difficulty; which evidently has little to do with this derivative of the derivative which the term *acceleration* envelops for us since the 17th century.

Aimed at showing the way in which, from lexical and grammatical forms borrowed from vernacular languages, logicians and mathematicians tried to elaborate logico-mathematical functions susceptible to founding a deductive reasoning, this last example thus links up with the conclusions I think I have already drawn from the previous examples; with one difference, this third example regards a composite of the notion of time, i.e., that of speed, the ratio of a certain distance to a certain time, then the limit of such a ratio.

However this third example shows moreover that it can happen that so called *natural* language itself borrows in its turn certain lexical and grammatical resources from logico-mathematical vocabulary. A car driver even of the most modest intellectual level, believes he knows what the instantaneous speed of the vehicle is when he reads the number 80 on the speedometer. If a Socrates were to sit next to this driver, he could ask him the very Socratic question of how he can say that the speed is 80, when an instant earlier the speedometer read 60, and an instant later perhaps it will

read 100. I shall pass over the rest of this Socratic dialogue which would evidently turn towards acceleration, for the purposes of which, our driver could point out to a Socrates decidedly out of his depth, there is a foot-pedal.

Conclusion: time does not allow itself to be spoken, or even communicated just anyhow. Bearing witness to this is a certain convergence of the expression of time in natural languages, and not only in Indo-European languages. Their relative divergence however, also testifies to the plurality of means from which a language has had to choose.

In passing from vernacular to logico-mathematical languages, we observe that, if the latter initially take their inspiration from the former, they retain and add elements open to giving to the *logos* functions without which the discourse could not make itself the vehicle for what we designate to be *deduction* and even, in some privileged cases, lend itself to what we call *operations*. Finally, our last example showed that these functional elaborations can in return leave their mark on natural languages.

# Time of Soft Ideas\*

Jean-Blaise Grize

## Introduction

My title encompasses primarily the notion of *soft ideas*, by which it should be understood that they are soft as opposed to hard, in the same way that we might speak of soft and hard sciences. However, they are also soft in the sense that they allow themselves to be shaped, just as wax does. Then there is *time*, which needs to be understood in two ways: on the one hand it refers to an epoch, as in 'harvest time'; on the other it refers to a concept, as it does in the theory of relativity. All this moreover in conjunction with the centenary of the birth of Jean Piaget, for two reasons plus one. 1) The role he played in the return to scientific prominence of the role of the human subject and 2) his way of approaching the problem of time. As for the third reason, it is the debt that I owe towards someone whose thought has marked my work as a whole.

## The epistemological turning point

One can say that the essential epistemological turning point is the relation between the knowing subject and the objects that he knows. It has a very simple answer that is even endowed with some conspicuous evidence: it is that the subject is in the presence of the spectacle of nature and that his vocation is to observe its habits and customs. Reality is given, the laws of nature are inscribed in the world, so that the task of the scholar is to formulate them into as rigorous a language as possible, this evidently being the language of mathematics. In his *Discourse on Method*, Descartes wrote:

"I derived the most pleasure from mathematics, because of the certainty and the evidence of its reason [...] and I was surprised that with its foundations being so firm and so solid, nothing more elevated had been built upon them".

Descartes would be surprised no longer: much has been built since 1637!

Perhaps my approach to some extent a caricature, but those who were adults in the sixties and seventies were able to witness, as I did, that such was the compost heap upon which structuralism, in vogue at the time, reposed. Of course, it has never been a case of underestimating the role of experimentation and thus the work of the subject. Nevertheless the fact remains that even William James, who had the merit of insisting upon the pragmatic dimension of knowledge, never questioned whether observed facts were indeed given facts. Certainly time was needed to progress from opinion to knowledge, but this was no more than a bad spell to be endured. Once the work had been accomplished, the scholar finally delighted in the contemplation of a truth which owed him nothing more since, as Russell (1912) said, the logical structures brought to the fore are parallel to those of the world. Those were the good times, when the structuralists agreed with each other and got together to "sing aloud in every key the song of thought without subjects" (Dufour, 1993).

I do not claim that nobody sings thus anymore. Piaget did however, opposing this sort of positivism with the conception of a certain form of constructivism. He ceaselessly showed that knowledge is never given in itself but that it is, at each moment, the result of interactions between the subject and his environment. It should not be forgotten that, when he started, Piaget studied biology and that if Neuchâtel has reason to celebrate his anniversary, the molluscs in its lake are to be taken seriously. Through his observation of their adaptation to their environment, they allowed Piaget to base his conception of the development of knowledge on the two great processes which are those of assimilation and accommodation. The thinking subject assimilates the data from his experiences to schemes that he has already elaborated, and in a parallel fashion he accommodates them to that which is exterior to them. From this ensue successive levels of

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\* Translated by Anne-Marie Rifai.

equilibration which are so many stages along the infinite pathway of knowledge.

The introduction of the subject and of his activity in the epistemological landscape establishes change. The problem then is no longer to bring back the changing to the identical, as Emile Meyerson did in *Identity and Reality* (1908), but to make it the very driving force behind the growth of knowledge. "The nature of the subject is to constitute a centre of operation and not the centre *a priori* of a finished building." The quote is taken from a volume on structuralism by Piaget in the *Que Sais-je* series (1968:123), showing that, far from rejecting structuralism, he subverted it and the key is found herein, that a structure is not conceived of as a static form, but as a system of transformations.

Nevertheless, this does not go without giving rise to certain problems. Firstly, in my language a transformation is a soft idea. The chrysalis transforms itself into a butterfly, the new owner transforms his house, and art transforms all that it touches. Furthermore, if there is transformation, then there are two states, and it is therefore natural – if not mathematical – to think that the one is prior to the other, thus launching the question of time.

### Speed and duration

I fear I could not, without impertinence and hence without indecency, compare myself to Saint Augustin: I have neither the faith nor the genius. Nonetheless, there is a point where, in all modesty, I can confess with him. "What is time? If nobody asks me this, I know the answer; but if I am asked and wish to explain, I no longer know it" (Confessions, Book 11, chapter XIV). I shall thus not seek to explain time and shall content myself with proposing a distinction: the distinction between the time of things and the time of subjects.

"It is in perceiving movement, wrote Aristotle, that we perceive time" (Phys. IV, II, 219a). Time thus appears to be exterior to the subject, it is a milieu within which changes take place, a milieu which moreover, with Einstein, revealed itself to be joined with that of space. Nevertheless, time offers its own difficulty, that of how to measure it. A distance is measured in relation to a length; time, however, cannot be

measured by a time any more than a temperature can be measured by a temperature unit. In the two cases, we have to call upon associated phenomena and it is here that I come to Piaget, for whom the problem was precisely one of the measurement of time. We know the solution: The associated phenomenon, the only directly perceptible one is speed, hence the duration of a movement is the quotient of a measurement of change by the speed of that change.

In accordance with his erudite approach, Piaget seeks invariants and laws of conservation, which, on the one hand may seem paradoxical when it is a question of coming-to-be, but on the other gives thought great coherence. The genesis of time thus appears analogous to that of number: it is the operative synthesis of seriations of events and the interlocking of durations. Even if, as he saw it, Aristotle sometimes had the mentality of a child of seven, Piaget agrees with him when the Stagirite completes his thought in writing "Time is thus a sort of number."

The outcome of this is that physical time is by nature essentially reversible and that, as Einstein wrote to his friend Besso: "the distinction between the past, present and future is only an illusion, albeit a tenacious one" (quoted by Prigogine and Stengers 1979:275). We reside in a world which is ultimately atemporal: However much  $x$  and  $y$  may vary, in  $y = f(x)$ ,  $f$  is constant. To be sure, classical sciences like to speak of cycles but if these cycles involve time, it is purely repetitive and not in the least creative time, as Bergson would have had it.

It is true that, again as Ilya Prigogine and Isabelle Stengers wrote on the same page:

"The physics of today no longer denies time. It recognises the irreversible time of evolutions towards equilibrium, the rhythmic time of structures whose pulsion feeds itself on the world which traverses them, time causing evolutionary branching through instability and exemplification of fluctuations, and even microscopic time [...] which manifests the indetermination of microscopic physical evolutions".

Nevertheless it remains that, even in atomic physics, the laws of conservation continue to play an essential role: conservation of energy, of the quantity of movement, of electrical charge, etc. What is more, in order to recognize the irreversibility of time, the physicist must take into

consideration the position of the observer, who has become a participant. This brings me to an examination of time with regard to the subject.

The best way of envisaging time lived by the subject is to do so from the point of view of duration, Paul Fraisse did this through his debate with Piaget. In his eyes, duration is the (temporal) distance that separates the subject from his desire and from his memory, which brings with it an essential qualitative aspect. In effect, only the desire for or memory of 'something' could exist, as a result we live through temporal experiences which have nothing to do with movement and speed. Duration thus finds itself to be the basis of a kind of evolution, it is the foundation of the prior and the subsequent. "Duration thus appears to us to be a dynamic organisation of the successive" (Fraisse 1966: 268).

Before going any further, I would like to stress that, in its most interiorized form, the experience of time takes the form of dream time – this time which, in an article in *Psychiatric Confrontations*, Paul Hermann says to be an "intuitive, uncultivated, shapeless, chaotic time full of the energy of desire" (1996:70). In fact, however, and seen from the outside, it justifies a non-mechanical causality, a psychological causality in which the cause can be slow to have effect. This psychological causality could even be, according to Barreau (1982), the only one to have a place in the Hopi mentality studied by Worth.

Having said this, it is important to note that considering the subject as a participant in the development of knowledge makes it necessary, as a consequence, to consider the way he communicates his knowledge, hence it is essential to study his discourse and its language mechanisms. One is thus led to distinguish between the tense of predicates and the tense of verbs. The tense of predicates is reduced to three theoretical moments:  $x$  is future,  $x$  is present, and  $x$  is past. However, the tense of verbs is necessarily attached to the moment of the utterance, to the moment when the subject shapes his ideas – which are thus soft ideas, in the sense that they can be shaped.

### Schematizations and models

It is time – so to speak – to adopt a more academic vocabulary. Henceforth I shall refer to

soft ideas as *notions* and to hard ideas as *concepts*. I shall, however, restrict myself to situations in which concepts and notions are communicated through a natural language. I shall thus leave aside the use of logico-mathematical languages. I shall thus examine the discourse activities that are generated from notions, which I call *schematizations* and from concepts, which I shall call *models*.

Specific to notions is that they remain linked to realities which are exterior to them, to what Peirce named dynamic objects and which I shall call *referents*. Thus, when Francois Furet (1996) speaks of "totalitarianism" in the much debated *The Passing of an Illusion. Essay on the Communist Idea in the XXth Century*, he is not only referring to a dictionary definition but also to Stalinism, Nazism and fascism, in that for us, culturally, they are united. A notion is thus dependent upon the speaker, the addressee, and the interlocutory situation. In contrast, a concept stands on its own, which is to say that it is taken 'as is' and that it is, as Sartre wrote in the introduction to *Being and Nothingness* "isolated in its being and maintaining no relationship with anything which is not itself" (1943: 33). Of course, the concepts in a model do not exist in isolation; however, each one draws only upon other concepts and never opens upon an exterior reality.

At this point, I would like to highlight five aspects that enable us to distinguish between schematizations and models.

- (1) In a schematization, discursive activity transforms the notions that it treats, each one being both the same and another, as is all that exists within the boundaries of time. In the case of a model, discursive activity substitutes one concept for another. A model thus proposes a succession of momentary snapshots and not an evolution.
- (2) A schematization can call upon a temporal and causal order, whilst a model only provides reasons. A demonstration constitutes the best example of discursive activity within a model. Firstly, a demonstration is an object: a series of propositions such that each of them is either an axiom, a theorem or the result of one or several propositions which precede it by the application of a system rule where, moreover, "to precede" is an order rela-

tion that has nothing to do with time. Then each of the axioms or the theorems used constitutes a reason for the conclusion and not one of its causes.

- (3) A schematization is a communication whereas a model is a presentation. Communication is made *hic et nunc* in the here and now. That is to say that the present is a sort of operator which, when applied to the future, is transformed into the past. In a model, the present only marks a state and the unforeseen has no place. The opposite is the case in a schematization, which communicates and is not content with merely presenting: in a discourse, which is always linked to its referents, meaning results from the activity of the addressee and hence something new may emerge.
- (4) A schematization is of a concrete descriptive order whilst a model is of an abstract theoretical one.
- (5) Finally it is possible to link schematizations to the idea of complexity. Unlike the idea of complication, what is complex is that which does not necessarily have a great number of elements but includes processes which are not only linear or even arborescent, but processes which loop, that is to say those processes which are as determined by their future as by their past.

Of course, schematizing and modeling are both the activities of the same thinking subject, a subject who is himself in time. However, whilst a modelization produces a model from which the creator has removed himself, the term schematization remains a nominalization and never leads to a result which would be detached from its initiator.

If it is evident that all knowledge, whether of the world or of man, is fundamentally based upon the observation of events, human sciences pose a particular problem: it is that man does not conceive of himself outside history, which “offers neither spontaneous repetition nor the possibility of isolating the variables under laboratory conditions” (Passeron 1991: 25). The problem then is one of the discursive repetition of events and it should be recognized that models, with their rigid concepts, do not lend themselves to this at all. A model never represents a singular event, but only classes of events. You will of

course put forward the argument of the Big Bang model, the Big Bang being an event that is generally considered to be unique and obviously having to do with coming-to-be. However, to say that it is a model is simply a figure of speech. In fact, it is presented as a story, as an account. It is true that we are not dealing with a fictitious account in the literary or mythical sense of the term, but it does have recourse to many sorts of phenomena which are themselves indebted to models of physics and chemistry *stricto sensu*. What then is an account? Gerard Genette replied that it is the representation – I would say the schematization – of what is an “act or event, the passage from a prior to a subsequent and resulting state” (quoted by Ducrot and Schaeffer 1995: 195). We are thus plunged into the domain of time, of causes and not of reasons.

It is necessary nevertheless to face up to a serious obstacle, computer simulation and expert systems (E.S.) which, on the one hand are entirely based on models – mathematical models even – and which on the other, moreover, unfold from processes which Hilbert type formal systems are quite incapable of doing. Let us therefore look at this more closely. You “run” an E.S. program and *after a certain time*, the screen displays a conclusion. “But why this particular conclusion?” you might ask. The system, at least if it is one of the first generation, will reply to you by listing the rules and axioms it used. We are apparently then quite close to Genette’s definition. However, two points should be noted. 1) We are in the presence of reasons and not causes, so that the conclusion, if it turns out well, is not for all that an event. Except of course for you. The program has effectively taken some time, but it is the time taken to calculate and write, it is not time which you live like an event, that is to say time which is outside the system. 2) What is more, in what we like to call “man-machine dialogue,” the machine produces only propositions, never statements. The machine is not in the position of co-speaker.

Somewhere I wrote a small article entitled “The ailing sociology of physics.” In fact, I spoke only of sociology for reasons of convenience – perhaps moreover I should state the causes! But it is the case that sciences of a historical dimension cannot be satisfied with models alone because, they live the singular. The most marked case is probably that of psychoanalysis, which goes as far as basing itself on

individual case histories: the case of Anna O. is a typical example of this. *Maxwell's demon* you may retort, but that is the point, the second principle of thermodynamics shows the impossibility of its existence, unlike that of Madame Bertha Pappenheim (1859-1936).

Since I have just alluded to entropy, the physical mark of the irreversibility of time, I would like to use this opportunity to emphasize that it is in fact precisely living organisms situated in time, subjects with their plans and desires, who are uniquely capable of reversing the workings of entropy. In conclusion, this leads me to return to the fact that, in contrast to the models from which he has withdrawn, the subject remains within the interior of his schematizations. The notions which he works upon there remain linked to the situation in which he communicates, they call, as I have said, upon referents, upon cultural unities which are more or less shared by the addressee who ceaselessly interprets what is being proposed to him. As Jean-Claude Passeron wrote in the conclusion to the work already quoted (1991: 380):

“the meaning [of these objects of thought] would not be exhausted by a ‘precise definition’ since they cannot be completely cut off, to retain an operative meaning in scientific language, from their didactic reference to names peculiar to historical individualities.”

Thus, contrary to what takes place in models, agreement upon definitions and the rules of the game is not pre-established. Metalanguage is totally interwoven with the object language. It is this that has often led Jean-Claude Gardin to be ironic regarding the too numerous publications of daunting thickness which exist in the field of

human sciences and in which the authors dedicate far more pages to the exposition of their point of view, their methods and the erring ways of their colleagues than to really dealing with the subject itself. This observation is irrefutable. What can I say, however, as Valéry wrote in *The idée fixe*: “A pearl must have a mollusc”: hard ideas presuppose soft ideas.

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# The Time of Rationality

Olivier Houdé

To be a developmental psychologist is to think time. In the case of cognitive development, it is to think the time of rationality, or to be more precise, to *rethink it after Jean Piaget*. On the occasion of the centenary of the birth of Piaget celebrated in Neuchâtel, the international colloquium "Mind and Time" provided the appropriate place for this reflection (see also our tribute published simultaneously in the special edition of *Psychologie Française: "Piaget après Piaget"*). It was an emotional gathering, in the presence of the three leading players in *La construction du réel chez l'enfant*: Jacqueline, Lucienne, and Laurent Piaget.

Jean Piaget taught us that cognitive development is a linear, incremental and refining construction: one rational structure replacing a less or totally irrational one. Today, by referring to Michel Serres (1992), for whom scientific development is not always linear, but more according to a time which folds and twists like a "crumpled handkerchief", we can take a different approach to the development of rationality. Let us say: it advances in an altogether tortuous way. Just like the well-worn routes taken by scholars, always wrong after the event, individual stories enclose curious contradictions in the folds of their own time. This is as true for babies as it is for adults. Through four examples relating to the construction of the object, to number, to categorization, and to reasoning, we can show the existence of evident competencies that undergo serious and irrational reversals. Why? Doubtless because to develop is also to know how to inhibit a concurrent structure or notion. And this does not go without saying.

**Whilst the child is functioning, "time is crumpling"**

Although it follows the rules of common sense, the Piagetian linear and hierarchical analysis of the "time in science" is now outdated. The sci-

ence historian Michel Serres in his *Eclaircissements* (interviews with Bruno Latour) suggests that time in scientific development is not always linear but extraordinarily complex, showing the stops, the ruptures, the lows, the highs of breathtaking acceleration, the rips, and the gaps. The author proposes the metaphor of time which folds and twists like an oft unfolded "crumpled handkerchief" at the bottom of a pocket whose relationships reveal some topology, a science of closeness and apartness, not the well defined and stable distances of "metrical geometry". From this it emerges that a "fold in time" can reveal not only equivalent modernness in two very distant elements (Serres gives the example of Lucretius and of the modern theory of fluids), but also the proximity of the modern to the archaic. This observation is not only true of the general history of sciences, but also at an individual level and can be applied to the route taken by scholars whose erratic genius is often denounced.

The child psychologist cannot remain insensitive to this turbulent concept of "time in science" all the more so given the emergence of current experimental data covering areas ranging from object construction in babies to reasoning in adults and given that cognitive development does itself appear to fold and twist, going one way and then another. Often, whilst the child is functioning "time is crumpling" and the indicators of the "folds in time" are, in this case, the rational proximity of behaviors which are temporally distant, hence the possible coexistence, at any point in development, of the "rational which has been constructed" and the "irrational which is presumed to be in the past".

From an analysis of this sort, some embarrassing paradoxes in developmental psychology can arise, such as the observation that a baby may be precociously rational whilst often the child or even the adult may not. Being intelligent is not simply a question of activating the "rational which has been constructed", it is also and above all one of managing to inhibit, at all times,

the "irrational presumed to be in the past", that is to say the ever possible transgression of the "rational which has been constructed". From this emerges the necessity for a precise study into the role of the process of inhibition in cognitive functioning and development.

### Cognitive development and inhibition

The history of the concept of inhibition is long and diverse (see Smith, 1992) and seems to have had new life breathed into it in terms of cognitive psychology. This re-emergence of the question of inhibition which goes back to the beginning of the nineties – simultaneously in France (Houdé, 1995) and in North America (Dagenbach & Carr, 1994; Dempster & Brainerd, 1995), mostly through the impetus provided by Juan Pascual-Leone (1988) – is a result of the study of developmental and individual differences, of the growing impact of cognitive neurosciences (the recent slide from the computer metaphor for activation to the neuronal metaphor for activation and inhibition), of connectionist models (the role of inhibition in the robustness of networks), of research on selective attention ("negative priming") and of the new relationships between psychopathology and cognitive sciences (cognitive models of mental instability in terms of executive dysfunction and inefficient inhibition).

Within the framework of the study of developmental and interindividual differences, current experimental research aims to analyze, at different stages of childhood cognitive development, the workings of the activation and inhibition mechanisms implicated in the selection of a pertinent resolution process (the activation of the "rational which has been constructed" and the inhibition of the "irrational which is presumed to be in the past"). The accent is thus placed upon cognitive competition in the treatment of information and upon resistance to interferences. The underlying hypothesis is that development cannot be reduced to the incremental substitution of new structures (as is the case with Piaget's structuralist theory and with the neostructuralist models of the 80's), but that "to develop oneself is also and often to inhibit a competing structure or notion" (Houdé, 1995). In order to illustrate this theoretical approach, here are four experimental examples: the con-

struction of the object, number, categorization and reasoning.

### The construction of the object

The question of the relationship between cognitive development and inhibition is posed from the genesis of the base unit of reality that is the permanent object. Cognitive research into the oculomotor activities of babies (the study into visual fixation times), notably uses the time taken to react to the impossible event, indicating the existence, from four to five months, of a precocious permanence of the object (Baillargeon, Spelke & Wasserman, 1985; Baillargeon, 1987). How then can we explain the famous "A-not-B" error observed by Piaget in babies towards the age of eight months and which continues to substitute up to the age of one?

We recall that in order to highlight this error, the experimenter places the baby before two equally accessible hiding places and puts an object in hiding place A. The baby finds it without difficulty. After this procedure is repeated several times, the object is moved very visibly into hiding place B. If the baby continues to look for the object in A, it commits the A-not-B error. According to Piaget, this error of localization reflects a permanence of the object flaw, in that the baby should know that the object continues to exist in hiding place B when it disappears from view in that place. However today, this explanation is no longer acceptable since cognitive research indicates that the notion of permanence of the object exists well in advance (from four to five months) of the A-not-B error! On the other hand, an analysis in terms of inhibition processes is able to lift this first "developmental paradox."

Situations such as the oculomotor reaction to the impossible event used by Baillargeon (an event which transgresses the permanence of the object) can in effect be considered as optimal contexts where the "simple" activation of the notion of permanence of the object is sufficient, whilst the Piagetian situation of the object which disappears in A-A-A-etc., and then in B is a "trap situation" which, according to neuropsychological analyses of the relationship between the prefrontal cortex and the A-not-B error, requires the inhibition of a dominant motor tendency: the gesture programmed towards A (Dia-

mond, 1991; Bell & Fox, 1992, 1994). The A-not-B error would therefore reflect an executive flaw in motor inhibition and not the absence of permanence of the object. One could even put forward the idea according to which this motor inhibition falls within the area of a flaw in the cognitive inhibition of certain experiential and implicit knowledge gained by the baby regarding objects and space, knowledge situated at the level of structures of memorization of past experiences which have close links with the prefrontal cortex (Houdé, 1996).

Thus for the baby, to be intelligent (to no longer make the A-not-B error) is to inhibit. Here we are at one with Diamond's conclusion according to which:

"cognitive development should not only be conceived of as the progressive *acquisition* of knowledge, but also as revealing a capacity for *inhibiting* reactions which hinder the expression of knowledge already presented [in this instance the permanence of the object]" (1991:67).

The following three examples relating to logico-mathematical operations (number, categorization and reasoning), show that the "folds in time", already characteristic of the sensory-motor level wherein coexist the "rational which is constructed" (the precocious permanence of the object) and the "irrational which is presumed to be in the past" (its transgression by the A-not-B error), continue to characterize cognitive performances up to adulthood. In effect, the baby who has become an "efficient inhibitor" with regard to the permanence of the object, precedes the child, the adolescent and the adult who often are either not or no longer, "efficient inhibitors" when the object-unit is placed within the context of more complex activities. Like the history of science, cognitive development ceaselessly "crumples," hence the recurrent aspect of the role of inhibition.

## Number

In the realms of the construction of number, cognitive research has also revealed the existence of precocious competencies of which Piaget was unaware. Recent studies have also shown that babies of four or five months whose oculomotor (time of visual fixing) functioning

was observed, are capable of detecting the transgression or the "conservation" of number when they are presented with possible and impossible numerical events (Wynn, 1992, 1995; see also Simon, Hespos & Rochat, 1995, for a replication). The experimental controls carried out do seem to indicate that the way the baby treats numerical information is founded upon an analytical process of "precise calculation" and not upon a global or holistic perceptive treatment process. Furthermore, from an adaptation of Wynn's paradigm, it has been shown that these "proto-numerical" abilities reorganize themselves at a cognitive-linguistic level through a mechanism of "representational re description" (a concept borrowed from Karmiloff-Smith, 1992) and are found in the child of pre-school age after a temporary drop in performance (Houdé, 1997). How then can the irrationality of the child of this age be explained in the Piagetian test of conservation of number where, when faced with two rows of counters of equal number but of unequal length (one row being more spread out than the other), the child considers that there are more counters in the longer row?

We are familiar with Piaget's interpretation according to which the child of pre-school age is still fundamentally intuitive, "preoperative", that is to say limited to a global and holistic perceptive process when treating information (founded upon length). The child has thus not yet constructed the "scheme of number" which will place at his disposal an analytical process of precise calculation. The cognitive research that has just been mentioned calls this interpretation into question. In effect, is it not more likely to be the case that here we are dealing with a new "fold in time", that we are in the presence of the coexistence of the "rational which has been constructed" (or "reconstructed" at a cognitive-linguistic level by the child of pre-school age, in this case the capacity for precise and analytical numerical treatment) and the "irrational which is presumed to be in the past": the transgression of number in the conservation test? Is this last test not, above all, a critical "number/length" interference test of the ability to resist the "length=number" visuo-spatial scheme?

In accordance with Dempster in his work *Interference and inhibition in cognition*, it does seem that

"situations of conservation and inclusions of classes have more to do with the

ability to resist interferences than with the child's ability to understand the underlying logic" (1995:15)

Here too, as is the case for the A-not-B error in the construction of the object, to be intelligent (to resist the visuo-spatial scheme) is essentially to be capable of inhibition (Houdé, 1995, 1997). We therefore join in Bryant's past observation (taken up by Cohen, 1992) according to which, it is difficult to continue to believe that children of pre-school age have not grasped the meaning of invariance when in fact, they use it in one situation (here Wynn's adapted paradigm) and bizarrely, not in another (when a "number-length" trap is introduced). The real problem is not one of knowing whether the child is conserving or not, but of knowing why he does or does not use his abilities.

### Categorization

In the realms of categorization, a coherent body of research into the logic of classes (Bideaud & Lautrey, 1983; Bideaud, 1988; Houdé, 1992) indicates that up to the age of eleven children fail certain modified tests of inclusion, called "Modification" and "Screen" (for example, "can we do something or not in order to have more of A than B?," in a situation where  $A \subset B$ ) even though they pass the classic Piagetian test ("Is there more of A or B?") from the age of seven. Thus, the child of school age, in the presence of material consisting of ten daisies and two roses, consider erroneously that they can obtain more of A (daisies) than B (flowers) by adding As or taking away Bs. The interpretation which is generally placed upon this (notably by Bidaud, 1988) is that this child is "empirical" and not logical, in so far as he treats the interlocking ( $A \subset B$ ) like disjointed collections as they exist in the schemas or scripts of the environment (the schema "make bouquets", the bouquet of As and the bouquet of Bs, for the flowers example).

However, is the child of school age really empirical in the sense of an absence of internal logic (absence in memory of a scheme of inclusion in classes)? Or, is he an "inefficient inhibitor" regarding locally inadequate cognitive routines such as, in this case, the arithmetic routine of adding and taking away? Are we not once again in the presence of a "fold in time" where there is coexistence between on the one hand,

the "rational which has been constructed", here the scheme of inclusion applied when taking the classic Piagetian test from seven to eight years old (in which the child correctly considers there to be more B than A) and on the other hand, "the irrational presumed to be in the past": the transgression of this scheme when taking the modified tests of inclusion up to the age of ten to eleven? Piaget himself, in one of his later works, *Vers une logique des significations* (Piaget & Garcia, 1987), shows that from five to six years old in optimal contexts of intensional logic (that is to say without the trap of the extensional quantification of the As and Bs), "inclusion does not give rise to a problem" (128) (see also Houdé & Charron, 1995). It appears in fact, from recent neuropsychological data (Houdé, 1995; Houdé & Joyes, 1995), that the intelligence required by those modified tests of inclusion undertaken successfully towards the age of ten or eleven, consists above all in introducing a discontinuity into the acquired loop, that is to say, in inhibiting the routine of adding and taking away and then integrating pertinent contingent factors, in this case, classes in relation to inclusion.

### Reasoning

In cognitive psychology inferential activities, upon which deduction and its requirement for necessity are founded, have been the object of numerous studies of adolescents and adults. Do they confirm the deductive competence of the "logical mind" described by Piaget? It seems not. The last two decades have seen experimental data jostling for position and animated debate on the question; the agitation is such that the presumption of rationality which credits the human mind with logic as automatic is constantly being "called to the bar" (Houdé & Miéville, 1993).

It is studies relative to the biases of reasoning which highlight the irrationality of the adolescent and the adult most strongly (Evans, 1989). It is a question of studying the systematic tendencies, taking into consideration factors that are not relevant to the task to be resolved, and ignoring those factors which are relevant. One of the classic biases of deductive functioning is the "bias of perceptive matching" which affects propositional reasoning in tasks of falsification

or verification of conditional rules: if p (antecedent), then q (consequent). For the example of the rule to be falsified "If there is not a red square on the left, then there is a yellow circle on the right", this bias consists of a preference for the elements cited in the rule under consideration (from whence the erroneous response "red square on the left, yellow circle on the right", thus false antecedent, true consequent: FT) and a neglect of the pertinent elements (a TF type situation) since they are not matched to either the antecedent or the consequent.

Should we conclude, when faced with this evidence of irrationality, that the essence of human reasoning is heuristic, that it does not conform to the canons of logic and that deductive competence is condemned to being short-circuited by cognitive bias? The data from research using the method of experimental learning of inhibition (Houdé, 1995; Houdé & Moutier, 1996) go in the direction of a "presumption of rationality" in so far as the biases which underlie the errors in reasoning do not appear to reveal a defect in the logic but a defect in the executive programming of inhibition (in our example, the inhibition of a matching scheme). Therefore for the adult, just as for the baby and the child it is – since the A-not-B error; the first ancestor of reasoning bias – a case of a time which "folds and twists", revealing the possible co-existence of the "rational which has been constructed", deductive competence and the "irrational presumed to be in the past": its transgression by reasoning biases.

#### "Time unfolded"

So many key examples where, for the psychologist, it is a question of determining what is a product of the irrational subject (absence of cognitive structuring: permanence of the object, number, inclusion in classes, deduction): and what is a product of the subject as an "inefficient inhibitor", that is to say incapable of inhibiting a concurrent and interfering structuring. Furthermore, throughout development it is a question of analyzing the relationships of psychological causality between these two explanations for performances: Is the subject incapable of inhibiting because he is irrational (which would bring us back to the classic Piagetian point of view) or does he appear irrational because he is incapable

of inhibiting? Unless one contents oneself with the classical and reassuring analysis (the first alternative), the answer to this question cannot be unique and clear cut. It all depends upon age, the experimental situation, and interindividual differences. To attempt to find an answer, whilst delimiting the diversity of facts as much as possible, could lead to a redefinition of the stages of cognitive development and the processes of transition.

After having folded the time of development like Serres' "crumpled handkerchief", it is in fact tempting to try to unfold it to look for a new metric, "new stages". If these show signs of the cognitive turbulence observed throughout development – from the construction of the object in babies to reasoning in adults – and the close relationships between "turbulent intelligence" and inhibition, they could not be confused with Piagetian stages.

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# The Temporality of Discourses: A Contribution to the Reshaping of Human Actions

Jean-Paul Bronckart

The propositions laid out in this contribution are in keeping with the general framework of *socio-discursive interactionism*. Being psychologists, our major sources of reference are the works of Vygotsky (1927-1934), crossbred with Piaget (1946), and because of the very principles of socio-discursive interactionism (Bronckart, 1994; 1997), we also think that psychology needs to integrate into its concerns the contributions of certain schools of philosophy, sociology and linguistics, in particular those of Bakhtine (1978; 1984), Habermas (1985), Ricœur (1984; 1986), Saussure (1916) and Wittgenstein (1974).

For us, the principal focus of human-social sciences is activity, carried out in historically constructed social formations. The very organization of this activity, in its most “practical” forms, is indissolubly linked with the presence of a particular kind of interaction, *language*, conceived as a process of negotiation and agreement about the contexts in which this activity takes place, and hence, as an instrument for evaluating this activity<sup>1</sup>.

Within the concerted efforts of social sciences, psychology takes *action* as its specific unit of analysis. Defined first from an external standpoint (which is also a genealogical one), action is a *portion of social activity*, which is carved out and ascribed to an agent by the play of socio-linguistic evaluations. From a second, internal standpoint, this unit of analysis can be defined as a product of the appropriation and interiorization of these evaluations by an active agent, which leads the agent to becoming a *person*, who possesses knowledge of the various facets of his or her own responsibility in the unfolding of portions of social activity.

The major problem of psychology is therefore the *interpretation of action*, and from there,

of the *acting person*, with his/her mental and behavioral dimensions. But since action is a product of linguistic evaluations, it can only be interpreted—directly or indirectly—by and in terms of actual linguistic productions, or *discourses*. This discursive evaluation of action comprises a synchronic aspect (the reciprocal *attributions* of capacities and responsibilities that come with these behaviors), as well as a historical aspect: from the point of view of the organization of their contents, as well as the semiotic forms making up this organization, discourses evidence the ways in which previous social formations bestowed human activities with meaning, how they interpreted and clarified activities in accordance with the situation, interests and stake that prevailed. It is in relation to this second aspect that we adhere to the thesis developed by Ricœur in *Time and Narrative* (1984; 1986; 1988) and in his later works, according to which discourses are examples of *reshaping* of human actions, aimed at conferring to them some sort of coherence.

As we know, from his theoretical and ontological assertions (that discourses *are* meaningful reconfigurations of human activity), Ricœur derives certain methodological conclusions for the social-human sciences: it is through analyzing discourses, using an *empirical hermeneutics*, that actions can be interpreted, or to be more precise, that one can analyze the mechanisms by which “events” are transformed into “actions”<sup>2</sup>.

In this general process of reconfiguration, the construction of temporality plays an essential role:

[...] time becomes human to the extent that it is articulated through a narrative mode, and narrative attains its full mean-

<sup>1</sup> The reader will notice that we borrow from the thesis developed by Habermas in *Theorie der kommunikativen Handelns* (1985).

<sup>2</sup> We take up the technical distinction made in analytic philosophy between “events” occurring in nature and “meaningful action” or “human action” carried out by a human being (cf. Anscombe, 1957).

ing when its becomes a condition of temporal existence (Ricoeur 1984: 52).

To present his argument, Ricoeur draws upon Augustin's gnostic problems of Time, and Heidegger's *Existential-temporal Worry* (1962). One of the Augustinian problems can be formulated as follows: "we measure time, but time has no space, and that which has no space we cannot measure":

I observed that we measure past periods of time so that we can say that one period is twice as long as another or equal to it, and likewise of other periods of time which we are capable of measuring and reporting. Therefore, as I was saying, we measure periods of time as they are passing, and if anyone says to me "How do you know?" I reply: I know because we do measure time and cannot measure what has no being; and past and future have none. [...] When we speak of lengths of time as single, duple, triple, and equal, or any other temporal relation of this kind, we must be speaking of periods of time possessing extension. In what extension then do we measure time as it is passing? Is it in the future out of which it comes to pass by? No, for we do not measure what does not yet exist. Is it in the present through which it passes? No, for we cannot measure that which has no extension. Is it in the past which it is moving? No, for we cannot measure what now does not exist (St. Augustine, Confessiones XI. 27).

An aspect of the Heideggerian *Worry* can be formulated as follows: the condition of being thrown amongst things tends to render the description of our temporality dependent on the description of the object of our Worry; and this fundamental *intra-temporality* is irreducible to a linear conception of time.

Ricoeur then borrows from the theme of *mimesis*, developed by Aristotle in the *Poetics*, to assert that *plots* in narratives have the particular function of creating a coherent temporal structure that is readable or interpretable; not only does the plot organize the events and/or the actions sequentially, it recomposes them into a *whole*, which constitutes the *story*; hence, the events and/or actions can be *situated* within this embracing framework, and thereby acquire a meaning that is, at least in part, a product of this discursive temporalization:

(...) We may say of the operation of emplotment both that it reflects the Augustinian paradox of time and that it resolves it, not in a speculative but rather in a poetic mode. It reflects the paradox inasmuch as the act of emplotment combines in variable proportions two temporal dimensions, one chronological and the other not. (...) Yet *poiesis* does more than reflect the paradox of temporality. By mediating between the two poles of event and story, emplotment brings to the paradox a solution that is the poetic act itself. This act, which I just said extract a figure from a succession, reveals itself to the listener or the reader in the story's capacity to be followed. To follow a story is to move forward in the midst of contingencies and peripeteia under the guidance of an expectation that finds its fulfilment in the "conclusion" of the story. This conclusion is not logically implied by some previous premises. It gives the story an "end point" which, in turn, furnishes the point of view from which the story can be perceived as forming a whole. To understand the story is to understand how and why the successive episodes led to this conclusion, which, far from being foreseeable, must finally be acceptable, as congruent with the episodes brought together by the story (Ricoeur 1983: 103-104).

Our purpose is to point out some of the more detailed or technical aspects of this reshaping function of the temporality of discourses.

With a non-negligible nuance, however, Ricoeur, as we have just noted, attributes this reshaping function only to narratives, and even, it seems, only to written narratives. The second restriction is untenable, for historical reasons; the first is debatable, and we shall maintain that in all types of discourses, to various degrees and by different methods, temporalization constitutes an essential element of the continual reshaping of human action.

Before illustrating this position by examining some excerpts of discourses, let us provide some clarifications of our references (linguistic, in particular) concerning the status of the temporal units that are found in languages.

In a standard conception, the temporal units (the tenses of verbs, in particular) are analyzed

in terms of the relations set down between the *moment of speech* (or the *moment of production*) and the moment of the events expressed by a verb. On this basis we can identify relations of simultaneity between the two moments (indicated by the PRESENT), of anteriority of the moment of the event with respect to that of production (indicated by PAST tenses), or of posteriority of the event (indicated by FUTURE tenses). This “physicalist” conception does by no means allow us to account for the actual conditions of usage of the whole range of temporal units, and must therefore be rejected. If it were correct, there would be a relation of simultaneity, for instance, only if the moment of the event coincided exactly with the moment that someone begins to speak. Which is exceptional, and everyone knows that most of the time verbs in the PRESENT tense denote events that, from a “physical” point of view, are anterior or posterior to the moment of production.

(1) *La semaine prochaine, le journal La Suisse réapparaît sous une forme nouvelle*<sup>3</sup>.

This example shows that in actual fact any analysis of temporal relations must take into account not just two but three parameters. To the moment of production and the moment of the event, we must add what Reichenbach (1947) calls the “psychological moment of reference.” Let’s look at some examples to introduce this *trichotomous* conception.

(2) *Demain, Pierre se rend à Lausanne.*

(3) *Demain, Pierre se rendra à Lausanne.*

(4) *Aujourd’hui, Marie range sa chambre.*

(5) *Aujourd’hui, Marie a rangé sa chambre.*

In (2) and (3), the event expressed by the verb is posterior to the moment of speech, and the enunciator has adopted a moment of reference (*demain*: tomorrow) that is also posterior to the moment of speech; thus, he has the choice of “coding” either the relation of inclusion (or simultaneity) of the moment of the event within the moment of reference [use of the PRESENT in (2)], or the relation of posteriority of the moment of the event with respect to the moment of

speech [use of the FUTURE in (3)]. In the utterances (4) and (5), the event expressed by the verb precedes the moment of speech, but the moment of reference that has been adopted (*aujourd’hui*: today) includes both the moment of speech and the moment of the event; again, the enunciator can choose to code the inclusion of the moment of the event within the moment of reference [use of the PRESENT in (4)], or the relation of anteriority of the moment of the event with respect to the moment of speech [use of the PAST in (5)].

This approach makes things clearer, but it concerns only simple phrases, cut from their context; moreover, it only accounts for the conditions of usage of a limited number of tenses. To analyse the function of temporality in its *natural setting*, namely in the context of discourse, we need to elaborate the trichotomous perspective, which we shall do by referring to the model put forward by Co Vet (1980).

- (a) First, let us note that any verbal production by a human agent “takes time”; a couple of seconds, a few minutes, several hours, and sometimes months or years for the production of novels or scientific works. It is thus preferable to speak of the *objective duration* of the act of production, rather than a “moment of production”.
- (b) This production is materialised in the form of a text of a certain *genre*, that is, a *communicative form*, constructed historically by social formations, and endowed with a greater or lesser degree of stability (novel, editorial, recipe, sermon, short story, etc.). And a text of a particular genre is itself composed of several types of discourses, interconnected in various ways. For us, the four fundamental types of discourses are *interactive discourse*, *theoretical discourse*, *interactive narrative*, and *narrative* (Bronckart, 1997).
- (c) The *types of discourse* are *linguistic forms* (i.e., forms which can be identified

<sup>3</sup> (1) *Next week*, the newspaper *La Suisse* reappears in a new form.

(2) *Tomorrow*, Pierre is going to Lausanne.

(3) *Tomorrow*, Pierre will go to Lausanne.

(4) *Today*, Mary tidies up her room

(5) *Today*, Mary has tidied up her room

In these examples, “the psychological moment of reference” is made explicit by *the nominal or adverbial phrases of time* “la semaine prochaine” (next week), “demain” (tomorrow) and “aujourd’hui” (today)

by their linguistic properties) that reflect essentially two decisions taken by the agent who produces the text. On the one hand, the decision to treat the content of the discourse as *disjoined* from the parameters of the situation of production (as is the case for interactive narrative and narrative), or, on the contrary, to treat the content as *joined* to this situation (as in interactive discourse and theoretical discourse). On the other hand, there is the decision to *involve* the parameters of the situation (as in interactive discourse and interactive narrative, which consequently include deictic units) or on the contrary to consider the discourse to be autonomous with respect to these parameters (as in narrative and theoretical discourse, which do not include deictic markers<sup>4</sup>).

- (d) The types of discourse reflect, in other words, the construction of specific *discursive worlds*, which have a status that is radically “other” than that of the objective or empirical world of the production activity. These worlds are governed by a formal entity that we generally qualify as the “*enunciator*,” but that is also called *narrator*, as in the case of an interactive narrative or narrative, and “*exhibitor*” in the case of an interactive discourse or theoretical discourse. In this construction of a discursive world, the producing agent (or empirical author), transfers as it were the “declarative responsibility” to the enunciator, who supervises the narrative process [*narration* as opposed to the *narré*, in the terms of Genette (1972)] or the exhibitory process.
- (e) This narrative or exhibitory process itself also unfolds over a certain period of time, a formal or psychological duration, which we call the *temporal reference axis* of a type of discourse.
- (f) Consequently, with respect to discourses, the three terms of the trichotomous conception then become:

- the duration of the act of production;
- the temporal reference axis of the created discursive world;
- the duration and the other properties of the referent of the verbal lexemes in the discourse.

Let's examine a short segment of *narrative*, taken from a genre in which it is common, the *historical novel*.

(6) Le 20 novembre, Charles Quint *fit* (iso) défilér sa formidable armée sous les remparts de la ville d'où les assiégés *purent* (iso) l'admirer non sans inquiétude. L'artillerie *commença* (iso) à démolir les parties les plus vétustes des murailles. [...] Derrière les vieux remparts, Guise *avait fait* (rétro) élever de nouvelles fortifications en gabions de terre d'où ses troupes *purent* (iso) mitrailler les assaillants. [...] L'artillerie impériale *s'épuisait* (iso) en vain contre ces fortifications toujours relevées. Charles Quint *fit* (iso) creuser des sapes sous les remparts et sous la ville. Ces tunnels bourrés de mines *allaient tout faire sauter* (pro).

(J. Orieux, *Catherine de Médicis*)

First we notice that in this segment none of the temporal units (verb tense, adverb, prepositional group) seem to indicate a relation to the duration of the act of production. As a matter of fact, the relation to the duration of production has been laid down *once and for all* when the discursive world was created, in this particular case when the narrative world was created. According to the principles of this type of world, as we have just pointed out, the contents evoked by the text are taken to be disjoined from the situation of production, and in particular from its temporal parameters. More specifically, this disjunction is one of “neutrality” or “indifference”. A narrative segment of this kind generally begins with a dating<sup>5</sup> (*in 1680*), that is, by an explicit indication of the *origin* (Fayol, 1985), which is simply the origin of the temporal reference axis along which the narrative is going to unfold. This origin is *absolute*, in the sense that it can be identified independently of the act of

<sup>4</sup> Obviously, deictic markers (*I*, *we*, for example) can appear in segments of narratives or theoretical discourses, but the function of these units is merely *internal*; they never refer directly to the empirical author of the text.

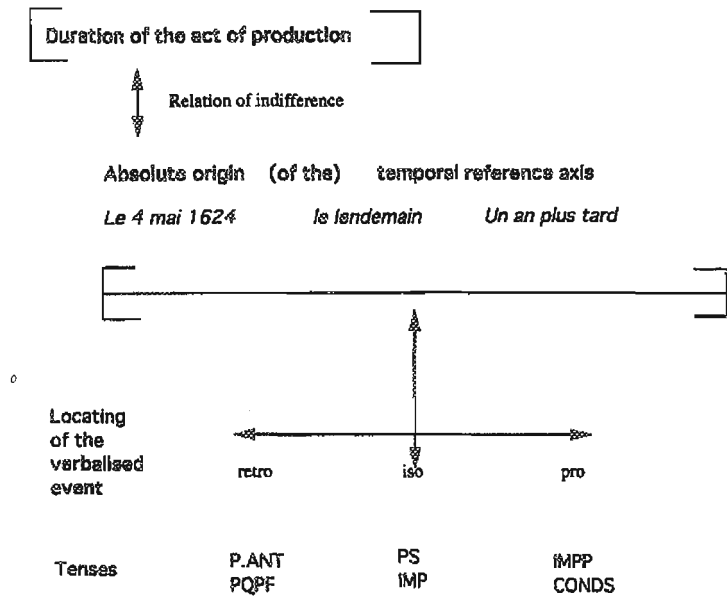
<sup>5</sup> In other narrative segments, in particular those belonging to the genre *tale*, the origin would be of the type “once upon a time” or “one day”.

production, which has thus no relevance here. Also, this origin can be relayed by statements such as “the 20th of November,” “the next day,” “three days later,” which are like the scansion markers of the narrative process itself.

Whenever the duration of the act of production is not pertinent, the value of each of the temporal units of the segment has to be analysed as arising from the connections that are established between the verbalised event and the reference axis, or, to use a Culiolian term, from the *act of locating* (*repérage*) the event with respect to the axis. This is therefore a function that is *internal* to the discursive world. But the tempo-

as following one another in the verbal sequence according to a relation that remains “parallel” to the ongoing narrative process, that is, parallel to the temporal reference axis; in this case we speak of direct locating or *isochronic locating* (*iso*). But the verbalised events can also be presented as following each other in the verbal sequence according to a time frame that is shifted with respect to the temporal reference axis; they can be taken to be anterior to the current phase of the narrative process, in which case we speak of *retroactive locating* (*retro*); they can also be considered to be posterior to the current phase of narrative process, in which

Figure 1: Primary temporality of narrative



ral organisation of narratives, and other types of discourses, is extremely complicated, and to pursue our analysis, we need to distinguish a *primary temporality*, a *secondary temporality*, as well as contrast mechanisms, involving *contrasts* that are *global* or *local*.

*Primary temporality* concerns the modes in which the various verbalised events are linked to the reference axis, or the modes of location of the events with respect to this axis. Such *internal location* can take three distinct forms. The narrator can present the verbalised events

case we speak of *proactive locating* (*pro*). In narratives in French, as our example shows, isochronic locating is indicated by the use of the PS<sup>6</sup> (simple past) or the IMP (past continuous); retroactive locating is indicated by the use of PANT (past perfect) or PQP (pluperfect); proactive locating is indicated by the use of the IMPP (“going to” + IMP) or CONDS (present conditional).

We talk of *secondary* (or *relative*) *temporality* when a first verbalised event is related to a second one which is, in turn, located with respect to

<sup>6</sup> PS for *passé simple*; IMP for *imparfait*, PANT for *passé antérieur*, PQP for *plus-que-parfait*; IMPP for *imparfait périphrastique* (*il allait régner*/he was going to reign); CONDS for *conditionnel présent*.

the reference axis. Secondary temporality is characterised by a mechanism of *syntactic embedding*, generally associated with an *opposition of tenses*. When the purpose is to express the *relative anteriority* of one verbalised event with respect to another, the first event (the earlier one) is presented in a subordinate clause, using compound tenses (i.e., verbs with auxiliaries), while the second event is coded within the main clause by the corresponding simple tenses. The earlier event in the subordinate clause is however more often coded by an infinitive form. The examples of relative simultaneity and posteriority can be analysed along the same lines.

(7) Quand il *eut grimpé* pendant un kilomètre environ, Fred *fit* une pause

(Manceron, *Pauvres petites crevettes*)<sup>7</sup>

(8) Après *avoir essayé* différents solvants dans un coin du panneau, Julia *prépara* un mélange d'acétone (...) et *commença* (...)

(Pérez-Reverte, *Le tableau du maître flamand*)

In order to introduce the *contrast* function, let us first point out that the PS and IMP in narratives express the *same* temporal value of isochronic locating, that, in a similar fashion, the PANT and PQP express the same temporal value of retroactive locating, and that the IMPP and CONDS of narratives express the same value of proactive locating. It is the choice of one or the other of the two forms in these pairs that introduces this additional value referred to as contrast.

The *global contrast* function is of *isotopic* nature; it consists in marking a distinction between two series of verbal forms: one series is set in the *foreground* and another (or others) in the *background*. Certain authors (Hopper, 1982; Labov, 1972) suggest making a distinction between *narrative phrases* and *non-narrative phrases*; the former being sequenced in an order that faithfully reproduces the chronology of the related events, whereas the latter are not subject to any such temporal constraints. This interpretation is generally associated with a distinction relative to the *human importance* of the events that are being related. According to Wallace (1982), for instance, the most significant events and the principal characters are presented in the foreground, whereas the background is kept for

events of lesser importance, digressions, and minor characters. Although this approach is very widespread, it should be rejected, since it is rest upon the assumption that the story (*diégèse*) is objective, as well as on the assumption of strict parallelism between the chronology of the story and that of the narrative process. As we have noted, any discourse is sustained by the creation of a *discursive world*, and in the case of narrative, this world can even be completely *fictitious*. In other words, the related story is never objective, and we are thus left without any criteria whatsoever for determining an *a priori* hierarchy of the human importance of the events that are presented in the story. In fact, all empirical analyses of narratives show that events which are apparently decisive for the progression of the story can be rejected to the background, whereas events of apparently secondary importance are projected to the foreground. These considerations make it clear that the function of global contrast does not consist in opposing sets of verbalised events according to their intrinsic importance with respect to the progression of the story; this function is always the result of a *decision*, taken by the *narrator*, to *highlight* certain elements of the story to the detriment of others.

In narratives in French, the foreground is indicated by the PS and the PANT, and the background is indicated by the IMP and the PQP. These four tenses convey, in addition, the primary temporal values discussed earlier.

The global contrast function can operate in interaction with *narrative schemas* (Adam, 1992; Fayol, 1985) that appear in certain narratives, and which generally comprise five main phases called *initial situation*, *complication*, *action*, *resolution*, and *final situation*. In principle, the initial and final phases include mainly the background events, whereas the action and resolution phases include mainly the foreground events (the complication phase is often characterised by the presentation of an opposition between these two types of events). Hence, the initial and final phases are saturated with verbs in the IMP/PQP, whereas the action and resolution phases are saturated with verbs expressing dynamic events, conjugated in the PS/PANT.

(9) A la gare de St. Pancrace, John Armitage, chauffeur de taxi, se *morfon-*

<sup>7</sup> Most of the examples are from Plazaola Giger & Bronckart, *Le temps du polar*, 1993.

*dait*. Il lui *incombait* de rester là en stationnement (...) Une sueur froide lui *coulait* le long de la colonne vertébrale (...) Sept heures *sonnaient*, arrachant John à son cafard (...).

A ce moment, un remue-ménage se *produisit* aux sorties de la station (...) Bientôt les premiers voyageurs se *montrèrent* et, tout de suite, John *remarquait* parmi eux un colosse en kilt (...)

(Exbrayat, *On se reverra petite*)

But the global contrast function can also be set up independently of any narrative schema, in which case the background events and foreground events are then distributed preferentially in the main clauses and the subordinate clauses respectively:

(10) Elle *répondit* à son geste par un éclat de rire qui n'*était* pas méchant. Elle *posa* les deux paniers qui *avaient laissé* des traces de boue.

(Manceron, *Pauvres petites crevettes*)

In this second case, it is sometimes difficult to distinguish between global contrast and *local contrast*. Local contrast, which can operate independently of any isotopic series, consists in creating a specific opposition between two verbalised events. These opposing events appear in clauses that are generally articulated with each other by a mechanism of *syntactic embedding*, whereby one event is presented as being the local context that constitutes the ground against which another event —the figure— is thrown into relief.

(11) Il *conduisait* donc, attentif à la circulation, lorsqu'*éclata* dans son dos un bruit assourdissant.

(Exbrayat, *On se reverra petite*)

As we can see, the “ground” event is indicated by the IMP (or its compound form, the PQP) while the event set “in relief” (or the “figure” event) is indicated by the PS (or its compound form, the PANT).

Of course, this is not an exhaustive analysis of the temporal organisation of narratives.

We might also examine the interactions that exist between the contrast functions and the aspectual markers (markers of *degree of accomplishment* and markers of *types of events*). Looking only at the types of events for instance, although it is the narrator who, in final analysis, chooses to relegate one series of events to the background, or to present one event as the

ground for another, it is a fact that the background and ground events are most often of the type *state*, *activity* or *accomplishment*, and that events in the foreground or ones set in relief are usually of the type *Achievement* (to use the typology inspired by Vendler, 1967). In other words, the narrator's decision is not completely independent of the intrinsic properties of the events in the story. Thus, given that the background or ground events are indicated by the IMP and PQP, and that foreground or in relief events are indicated by the PS and PANT, it follows that events of state and duration are regularly associated with the IMP or PQP, and that dynamic and resultant events are regularly associated with the PS and the PANT.

We might also mention mechanisms that are more of a “literary” nature, such as the one adopted by Simenon, for example, which consists in introducing a systematic retroactive shift between the narrative process and the unfolding of the narrated events – giving the impression that the narrated events are retrieved from the narrator's “memory” –, and in using isochronic locating only occasionally to produce an effect of accentuation or acceleration. Decisions of this type involve very complex *narrative strategies*, which we cannot go into here.

(12) Lognon, lui, ne *perdait* pas un poil de son sérieux; c'*est* en vain que, pendant deux bonnes heures, La Souris *avait essayé* de le dérider. (...) Le fait est que Lognon *était* presque dessus; (...) il *avait passé* la nuit au poste de l'Opéra. Dès le matin, il *avait suivi* ....

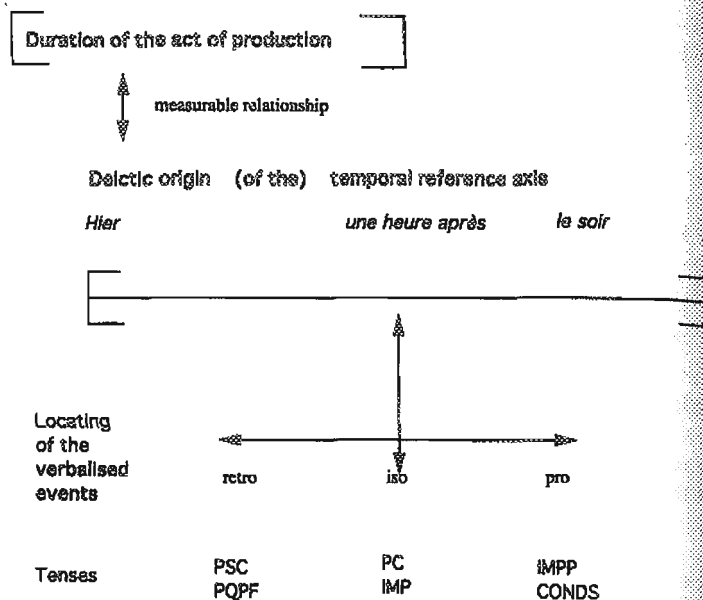
(Simenon, *Monsieur La souris*)

The analysis we have just proposed for narrative applies almost in full to *interactive narratives*.

(13) C'est vers 19 heures que l'absence de Simon *a été remarquée* (iso). Simon *avait quitté* (retro) les environs de la cabane et *s'était perdu* (retro) dans la forêt. Malgré les recherches immédiatement engagées, hier matin, Simon n'*était* toujours pas *retrouvé* (iso). Quelque cent trente personnes *ont repris* (iso) les recherches. Puis, vers 9 heures, un hélicoptère de la Rega *a été mobilisé* (iso). Finalement, Simon *allait être retrouvé* (pro) sain et sauf vers 10 heures, à un kilomètre de la cabane.

(*La Suisse*)

Figure 2: Primary temporality in interactive narrative



In segments like this one, we find the same functions of primary and secondary temporality, as well as global and local contrast. The main difference is that in interactive narratives, the origin of the temporal reference axis entertains a measurable relationship to the act of production: we have an origin that is neither absolute nor irrelevant, as in narrative, but *deictic* ("last week," "yesterday," "two days ago," etc.). In French, this difference in the status of the temporal reference axis is indicated by the use of the PC and PSC<sup>8</sup>, which take on respectively the functions of the PS and PANT in narratives.

The same type of analysis can be applied to *theoretical discourses*. What is particular in this case is that the temporal reference axis of the discursive world is unlimited, *boundless*, or without an origin. By its very status, theoretical discourse offers elements of content (notions, concepts, theories, etc.) that are presented by the narrator "as if" they were eternally valid, and independent of any particular time frame. Thus, the main tense of theoretical discourse is the PRE<sup>9</sup>, which suggest a *neutral*, or neutralized location (neut).

However, in this type of discourse, the tenses of the verbs can also code the relationship between the unfolding of the expository process

itself and the unfolding of the events that are presented; and we thus obtain the three forms of locating in *primary temporality* that we discussed earlier. In French, isochronic locating is indicated by the use of the PRE, retroactive locating by the use of the PC or the IMP, and proactive locating by the FUTS or CONDS. To these simple forms we can add the five corresponding composed forms (respectively PC, PSC, PQQ, FUTA and CONDC<sup>10</sup>), which confer an aspect of completion to the primary temporality or a value of secondary temporality:

(14) Tout développement généalogique ou collectif *aboutit* (neut) à la construction de phylums relativement stables [...]. Ces phylums stables *sont* alors *décrits* (neut) en termes de règnes, embranchements [...]. Aux époques où l'idée d'évolution *était* inconnue (retro) [...], cette notion réaliste [...] *suffisait* (retro) à assurer une adéquation suffisante avec le réel [...]. Ce *n'est* (iso) pas le lieu d'insister [...]. Nous *y reviendrons* (pro) au chapitre 4...

(J. Piaget, *Biologie et connaissance*)

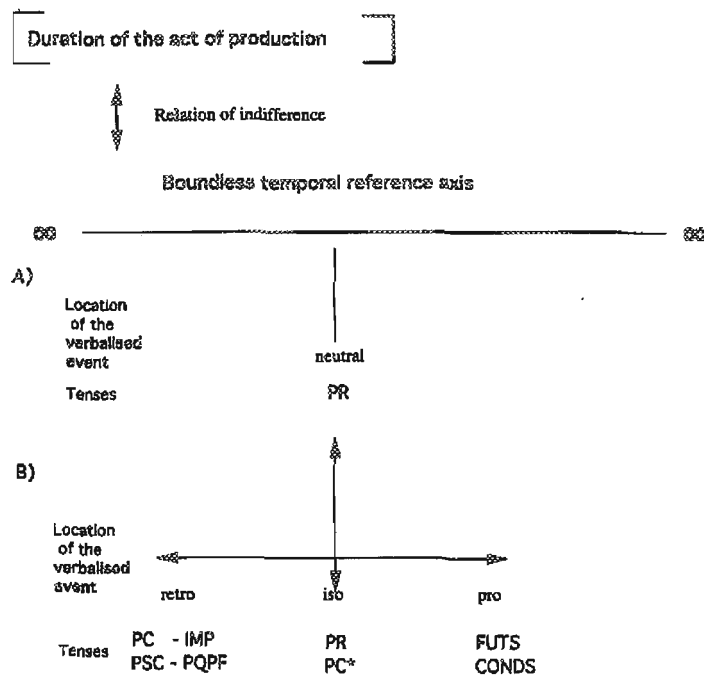
In this type of discourse, produced in French, the contrast function is not indicated by oppositions between tenses, as is in interactive dis-

<sup>8</sup> PC for *passé composé*; PSC for *passé surcomposé* (*il a eu travaillé*)

<sup>9</sup> PRE for *présent*.

<sup>10</sup> FUTS for *futur simple*; FUTA for *futur antérieur*; CONDC for *conditionnel passé*.

Figure 3: Primary temporality of theoretical discourse



course or narrative; it seems to be expressed instead by processes of syntactic embedding.

Analysis of the temporal organisation of *interactive discourses*, be they dialogues or monologues, is much more complex, particularly because these types of discourses can comprise several temporal reference axes.

The producing agent can set up a first sort of reference axis, one that is *disjoined* from the act of production; this disjunction is generally made explicit by adverbs or clauses of time ("yesterday," "tomorrow," "this morning," "on the 10th of January," etc.). Axes of this sort are usually limited or *bounded*; they can follow each other throughout the discourse and therefore have only local validity. Once such a disjoined axis is created, the producing agent can choose to indicate his relation to the moment of the event. And this relation always seems to be one of inclusion, in which case we speak of *location of inclusion* ("Demain, Pierre se rend à Lausanne": *Tomorrow, Peter goes to Lausanne*). As the examples (3) and (5) have shown, in this same case the producing agent can also choose not to relate the moment of the event to the disjoined reference axis, indicating instead the relation that exists between the moment of the event and the duration of the act of production ("Demain, Pierre se rendra à Lausanne": *Tomorrow Peter will go to*

Lausanne). Of course, this possibility becomes a necessity if a disjoined reference axis has not been specified.

This second type of relation is by no means of a *mechanical* nature, as the trichotomic theory would have it. It is not the physical "moment" of production with which the event is linked, but the psychological duration built around (or "on the basis" of) the act of production; this duration can be more or less long, and can also change constantly. This is thus also a temporal reference axis, but one that takes another form, being *adjoined* to (or dependent on) the duration of production. This type of axis can be limited or bounded, in which case we have a *relation of anteriority*, if the moment of production is considered to be situated before the "left boundary" of the axis; a *relation of posteriority* if this moment is considered to be situated after the "right boundary"; and a *relation of simultaneity* if it is considered to be included within the boundaries. This type of axis can equally well be unlimited or boundless, in which case the moment of any kind of event necessarily entertains a relation of inclusion with the axis; we then have a *neutral relation*, similar to that found in theoretical discourse.

In interactive discourses in French, neutral relation, relation of simultaneity and relation of

inclusion are all indicated by the same tense of the verb (PRE). But in spite of this morphological identity, each form takes on a different value, which is determined precisely by the underlying form of location; grammarians sometimes call these values the *generic present* in the first case, the *present of simultaneity* in the second case, and the *psychological present* in the third. The latter expression indicates that the choice of linking the moment of the event to an embracing, disjoined axis is intended to arouse in the receiver a paradoxical feeling of proximity to the event, in spite of the fact that it precedes or follows the act of production. Locations of anteriority are indicated either by the PC or the IMP, and locations of posteriority by the FUTS or by the FUTP (*aller* + infinitive).

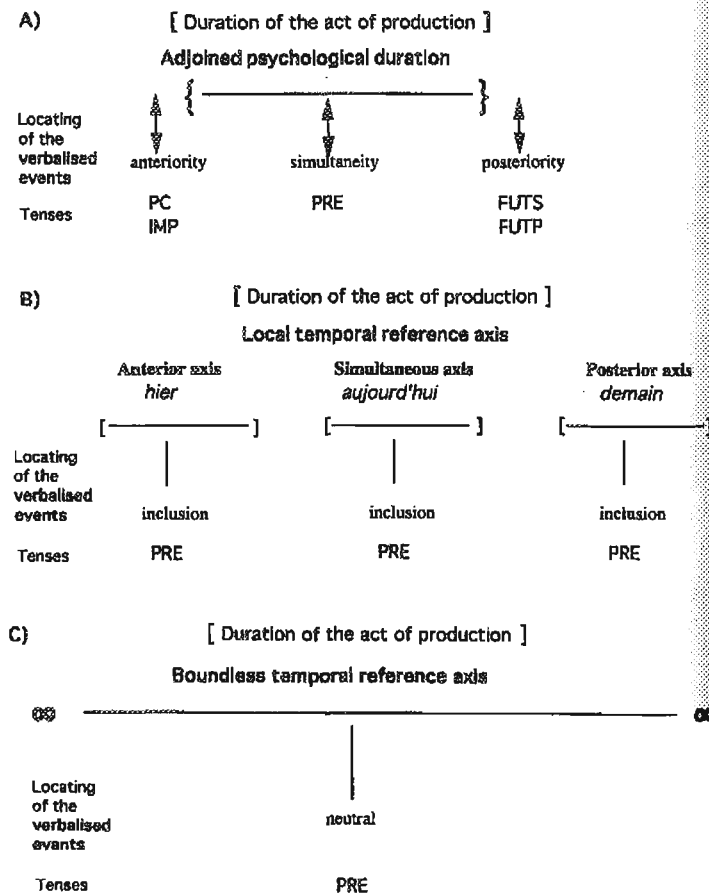
These general laws of temporal location in interactive discourse obviously need to be completed with considerations concerning aspects and secondary temporality.

Let us now compare the temporal organisation of these four types of discourses.

In the three types of discourses that are of an exclusively monologic nature (narrative, interactive narrative and theoretical discourse), the relation between the objective duration of the act of production and the temporal reference axis of the discursive world is fixed once and for all, as we have seen. Hence, verbal forms express only *internal temporal values*.

- *Primary temporality* has to do mainly with the relation of the unfolding of the discursive process chosen by the enunciator (narrative versus expository process) to the unfolding of the verbalised event; there can be parallelism between the two time references (isochrony), a relation of forward displacement (proactive) or backward displacement (retroactive).
- *Global contrast* reflects the hierarchy the enunciator introduces between series of

Figure 4: Primary temporality in interactive discourse



isotopic events (foreground and different levels of background, sometimes inter-locked).

- *Secondary temporality and local contrast are relative mechanisms*: in the first case, the event is situated from a temporal point of view with respect to another event for which primary temporality has been determined; in the second case, an event is located from the point of view of aspect with respect to another event that has also been subject to primary temporal location.

In accordance with Ricoeur's thesis, these four functions contribute to the clarification of the verbalised actions, states or events. More precisely, it is the process of text production itself (the narrative or expository process) which is the real creator of concordance and homogeneity.

- On the one hand, the producer establishes, for the sake of the recipient, the hierarchical levels of sets of verbalised events. This contrast function is not unrelated to the internal or aspectual characteristics of events, but in the final analysis, it is always the enunciator who chooses whether or not he takes into account the properties attributed to the events in the world.
- On the other hand, given that the activity of text production has its own time frame (our reference axis), it is the location of the verbalised events with respect to this time frame of production that gives them their temporal organisation (function of primary temporality). The time frame of the represented worlds is thus a by-product of (or relative to) the time frame of the discursive activity.

It is the activity of elaborating discursive worlds which organises the verbalised events into a hierarchical and temporalised structure, in other words, which creates a concordant structure that can be understood and interpreted by the recipient.

Then what about the temporal organisation of interactive discourses, which are fundamentally dialogic in nature?

First, we stipulate that interactive discourse, as any other type of discourse, is supported by the creation of a discursive world; however, this world is constructed through interaction and is subject to constant, on line re-negotiation. Hence, the enunciator, as a formal entity, is actu-

ally manifold, and the temporal unfolding of the text production is in constant movement, or even chaotic. Thus, through alternation, and sometimes through competition, interactive discourse leads to the creation of three sorts of temporal axis:

- an unbounded axis, similar to that found in theoretical discourse;
- a local, bounded axis, made explicit by expressions such as "yesterday," "last week," etc.;
- and finally an axis built around the objective duration of production.

It should be noted that the latter axis is the only one that can really be used as a reference for *external* location of simultaneity, posteriority, and anteriority. Hence, this type of relation is a special case, and a rather rare one, in the temporal organisation of discourses.

Whatever the case may be, the decision to create and use one or other time axis always comes from this formal (enunciating) entity. And it is from the connections to these axes that the verbalised events acquire temporal coherence. But only a potential coherence and intelligibility, as is obvious to those who try to interpret interactive discourses independently of their context. Although we must therefore grant to Ricoeur that interactive discourses clarify human activities less well than narratives do, it seems to us that one should not confuse the process itself, which does indeed have the aim of clarifying, and the result in the dialogues, which is rarely satisfactory.

To make up for burdening the reader with these technical considerations, we conclude this exposé with some "free" suggestions regarding the problem of the genealogy of discourses, and that of the very status of temporality.

Socio-discursive interactionism, to which we rally, contests the notion that the foundations of human rationality (formal logic, in particular the temporal logic of mental operations) are exclusively biological, as Piaget would have it. For us, the works of developmental psychology (including those of Piaget) show that formal logic is a secondary product, which develops late and is always fragile; that it is constructed on the basis of abstraction and decontextualisation of natural logic, which is nothing other than a logic stemming from the appropriation and interiorisation of the properties of natural languages. In this sense, primary logic is a social logic, for it de-

rives from the social constructs that are natural languages.

This primary, natural-social logic is itself the product of the continuous historical process of reconfiguration of human actions in discourses; of the attribution of hierarchical and temporal organisation to these actions.

But what types of discourses contribute most effectively to this clarification of actions. Evidently narratives and interactive narratives come first, then theoretical discourses, and last interactive discourses. According to us, this *de facto* observation should be confronted with the dominant theses concerning the genealogy of discourses and temporality.

The theses concerning the emergence of language in our species, including those of Engels (1946), and found implicitly in the works of Habermas, all postulate the primacy of interactive discourse: language is first constructed in the form of dialogue, in work/labour situations, as an instrument for defining the contexts of collective activity; monologues appear afterwards, as abstractions of these interactive situations.

Now what if we contested these theses, just to see? Because, for one thing, interactive discourses are so complex in their organisation that it is hard to imagine the sort of processes by which a "logic" could have derived from them. And then, more fundamentally, we can argue that the emergence of a semiotic function necessarily implies establishing a *distance* with respect to immediate action and its context. It would therefore seem to be at least as reasonable to suppose that language was first constructed in narrative activity that recalls or plans work, rather than during work itself. We might turn around Engels' formula and claim that language is fundamentally a product of *leisure* and that narrative is consequently the primary form of discourses.

And then "primary" temporality would indeed be as we have qualified it: a product of the establishment of connections between processes and the unfolding of monologic speaking activity. And relations of anteriority, posteriority and simultaneity, which are external in the sense that they involve the situation of the producing agent, would then be secondary constructions.

Genealogically secondary, that is, which does not mean of course that these constructions have not played a decisive role, as we know, in the elaboration of a temporal logic.

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## **Part IV.**

### **Developmental Timing**



# Time in Developmental Psychology: Development in Time

August Flammer

It was always clear that development had to do with time. But it took developmental psychologists quite a while before they started to draw more general and radical consequences from this trivial insight. Partly, time has been overlooked, partly, it was accounted for in problematic ways.

## Time and age as developmental variables?

Early developmental theorizing has heavily relied on the age of the developing organism, i.e., the developing person. Thus Gesell (1946; Gesell & Ilg, 1946; Gesell, Ilg & Ames, 1940; 1956) had extensively categorized child and adolescent behavior according to the age at which it typically appeared. In the first half of this century, there was a strong German tradition which preferably used ages for the ordering of developmental phenomena (e.g., Busemann 1959, 5th edition; Piaget, 1947, etc.; Rempelin, 1963, 11th edition).

In the sixties and seventies, age scales were criticized because of large individual differences in developmental pace and because researchers and educators tried to speed up the development. Indeed, many studies, mainly in the Piagetian context, have shown that Piaget's age indications were not generalizable over historical times.

However, a more principled critique arose: Age cannot be a serious independent variable because age as such cannot explain changes nor can it produce changes. Changes simply take place over time, and by passing time people get older. Therefore some correlation between changes, i.e., between sequences of states and time, is inevitable, and therefore age can be of some descriptive value only (Wohlwill, 1970). This is how overuse of the time variable was corrected within the second half of this century.

## The historicity of development

Individual development not only runs over time but also takes place in historical time.

Mainly the dialectical approaches to development (Galperin, 1969; Holzkamp, 1973; Leont'ev, 1959; Llubinskaja, 1961) demonstrated that socialization in different historical times varies enormously (socialization is taken here as an essential part of human development). Development is partly a product of the interaction between individuals and culture. Furthermore, the developing individuals produce and co-produce culture which in turn co-determines their own development and the development of the next generation. It is immediately evident that due to these interactions, the course of development not only varies historically but also from culture to culture.

In Western developmental psychology, the historicity of human development became widely evident thanks to a relatively trivial methodological discussion. For decades, people were persuaded that intelligence generally increased up to about the age of 25 and then slowly decreased again; this conviction resided on hard data, repeatedly found (Jones & Kaplan, 1945). In the sixties, researchers questioned the methodology in that it compared different people of different ages instead of the same people at different ages. Indeed, longitudinal designs produced data showing that in general intelligence continued to increase over early and middle adulthood (certain facets even longer) and that a general decrease was not to be expected during the first six decades of life (Schaie, 1994; Schaie & Strother, 1968; Schaie & Labouvie-Vief, 1974). Evidently, people born at different times, so-called cohorts, not only had experienced different socializations which determined the general level of the developmental curve, but – at least nowadays – had life conditions that continued boosting their intelligence.

Research on historical and on cultural differences is able to shed refreshing light on the cultural contingencies of human development (e.g., Ariès, 1960; Kooops, 1991, 1996a and b; Berry, Dasen & Saraswathi, 1997).

## The historicity of developmental psychology

Somehow, it was always known that earlier descriptions of childhood and adolescence had become obsolete and were to be updated (e.g., Roth, 1983), and this not only for reasons of research methodology, but also because of the theoretical thinking and the theoretical focus change with time/history. Thus, during the 18th and the 19th century, children and adolescents were preferably described as they should be and behave, i.e., from an educational standpoint (e.g., Rousseau, 1762), with outgrowths into the 20th century (Spranger, 1924). The turn from the 19th to the 20th century was heavily characterized by foregoing progress in natural sciences and biology. Willem Koops (this volume) demonstrates how much Ellen Key's thinking was influenced by the geneticist thinking of the 19th century and that the inspiring title of her famous book (*The century of the child*, 1900) was later simply associated to more fashionable thinking.

## Time in the developing peoples' heads

Theoreticians who took time as an orienting or even as a causal variable could be justified by the fact that developmental change is sometimes produced by people according to time and age. Thus, society prescribes certain changes that are developmentally important, i.e., entrance to school, getting voting rights, retirement, etc. And even what is not prescribed in relation to exact age, is more or less expected within certain age ranges, for instance graduation from the first professional education, leaving the parents' home, having children, etc. (Hagestad & Neugarten, 1985; Heckhausen & Krueger, 1993; Neugarten, 1979; Neugarten, Moore & Lowe, 1965). Social expectations have indeed a great impact on individual developmental progress: non-fulfillment of certain expectations can be sensitively sanctioned (Grob, Flammer & Rhyn, 1995).

People know about societal expectations, they participate in them, and typically hold them as rational and beneficial for themselves too. Wrosch and Heckhausen (this volume) demonstrate how much such knowledge regulates individual development.

## Time to be spent

People are not only aware of the timeliness of certain actions and developmental steps, but also of time as a good to be used or to be spent for something. It is only more recently that researchers have started to investigate how children, adolescents, and adults think of their time to use and how they actually use it. Naturally, young people have (on average!) ample time to realize their far-reaching goals, and they are aware of it (e.g., Nurmi, 1991). However, their everyday use of time is often characterized by a shortage of time, quite comparable to adults. Saying that one has too little time amounts to saying that one wants to realize too many things within a given interval of time. It may therefore be questioned whether the actual priorities of activities are optimal, e.g., in relation to distant socialization goals. For this reason, studies on watching TV and on many other activities have been undertaken (Flammer, Alsaker & Noack, 1999; Flammer & Schaffner, 2003; Larson, Kubey & Colletti, 1989). Alsaker, Flammer & Tschanz (this volume) will provide a review of findings related to time-use over the life course, with a concentration on the changes between early and late adolescence.

## Conclusion

Panta rhei ("Everything flows, nothing stays," Heraclit). Once more, this saying is very true, so much as to be a commonplace. Developmental psychology and psychology in general produces knowledge to be generalized (otherwise psychology could simply be a part of history). However, given the historicity of developmental psychological scientific knowledge and its cultural relativity, the generalization is always bound to be limited. The limits can not be indicated from the outset. They have to be determined again and again as time goes on: the times of developmental psychology and the times of individual (and societal) development.

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# Time Use in Adolescence

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“Time is money,” business people say. “Save it,” authors of bestsellers on personal management say. In everyday life, people have a conception of time as a good to be used, to be managed, or to be filled. Not having enough time is experienced as stress, and also the feeling that one has “too much time” is experienced as a burden.

Objectively speaking, everybody has the same number of hours to his or her disposition each day. However, some people experience having too little time and other people having too much time. The first may have more to do than the second; they may plan their activities more densely in time. In this paper, we assume time to be measurable in terms of an agreed-upon scale. Furthermore, we assume the experience of availability of time to depend on how many constraints people encounter and what kind of activities they perform, that is on their “use” of time.

In turn, individual differences in time use are due to individual as well as to societal factors. Society’s influence on individuals’ time use may be direct (e.g., organization of compulsory education) or indirect through factors such as norms, cultural traditions, or the economic system. For example, financial strain has been demonstrated to negatively influence unemployed adolescents’ activity level (Ullah, 1990). Furthermore, societal and individual factors are assumed to interact. As an example, we may expect a long school (or working) day to be tiring and lead to the need for more sleep in some individuals and not in others.

Time use research does not have a long tradition. Psychologists have a longstanding preference for studying what people are capable of doing instead of what they really do, i.e., they prefer to study competence, mental representations, reactions, etc. Nevertheless, we contend that it is worthwhile to study what people actually do as

well, i.e., to study how they use their time, and this for several reasons.

First, the mere description of what people do, when they do it, for how long they do it and with whom they do it, is of interest. People may have competencies and preferences for certain activities; however, if preferences and competencies do not result in performances, they have little impact on the life course. To put it simply: A living system is not only capable of living, it is indeed living.

As an example, it may be of interest to know what adolescents do during the time left after all commitments and duties are accomplished, i.e., during leisure time or free time. Descriptive results on time use provide information about the ratio of time allocated to commitments (or necessary activities) and leisure activities and about the strictness of schedules individuals live with. In children this ratio depends very much on the time they are required to spend in school and on homework. However, leisure time activities, too, may be embedded within rather inflexible commitments and tight schedules. Descriptive time use research may give some useful information about the tightness of adolescents’ schedules.

Second, time use is an indicator of values. That is, getting information about the way individuals organize their everyday lives provides essential information on individual as well as societal priorities and values. Asking people about the importance of certain values may only provide information about individual or socially shared ideals. Such utterances do not necessarily indicate what *impact* such perceived values actually have on people’s lives. For example, a student may convincingly state that it is important for him to play his musical instrument for 20 minutes daily, but he may not do so at all. Or as an example on the societal level, people in most industrialized societies will agree that school is

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important. However, the actual place occupied by school in everyday life in different societies varies to a large extent. This, in turn, affects the importance that may factually be attributed to leisure time activities in these different countries. That is, cross-national and cross-cultural studies on time use can provide information about differences in *actual* impact of values between countries and/or cultures. Thus, results from a recent cross-national study (Alsaker & Flammer, 1999; Flammer, Alsaker, & Noack, 1999) have demonstrated that the largest differences between countries as to time use in adolescents seem to reflect differences in the institutional regulations of the respective societies. Not surprisingly then, the countries yielding the highest percentages of time spent on earning money were countries in which adolescents reported to have relatively short school days.

Societal regulations still leave some degrees of freedom. Individual preferences, too, play a role in determining how people use their time. For example, in the study cited above, even in the countries with the largest average of time used for earning money, there were more adolescents who were not working for money on the target day than adolescents who were.

Third, time use is an indicator of socialization opportunities in the sense that it indicates what kind of experiences people make. Studies on time use may therefore be helpful in understanding the socialization of certain groups of people. It is, for example, well established that depression is accompanied by some degree of social withdrawal and some passivity (Harrington, 1993). A recent study conducted in Switzerland and in Norway (Alsaker, 2000) has shown that depressed adolescents were less involved in all kinds of social activities than their non-depressed peers. Thus, depressed adolescents miss a lot of opportunities to learn how one behaves among peers, to get feedback on their behavior, etc. Another example is the case of a person with eating disorders. She (or he) is likely to use much time on preparing meals, possibly on eating, possibly on avoiding eating situations, and quite often on exercising. In consequence, little time will remain available for other activities, as for example social ones.

The idea of using time use studies in order to investigate instantiated values implies methodological challenges. First, subjects often do not have the necessary degrees of freedom to do

what they judge to be most valuable to them. Second, a basic challenge is that if one is not able to continuously and carefully observe the subjects, most time use studies have to rely on self-reports and subjects' accuracy in recalling what they usually do.

Researchers have used very different methods of investigation. The least cumbersome is to ask subjects what they typically do on certain days of the week or even the year long and how much time, possibly in percentage, they devote to each of these activities. Nirikko (1994) presented to students of grades 4, 7, and 8 an empty timetable for one week and asked them orally to help the interviewer to fill it out with reference to a regular school week. Thus, there were clearly interindividually repeated patterns, e.g., sleeping, body care, breakfast, way to school, and clearly individually unique patterns like a musical instrument lesson each Wednesday from 16:30 through 17:00. This method allowed very specific insights: e.g., the fact that Swiss 4th graders do their homework before supper in 85% of the cases as compared to the 8th graders who do this only in 45% of the cases. In order to help the subjects to think of (almost) all possible activities and in order to make the data coherently analyzable, it is advised to present a list of activities to the subjects and have them answer to each of them.

Asking subjects what they typically do sounds somehow unspecific and leaves out rare and special activities (Csikszentmihalyi & Graef, 1980). Therefore, most researchers refer to a specific day and date, mostly to the day before the questioning (e.g., Aregger & Steinmann, 1989; Katz & Gurevitch, 1976; Roniger, 1994; Stolte, 1973). Although this method yields much more specific information, it relies heavily on the subjects' memory performance which may not be very reliable in this respect. As memory processes are known to be reconstructive to a large extent (Neisser, 1981), this method may lead to an uncontrolled mixture of really recalled events and inferences from what is typical. One can try to minimize this danger by only asking about yesterday afternoon and (in the afternoon) about this morning (i.e., today). Insofar as the yesterday-interview is really specific, the results are very colorful on a descriptive level (e.g., Alsaker & Flammer, 1999, had one adolescent who during the school week indeed for specific reasons went to bed

only at three in the morning). Descriptive averages over subjects are easily calculated. On the other hand, this method does not lend itself easily to correlational analyses. For instance, if the question is whether depressed students are less likely to participate in active group sport clubs than the non-depressed, then the correlation is bound to be low. Those who have not gone to such a club on a given day may by far not be unathletic. Most adolescents who are active in group sports simply do not go to their club each and every day. This does not jeopardize the validity of the correlations but makes them very low.

There are other ways to boost the reliability of self-reports. The most fashionable one is the Event Sampling Method (ESM; Hormuth, 1986; Hurlburt, 1979; Stone, Kessler, & Haythornthwaite, 1991). Subjects carry wristwatches that can be paged from a distance. Each time the watch beeps, the subject is required to fill out a little questionnaire he or she carries with him or her. The subjects go through their regular day and indicate on the spot what they are doing right at the given moment, where and with whom they are, how they feel etc. This method circumvents memory problems and offers yet another way of investigating actual personal values (e.g., by asking the actual feelings toward a situation or an activity; Cantor et al., 1991). However, this method is intrusive in a way, although one can stop sending beeps during sleeping time or – according to the research interest – during school time. Typically, subjects are fascinated by the ESM and therefore respond quite reliably. But even this method has disadvantages, namely (1) its practical inability to reliably measure durations and (2) the scarcity of data related to rare activities. For sure, the most reliable method for coding activities in terms of open behavior remains direct observation as Barker and Wright (1955) have practiced it many years ago. This method presupposes a lot of resources. Also, this method is very intrusive in that observers are present in the subjects' regular daily lives. Even if video cameras are used, the subject may constantly have the feeling of being observed.

In the following we want to summarize some results from the literature on time use by adolescents. In order to give structure to the results from a rather broad and heterogeneous field of research, we want to address three issues, age

differences, gender differences, and cross-national/cross-cultural differences.

### Age differences in time use

That children and adults use their time differently is trivial: Children spend more time for sleep, for free play, they go to school; adults work longer (at least in terms of working for money), they use much of their time for child care and child raising activities etc. Age differences are more interesting when it comes to comparing adjacent ages.

Comparing adolescents with children, Timmer, Eccles and O'Brien (1985) found that American adolescents aged 12 through 17 spent more time conversing, watching TV, listening to music, and doing active sports than did children aged 3 through 11. Children, however, spent more time eating, sleeping, and playing than adolescents did.

In the Euronet study (Alsaker & Flammer, 1999; Flammer et al., 1999), which was conducted in 12 countries, i.e., 11 European countries including two Swiss samples (French-speaking and German-speaking) and the United States, a written yesterday-questionnaire with a list of activities was used. The subjects, aged 14 to 16, had to describe the preceding regular school day. The main activity in terms of duration was sleeping. Number two on the ranking list was attendance to school, followed by watching TV, homework, meals, leisure time with friends, way to and from school, organized sports, body care, and leisure reading (Flammer et al., 1999). These results fit well with those from Timmer et al. (1985) who reported children and adolescents (aged 3 through 17) to use 60% of their daytime on what they called "non discretionary activities" (p. 365). A closer look at their findings shows that adolescents (aged 12 through 17) used as much as 70% of their time on such required or necessary activities. That is, necessary – non-leisure – activities typically increased with age. However, this increase has to be differentiated. Whereas commitments and duties typically increased, activities depending on physical needs, like sleep, typically decreased.

On average, newborns sleep about two thirds of the time. This proportion decreases rapidly over the first year of life to approximately 12 h

and continues decreasing virtually over the whole life-span (Roffwarg, Muzio, & Dement, 1966). Also, results from a Swiss-Norwegian study including students aged 10 through 16 in both countries (Flammer & Tschanz, 1997) showed an astonishing decrease of about 20 min per year<sup>2</sup>. The method used in the latter study differed from the method used in the Euronet study (yesterday-questionnaire) in that the students were asked to report the average time they used on certain types of activities (a) on an ordinary school day, (b) on Saturdays, and (3) on Sundays, or also to report average durations on a weekly basis, or how often they performed certain activities. Interestingly, the difference in methods did not influence the results regarding sleep; in the Euronet study, too, younger adolescents (age 13 through 14) slept longer than their older peers (age 14 through 16), i.e., 8 h 41 min and 8 h 10 min, respectively.

An American study by Larson and Richards (1989) including adolescents from grade 5 through 9 and using the experience sampling method, has shown that the proportion of time spent with peers increased with age at the cost of time spent with family members. Over these grades, time spent on school homework decreased in girls and remained stable in boys (Leone & Richards, 1989). Interestingly, adolescents who spent a decreasing amount of time with their family increased the amount of time spent listening to music. In turn, listening to music was associated with less time spent watching TV (Larson, Kubey, & Colletti, 1989).

Time use changes during the pubertal period are due to quite different conditions. Some differences originate from structural factors. This is the case when older adolescents have longer school days and need more time for their way to and from school (Alsaker & Flammer, 1999). The first result is due to the scholastic system requiring more presence from the older adolescents, and the second result is due to the fact that schooling in higher grades in most countries becomes more specialized. Specialized schools cover a larger geographical area than more general schools, therefore students attending these schools have longer journeys to and from school. However, one can hardly attribute to formal requirements the fact that older adolescents

spend more time than younger adolescents on dating and hanging around with their friends. In this case, informal social requirements, based on biological changes, seem to be at work.

Interestingly, a pervading Euronet result that was consistent across countries was that younger adolescents generally spent more time on sports activities than older adolescents. Do older adolescents lose interest in sports? Given that the older adolescents reported more school-related activities (time in class, way to school, homework), one could also consider their lower sports activities as a reflection of the reduced availability of time and not of less interest. In the Swiss-Norwegian study, younger adolescents were found to be more often active in sport clubs than their older peers. However, the older adolescents who reported doing sports in clubs did it for longer times than their younger peers (3 h 45 min and 2 h 27 min per week, respectively). That is, the percentage of adolescents participating in sport clubs may decrease with age, but the intensity seems to increase for those who are still engaged in sports when they get older (Tschanz, 1997).

The interindividual differentiation in sports activities points to the fact that there are still individual degrees of freedom after societal constraints. This notion is even strengthened by the finding of Flammer et al. (1999) that boys who reported having done more sports reported spending less time on almost all other leisure activities and in almost all countries, i.e., on playing a musical instrument, on leisure reading, on hanging around with friends, and on dating. When the correlation was calculated with the proportion of remaining time after subtraction of time spent on sports, the correlations with the mentioned leisure activities remained negative, but correlations with the most important "necessary" activities turned from negative to positive, i.e., with school and with sleep. The latter indicates that school and sleep continued to occupy a large amount of time in terms of duration, and that they consequently occupied a greater proportion of the time remaining after sports activities were accomplished. That is, doing sports is still the result of an individual choice at the cost of other leisure activities but the boundaries are tighter. Further age differences found in the

<sup>2</sup> Evidently there were great individual differences in time spent sleeping. Even if one disregards of the lowest 10% and of the highest 10%, sleeping time still yielded a range of one hour and 45 minutes.

mentioned Euronet study concerned increases in time spent on body care, dating, and paid labor.

Whereas time spent on meals in general does not vary to a great extent with age, more and more adolescents seem to skip breakfast when they get older, girls more than boys (Flammer & Tschanz, 1997; see Figure 1). These results show that, among other things, society's beauty norms play a great role for adolescents' behavior and in this case for girls more than for boys.

In conclusion, older as compared to younger adolescents spend *more* time at school, on their way to and from school, on body care, on working for money, with peers and with girlfriends/boyfriends. Older adolescents spend *less* time on sleep, active sports, and with family members. The societal regulation of the day increases with the adolescents' age.

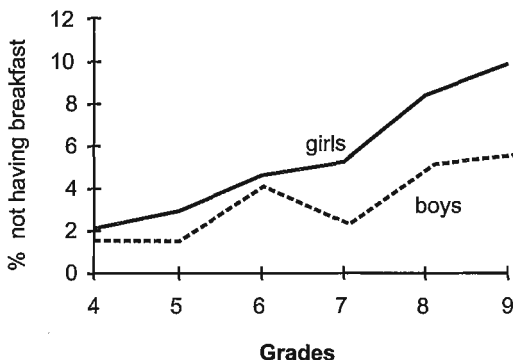


Figure 1: Percentage of adolescents not having breakfast. (Swiss sample; from Flammer & Tschanz, 1997, p. 60.)

### Gender differences in time use

According to several studies conducted in the US, boys in grades 5 through 9 watch more TV (Larson et al., 1989) and do more active sports than girls (Kirshnit, Ham, & Richards, 1989; Larson & Richards, 1989; Timmer et al., 1985). Girls, on the other hand, spend more time listening to music (Larson et al., 1989), doing homework (Leone & Richards, 1989; Timmer et al., 1985), conversing with peers (Raffaelli & Duckett, 1989), eating their meals, caring for their bodies, and performing household chores (Timmer et al., 1985).

The Euronet study, too, astonishingly confirmed many known gender differences. Girls

spent more time on homework, leisure reading, body care, household chores, and shopping, while boys did more sports and watched more TV (Flammer et al., 1999). Understandably, because adolescent girls usually date slightly older boys and because dating behavior increases with age, girls reported to spend more time dating than boys.

It seems that traditional attitudes are well alive among adolescents. Possibly, some attitudes have indeed changed, but only at a superficial level or only in very specific domains. The fact that, officially, women have the same political and occupational rights as men does not prevent them from being socialized according to old stereotypes.

In the same vein, girls seem to use their time to a greater extent on interpersonal and related activities. During adolescence, for example, they use much more time than boys on discussing with friends (Raffaelli & Duckett, 1989).

Another finding worth emphasizing is that girls in American and in European studies have been found to spend more time on school homework, while boys do sports. The finding that girls spend more time on homework (and leisure reading), while boys do sports, corresponds well to the general expectation that girls are more quiet and careful, but also more serious. The latter characteristic, combined with the new expectations that women – like men – should get a good education and have a good profession, may herald some reversal of gender roles in coming decades. In fact, in countries in which professional expectations towards women are well established, such as Poland or Russia, more young women get higher education than young men. However, it might be too early to draw such conclusions on the basis of time used on homework. Actually, longitudinal results (Smith, 1992) showed that in 7th and 9th graders growth in academic achievement over a two-year period correlated neither with time spent on homework at the beginning of the study nor with time spent on leisure reading; this study disconfirmed Leone and Richards' 1989 study in which higher academic achievement was associated with increased homework, particularly if the homework was done with the parents. On the other hand, in Smith's (1992) study growth in academic achievement correlated negatively with time used on household chores. Speculating further about changes in gender roles, it is also possible

that the academic domain is becoming more feminine, while the so-called "stronger" gender finds its new ecological niche in business and money.

In sum, research so far suggests that girls devote more time than boys with peers, on body care, leisure reading, music (i.e., listening to music), household chores, school homework, and shopping. Boys spend more time on TV and active sports. Most other gender differences in the Euronet study were qualified by an interaction with either age or country. This leads us to the next issue addressed in this paper: Time use in cross-national comparisons.

### Time use in cross-national and cross-cultural research

As argued earlier, there are good reasons to expect time use to vary in different cultures. For instance, religious affiliation may affect certain activities as well as the whole weekly rhythm. Also, as shown earlier, gender roles may dictate varying time use in girls and boys in different countries. In addition and probably most importantly, time use is bound to societal and political regulations, i.e., the organization of the school system, then of the school week and the school day, and the typical general organization of the working day at work places and in families. Such organizational patterns are most often bound to countries.

Within the Euronet study 12 countries were compared. Figure 2 gives an overview of the average durations of the main activities on a target day (yesterday questionnaire). It should be noted that this target day was always a regular school day.

A first look at Figure 2 reveals that adolescents' days in the chosen countries were generally rather similar. This impression is mainly due to the two most important activities in terms of duration, i.e., sleep and school. However, examining each activity separately, there were impressive differences between some countries. As far as activities for which the country variable did not interact with the age variable nor the gender variable or the interactions were ordinal, the coefficient maximum/minimum for the time spent on sleep was 1.15 (maximum in French-speaking Switzerland and France with 8 h 48 min, followed by Romania; down to Russia, the US, and

Poland with 7 h 38 min). The corresponding coefficient for time spent on meals was 2.38 (France with 1 h 53 min, French- and German-speaking Switzerland, ..., USA, Hungary, CSFR with 0 h 47 min), the coefficient for time spent at school was 1.38 (France with 7 h 2 min, Finland, USA, ..., Romania, Poland, Bulgaria with 5 h 7 min), for playing a musical instrument 11.3 (German-speaking Switzerland with 0 h 20 min, Germany, Norway, ..., Bulgaria, USA, Romania with 0 h 2 min), for active sports 4.5 (Norway with 1 h 26 min, USA, CSFR, ..., France, Bulgaria, Russia with 0 h 19 min), for watching TV 1.8 (Bulgaria with 2 h 22 min, CSFR, Romania, ..., Hungary, German-speaking Switzerland, France with 1 h 19 min), for dating 10.3 (Germany with 1 h 14 min, Finland, USA, ..., CSFR, Norway, France with 0 h 7 min), for "time spent hanging around with friends" 8.5 (Finland with 1 h 38 min, Hungary, Bulgaria, ..., German-speaking Switzerland, Germany, French-speaking Switzerland with 0 h 11 min), for shopping 3.7 (Poland with 0 h 22 min, Germany, CSFR, Norway, Russia, France with 0 h 6 min), and working for money (USA with 0 h 40 min, Norway, Germany, ..., French-speaking Switzerland, Hungary, Russia with 0 h 0 min).

It is worth noting here that some of these differences may depend on the method used (yesterday-questionnaire). In fact, when comparing Norwegian and Swiss adolescents using a questionnaire about the students' own estimates of their average weekly time allocated to given activities, Tschanz (1997) found Swiss adolescents to report doing more sports than the Norwegian (around one hour more a week). The explanation is probably that due to very different school schedules, the Norwegian adolescents typically do sports on school days, while Swiss adolescents use the half school days or free days for sports.

In terms of socialization experiences, some constellations of activities are of particular interest. Larson and Verma (1999) have reviewed studies on time use in adolescents all over the world and focused on the differences associated with the transition from non-literate pre-industrial to literate post-industrial conditions. They examined mainly two categories of activities: work and play. Compared to post-industrial societies, the figures reported in pre-industrial societies as to household chores are extremely high. As an example, Cain (1980, cited from Larson

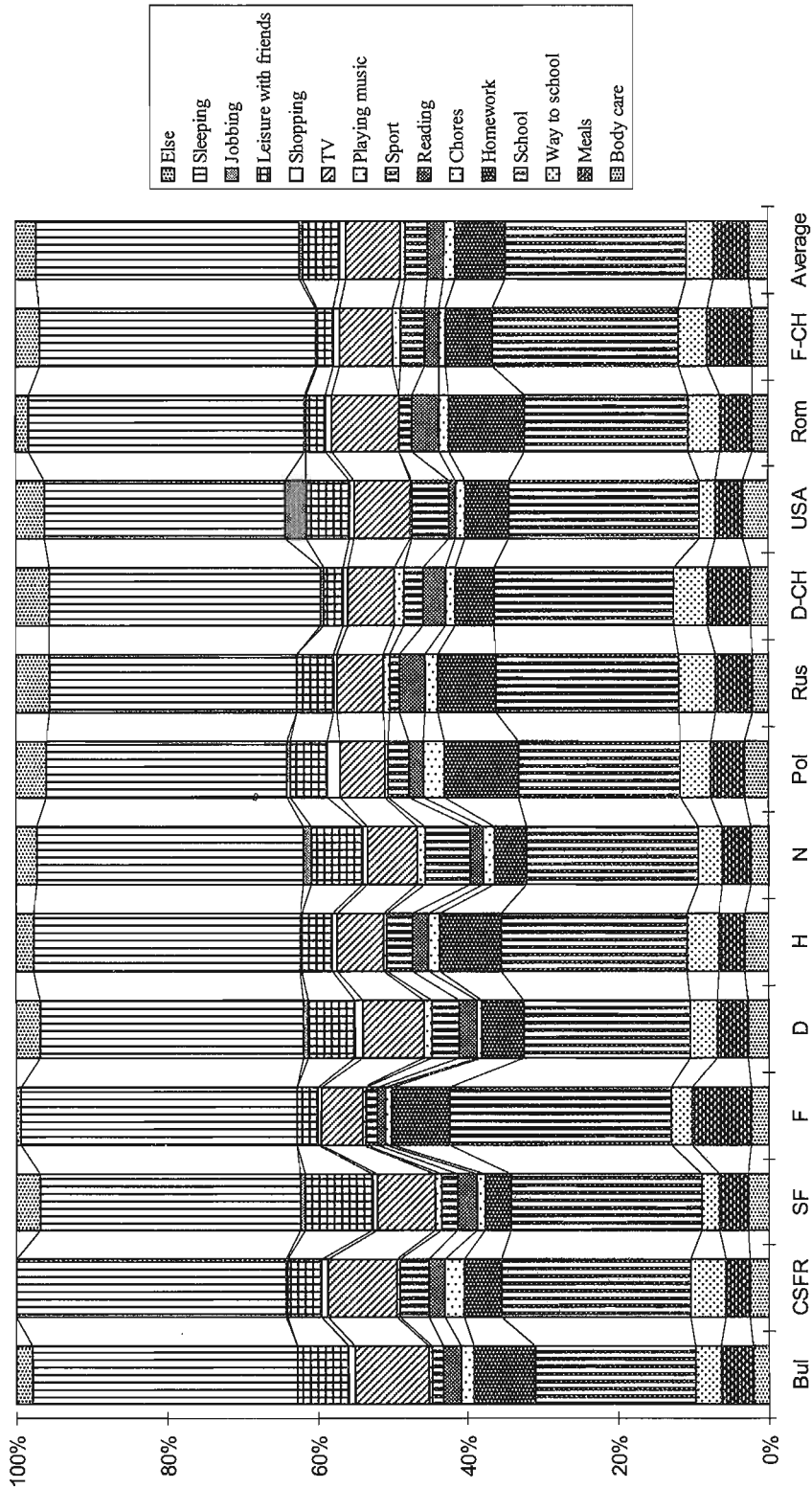


Figure 2: A regular schoolday in eleven European countries and the United States. Bul = Bulgaria, CSFR = Czechoslovakian Federal Republic, SF = Finland, F = France, D = Germany, H = Hungary, N = Norway, Pol = Poland, Rus = Russia, D-CH = German speaking Switzerland, Rom = Romania, F-CH = French speaking Switzerland.

& Verma, 1999) reported girls and boys aged 13 through 15 in Bangladesh to use approximately 8 and 7 h per day, respectively, on household chores. As a matter of comparison, the figures reported in the Euronet study varied from a low of 12 min to a high of 40 min a day (for girls and boys together; Alsaker & Flammer, 1999). However, the large difference between pre- and post-industrialized countries should not lead us to overlook variations in either one or the other group of countries. In fact, the variation in time used for household chores was rather systematic in the Euronet study, showing that adolescents from the Eastern/Central European countries did consistently more of it than their Western European peers (Alsaker & Flammer, 1999).

Interestingly, Larson and Verma (1999) classified paid labor as work, whereas Flammer et al. (1999) dealt with it under leisure activities. This points to the difficulty of categorizing activities across cultures. Paid labor is not a unified concept. In pre-industrialized countries, and also in some subcultures in industrialized countries, working for money is a necessary part of the family income, whereas it mostly serves the adolescents' "luxury" in industrialized countries. As shown by Larson and Verma (1999) social class plays an additional role in time used on paid labor in pre-industrialized countries, adolescents from lower social classes spending much more time earning money than other adolescents. Cain (1980, cited from Larson & Verma, 1999) reported adolescent boys (13 to 15 years old) in the lowest social classes to use approximately 6 hours on paid work.

Even if adolescents in industrialized countries are far from reporting such figures, there are astonishing differences between countries. Fuligni and Stevenson (1995) reported American adolescents to work more than their Chinese and Japanese peers. In fact, they reported 80% of their American teenagers (16 to 17 years old) to hold part-time jobs, whereas this was the case for 26% and 27%, respectively, for the Chinese and Japanese adolescents. Also, nearly half of the Asian adolescents who reported working did it as part of a vocational training, which was not the case in the United States. American students reported working 12 h per week on average, that is approximately 1 h 40 min per day (including Sundays).

The figures reported in the Euronet study, too, showed American students to work more

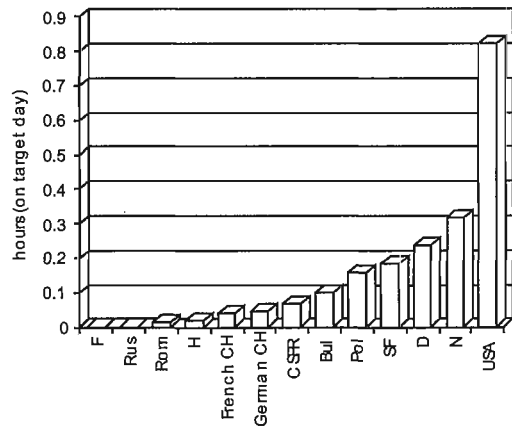


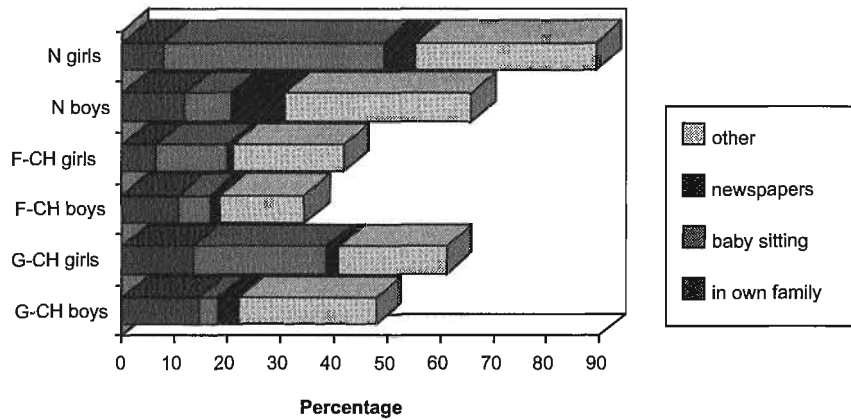
Figure 3: Working for money on the day before data collection (from Flammer & Tschanz, 1997)

than their European peers (see Figure 3). In fact, in terms of duration of activities one of the most striking differences was found as to time spent on earning money. On average, American adolescents had used nearly one hour on working on the school day before data collection. The next country was Norway, with around one third of an hour a day. As could be expected on the basis of what is known about the place occupied by school activities in the different countries, French adolescents were at the bottom of this distribution. In our opinion, what makes these results interesting is not the fact that American and Norwegian adolescents work for money while the French do not. Much more, it is the fact that the organization of the school day in a given country seems to have such practical consequences for children's and adolescents' socialization experiences.

Again, even if there is not much time left after the required activities, one can still follow priorities, one can still choose. The mentioned American and Norwegian adolescents could have spent their free time on other activities than on working for money. That is, these differences also mirror deeper value choices or possibly traditions at the societal level. Norwegian adolescents, for example, are more or less expected to take some small jobs in the afternoon to earn some of their pocket money. Actually, girls often start already in first grade, walking around with the neighbour's dog or with a baby buggy.

Flammer and Tschanz (1997) also asked the adolescents what kind of jobs they had. Typi-

Figure 4: Job activities among the adolescents who earned money; more than one choice possible (from Flammer & Tschanz, 1997).



cally, they reported working as babysitters and as newspaper boys or girls, some also reported working in the family enterprise (see Figure 4). The high percentage of Norwegian girls having indicated "other jobs," besides babysitting might indicate that many of them earned money on different small and occasional jobs, rather than on regular part-time jobs. Another interesting finding is that distributing newspapers was much more frequent in the working Norwegian adolescents than in their Swiss peers. This has a long tradition. In fact newspapers are distributed to a very large extent by students in Norway, early in the morning or just after school.

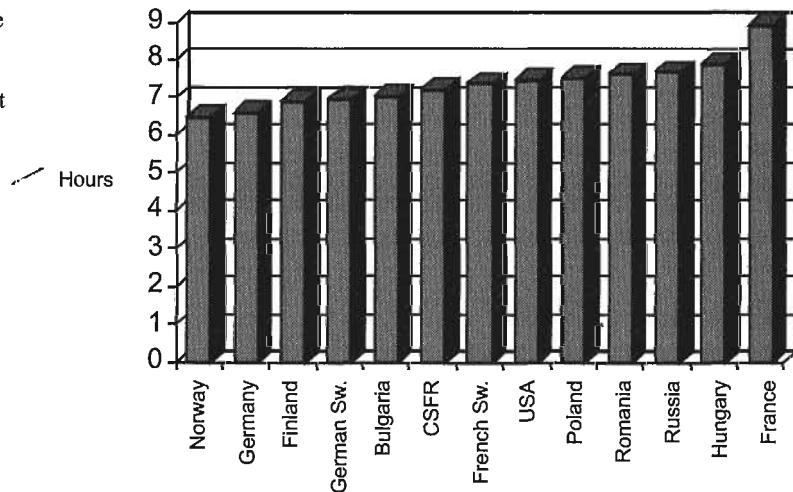
In their review, Larson & Verma (1999) concluded that the shift from paid labor to school work is a shift towards developmental benefits in pre-industrialized countries. However, they also raised the question whether some societies have

gone too far, occupying too much of children's time for school. Time use studies on single days cannot answer this question. One should need time load measures over whole weeks or over whole years. A partial answer can be found in Larson & Richards' study (1998). Generally, children's positive mood has been found to be slightly higher over the weekends and worst in the middle of the week. While this effect was small among students of 5th to 8th grade, it was very large among students of 9th to 12th grade.

Possibly, children are able to compensate over the week-end for the lack of leisure time during school days, possibly also they get so tired from the long school days that they are not able to use their free time adequately.

Time used in school and on homework varies among countries (see Figure 5). In the Euronet study, Norway yielded the shortest amount of

Figure 5: Amount of time used in school and on homework in the 13 samples from the Euronet study.



time allocated to school and homework altogether and France was on the top. The difference between these two countries was around two and a half hours a day! Both Swiss samples were in the middle of the distribution. However, simply measuring the time spent in school may be misleading. The organization of the school schedule is another important variable. In Norway the students go to school on five consecutive days and their school day is organized in one block, without any lunch break. The French school week includes four and a half days, with a free day in the middle of the week. And, the French school day is divided in a morning part and an afternoon part, usually with a two-hour lunch break. That is, in comparison to most of their European peers, Norwegian students come home from school very early in the afternoon and they have a long afternoon at their disposition, but they may be very tired by then. The resulting question is whether they draw enough benefit from this long free afternoon as compared to students with longer school days.

The Swiss-Norwegian study holds some answers to this question. We have already reported that Norwegian adolescents worked more for earning money. This may be both distracting and a worthwhile socialization factor. They may learn to handle money somewhat earlier than their non-working peers and also get a feeling of personal importance in society. Given that they have much free time, and that working for money occupies only some of this time, one could also expect the Norwegians to do a lot more things in their leisure time, especially on regular school days, than their Swiss peers. In fact, the Euronet study had demonstrated that they did more sports than the Swiss adolescents *on a regular school day*. However, as reported earlier in this section, when week averages were compared, the Norwegian students did in fact less sports than their Swiss peers. Tschanz (1997) reported that they were also less active in playing

musical instruments and in leisure reading. They also went less often to restaurants, sports events, movies etc. All in all, they did not seem to use their free time more actively than their Swiss peers. So what did they do on their long afternoons? There were at least two leisure activities on which Norwegian students used more time, they watched much more television and video than their Swiss peers, and they spent much more time on so called "non-organized spare time activities", both especially on school days. Non-organized spare time activities were defined as activities such as playing games (including computer games), playing outdoors or indoors, painting, building things, etc. Actually, time used on non-organized leisure activities on school days (see Table 1) yielded massive differences between the three samples. The Norwegian adolescents spent about three hours per day on non-organized activities, which was three times more than their peers from the French-speaking part of Switzerland.

Speaking of benefits typically reflects a set of cultural values. Therefore, answering the question whether Norwegian adolescents draw benefits from their long free afternoons is difficult. In terms of educational benefits, they do not seem to be better off than their Swiss peers. They do not seem to use their free afternoons on activities that would give them advantages in terms of intellectual growth. However, at the beginning of this chapter we raised the issue of overloaded leisure time schedules. Therefore, benefits could also be conceived of in terms of recreation and "free non organized" time. In this perspective, Norwegians are possibly better off than their Swiss peers. Another way to answer the question of whether free activities represent a benefit is to ask the adolescents themselves whether they perceive non-organized time as valuable.

The adolescents had been asked whether they would have liked to have more time for these non organized spare time activities, or if they

*Table 1:* Time used on non-organized activities on an average school day, and percentages of adolescents wishing to have more time for such activities.

	Unstructured activities on school days	Percentage wanting more time available for unstructured activities
German Swiss	83 minutes	34%
French Swiss	52 minutes	49%
Norwegian	181 minutes	29%

felt it was all right the way it was, or else if they even felt it was already too much (Alsaker, unpublished data). Figures varied according to the socio-cultural context and, as shown in Table 1, to the amount of time spent on such activities. 34% of the German-speaking Swiss students wished they had more time for non organized activities, and about 50% of the French-speaking Swiss students reported the same wish. Norwegian adolescents were at the bottom of the distribution, but rather close to their German-speaking Swiss peers. The fact that 27% of the Norwegian adolescents still wished they had more time for non organized activities indicates that this kind of activities are perceived as valuable.

The results presented in this section on cross-cultural differences have shown that school (versus no school) and the organization of the school day play an important role for the socialization opportunities outside school. However, the amount of time used on school-related matters and the organization of the day are not the only explanation for the large differences on time used on different activities. The differences may indeed indicate the extent to which these activities are valued in the different countries.

### Concluding remarks

Time use studies reflect what people do and not just what they are able to do and are inclined to do. Especially for children and adolescents, they chart their actual socialization opportunities.

The actual time use is always a trade-off between necessities and choices. There are biological necessities (e.g., sleep), societal necessities (e.g., school), and consequential necessities derived from former or more global decisions (i.e., once an adolescent has decided to take music lessons, he or she has to attend such lessons at a specific time in the week, at least for the duration of a semester). There are choices as well, some are very free (e.g., leisure activities after school), others are partly free (i.e., the time invested in school homework). Societal necessities reflect societal values, individual choices reflect individual values. Because many choices are a response to derived necessities, be they social or individual, the underlying value system is still more or less to be inferred. This is valid for all studies that are reviewed in this chapter. One way to go beyond this would be to witness actual

activity choices and ask the participants why they undertake what they do. Many answers would be: "I have to." Further questioning should reveal possible dependencies of such "necessities."

Research on time use is not very advanced so far. Still, concerning adolescents, there are some reliable conclusions to be drawn. With increasing age, adolescents in Europe and in the USA sleep less, but (have to) spend more time for school-related activities. They spend less time with their family but affiliate more often with peers and friends. Interestingly, many reduce their sports activities drastically, a few, however, increase sports activities. "Naturally," they engage more time with girlfriends/boyfriends and increasingly invest time in body care.

Comparing adolescent girls with adolescent boys somehow deluded our naive expectations in that they confirmed good old stereotypes. While boys do more sports than girls and sit longer in front of the TV set, the girls do more household chores, school homework, shopping, and body care, but also music and leisure reading.

Comparing time use in different countries is interesting and meaningful, interesting primarily for those who are curious to compare one given country (e.g., their own) with others, meaningful primarily for those interested in general insights into cultures and national institutions. As an example, it was shown that societal institutions like the organization of the school week and the school day influence quantity and type of "post-school" activities. However, conclusions are difficult as long as one does not inquire directly about the motives for the remaining choices. And even then, such indications may simply reflect stereotyped everyday explanations. A more strict test would consist in purposefully altering the organizational structures. But such structures go along with values, naive theories, and attitudes. These variables are naturally and necessarily confounded.

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# Being On-Time or Off-Time: Developmental Deadlines for Regulating One's Own Development

Carsten Wrosch and Jutta Heckhausen

The human life course provides a rich set of possible developmental pathways individuals can choose, follow, or disengage from. The repertoire of viable life-course pathways, however, is canalized by age-graded constraints throughout the life course. A corollary of this principle is that age-graded constraints determine the opportunities for realizing important life goals. For example, the opportunities for goal attainment can change from plentiful to sparse if people advance in age (e.g., having a child at twenty versus forty years of age), a phenomenon that we call a "developmental deadline" (J. Heckhausen, 1999; Wrosch, 1999). In the first part of this chapter, we discuss different factors that determine the age-graded structure of the life course. This discussion leads to a model of adaptive control processes involved in the management of personal goals before and after the occurrence of a developmental deadline. It is argued that age-graded opportunities and constraints guide the individual's striving for developmental goals. In addition, successful developmental regulation is conceptualized as an adaptive fit of a person's control potential with age-graded constraints. In the second part of this chapter, the life-span theory of control (J. Heckhausen & Schulz, 1995; Schulz & J. Heckhausen, 1996) is discussed as a theoretical and empirical framework that postulates age-graded control processes to strive for the attainment of chosen goals and to cope with the emotional turmoil resulting from failure. At times of favorable opportunities, the individual should intensify active investments in goal striving. During age phases with sharply reduced opportunities and salient constraints, however, the individual should deactivate goal striving and invest in alternative goals. The third part of this chapter proposes a model of adaptive developmental regulation around developmental deadlines, labeled as the "Extended Model of Action Phases"

(J. Heckhausen, 1999; J. Heckhausen, Wrosch, & Fleeson, 2001; Wrosch, 1999; Wrosch & Heckhausen, 1999). Developmental deadlines are described as prototypical phenomena of the interplay between age-graded constraints and individual control behavior. The concept of developmental deadlines allows an investigation of a person's response to changing opportunity structures in terms of personal goal setting and control striving. This model hypothesizes adaptive processes of developmental regulation when individuals approach a deadline, pass a deadline successfully, or pass a deadline without achieving the intended goal. Empirical evidence concerning the proposed model is discussed with respect to developmental regulation around two developmental deadlines: 1) having your own children (J. Heckhausen, Wrosch, & Fleeson, 2001) and 2) forming an intimate relationship (Wrosch & Heckhausen, 1999).

## Timing of developmental goals across the life course: The impact of biological, socio-structural, and age-normative factors

For the past five decades, life-span developmentalists and life-course sociologists have become interested in the time-ordered frame of the life course for individual development. Particularly influential were conceptual models of identity development (e.g., Erikson, 1963, 1968) and developmental tasks (e.g., Havighurst, 1953, 1967). These models postulate that successful development depends on effective management of age-graded developmental tasks or psychosocial crises. Failure to master age-graded challenges should result in dissatisfaction, social rejection, and difficulties regarding the solution of further tasks.

What are the relevant factors that comprise the age-graded structure of the life course and

thus scaffold individual development? A classification of factors underlying the age-graded structure of the human life course has been proposed by J. Heckhausen and Schulz (1995). They differentiate age-graded constraints into biological, socio-structural, and age-normative factors. We note that the impact of these factors does not only vary across the human life course, but also may be affected by socio-historical and cultural change (e.g., history-graded factors; Baltes, Cornelius, & Nesselroade, 1979).

*Biological factors* are related to relatively universal patterns of change based on maturation and aging. Overall, biological change produces an inverted U-curve pattern of functional capacity across the human life span. During childhood and adolescence, maturation promotes the organism from complete helplessness to a well-functioning individual. In early and middle adulthood, maturation is complete and aging has not yet significantly compromised functioning. From middle adulthood on, biological aging negatively affects personal functioning and leads to a progressive decline in competencies and resources in old age. For example, objective markers of biological decline, such as cognitive skills and capacities (Baltes, 1987) are decreasing with age, especially at the limits of individual performance (Baltes & Kliegl, 1986; Kliegl, Smith, & Baltes, 1989). This cycle of growth and decline is also reflected in laypersons' conceptions about development. Adults at different age levels consensually expect an increase of undesired change in old age (J. Heckhausen & Baltes, 1991).

*Socio-structural and institutional constraints* are anchored in modern societies in legislative rules for the age timing of life course transitions such as school entry or retirement, in socio-demographic structure such as the age-graded marriage market, and in corporate rules about age and sequences of promotion. Implicit and explicit restrictions based on chronological age provide a structure for entry and transition times of developmental projects. For instance, institutionalized age strata for specific professional careers can obstruct the attainment of intended life-course tracks when individuals are too old. The age-sequential structure of the life course (Sørensen, 1990) furnishes sequentially organized patterns in terms of opportunities and constraints for the attainment of developmental goals. Thus, the realization of possible goals in

late midlife and old age can be obstructed when a person's age does not fit with socially structured patterns of age-graded developmental tasks. The impact of age-graded socio-structural and institutional constraints (for education, promotion, family formation, etc.) implies for the individual that an age-appropriate timing (Hagestad & Neugarten, 1985) of personal goals facilitates successful development. Using opportunities at the right time in life helps to attain positive outcomes, while trying to attain life-course achievements against external constraints ("swimming against the stream") bears high costs for a person's resources.

In general, it can be assumed that social structure and societal institutions provide an age-graded timetable of life-course transitions that canalize the choice and the focus with respect to different development pathways (Hagestad, 1990). The social structure of modern societies with high levels of social mobility shows in spite of constraining factors much variability in terms of viable developmental pathways. Thus, individuals can have an active influence in shaping their own developmental pathways.

*Age-normative conceptions* about development influence the selection of developmental tracks across the life course. Age-normative conceptions are described as socially shared conceptions about change from birth to death (Hagestad & Neugarten, 1985). They can be understood as social constructions of reality and represent assumptions about the normative life course and age-appropriate behavior (Berger & Luckmann, 1966; Neugarten, 1969; Neugarten, Moore, & Lowe, 1968). Normativity is considered to be present in a given society when two conditions are fulfilled: a consensus within a community and social sanctioning in case of norm violation (Udry, 1982). Empirical evidence for a high consensus in age-normative conceptions has been reported by Neugarten, Moore, and Lowe (1968). Neugarten and colleagues identified highly consensual conceptions about the ideal timing of life-course events and transitions like the age of marriage (age range: 19–25; congruence: 80–90%), starting a career (age range: 20–22; congruence: 82–86%), retirement (age range: 60–65; congruence: 83–86%), and the age one has the most responsibility in life (age range: 35–50; congruence: 75–79%). Moreover, these consensual normative conceptions reflect the underlying bio-

logical and social structure of the life course (Nurmi, 1992). The findings of a high consensus in age-normative conceptions could be replicated in studies conducted more recently (Zepelin, Sills, & Heath, 1986–87) and in a different cultural context (Japan; Plath, & Ikeda, 1975).

Normative conceptions can significantly influence the choice of developmental goals, the investment of personal resources in realizing and elaborating chosen developmental tracks, and the process of adaptation after failing to achieve a goal. Two general features characterize the role of normative conceptions for processes of developmental regulation. First, they inform the individual about opportunities and risks concerning intended developmental outcomes (J. Heckhausen, Hundertmark, & Krueger, 1992). Thus, individuals may optimize their own development by investments of increased effort in protecting and accelerating intended developmental processes. Moreover, the subjective internalization of age-normative conceptions may enhance a person's commitment to strive for intended goals within the normative time frame (Hagestad & Neugarten, 1985). Thus, normative conceptions may function as social reference frames (Festinger, 1954) that provide typical models of possible behavior. Individuals who are "on time" concerning their developmental processes usually have a set of peers who can provide social support (Brim & Ryff, 1980). By contrast, individuals who are "off-time" often have to invest much more internal resources for compensating the missing socio-structural support (Wrosch & Freund, 2001). In addition, normative conceptions are markers for developmental deadlines that indicate when individuals have to disengage from unattainable goals (J. Heckhausen & Lang, 1996). In this case, normative conceptions can prevent a person from investing resources in futile developmental projects. This latter function of normative conceptions should be highly adaptive, given that it may prevent a person from wasting his/her personal resources.

Second, normative conceptions may function as a reference frame to protect the individual's self-esteem against negative emotional consequences of failure and developmental losses by comparing the own standard with negative age stereotypes. These processes have been described in the literature as downward compar-

isons (Wills, 1981) or social downgrading (J. Heckhausen & Brim, 1997). It may serve self-protective functions, for instance, when older adults assume that most other people at a similar age are more forgetful or less mobile as compared to themselves.

To summarize, the biological, societal, and age-normative structuring of the life course produces an age-graded timetable for developmental tasks (Havighurst, 1953). Developmental tasks play a relevant role in the ordering of major life-events across the life course. They are generally related to normative development and arise at or about a certain period in the life of an individual (Havighurst, 1967). Various studies provide evidence that individuals select their developmental goals at any given age in accordance with their respective developmental tasks. Nurmi (1992), for instance, reported that goals and interests of adults are well adapted to the respective age-congruent developmental tasks. Similarly, J. Heckhausen (1997) found congruence between nominated developmental goals and major markers of the social and biological structure of the life course (e.g., health, work, leisure). Thus, age-graded normative tasks provide a general plan to selectively invest personal resources (Cantor, Norem, Langston, Zirkel, Fleeson, & Cook-Flannagan, 1991). Accordingly, the individual is challenged to manage the impact of constraining factors on development as well as to actively select and promote intended development pathways.

#### **Processes of developmental regulation: Optimization in primary and secondary control**

Individuals take an active part in shaping their own development (Lerner & Busch-Rossnagel, 1981). People select goals, strive for their attainment, and manage the consequences resulting from success and failure. As mentioned above, we conceptualize successful developmental regulation as an adaptive fit of the individual's striving for developmental goals to the biological, socio-structural, and age-normative constraints of development. This position holds that successful development can be achieved by a functional (age-adjusted) goal selection, a high focus on and realization of attainable goals, and the deactivation of unrealistic intentions (J.

Heckhausen, 1999). The life-span theory of control (J. Heckhausen & Schulz, 1995; Schulz & Heckhausen, 1996) identifies two fundamental requirements of human behavior and proposes a set of adaptive strategies to select appropriate goals, to focus on chosen goals, to realize the goal intentions, and to cope with the motivational and emotional turmoil resulting from failure. Moreover, the life-span theory of control considers different developmental ecologies across the human life course and postulates adaptive primary and secondary control strategies for mastering agegraded developmental challenges.

Human behavior is less predictable, as compared to other species, because of the huge diversity of possible developmental pathways. Moreover, behavioral variability generally enhances the likelihood of failure, with its consequences in terms of frustration and negative self-image. This notion of variability in human behavior implies that the individual has to manage two basic requirements throughout the life span: *selectivity* and *failure compensation* (J. Heckhausen & Schulz, 1995; Schulz & Heckhausen, 1996). First, the variability of goals and behavior requires the individual to be selective. Possible alternatives of future development have to be carefully deliberated and a certain developmental pathway needs to be selected. Thus, individuals need strategies to decide for the one and against the other alternative. Once a decision is made, the motivational commitment to this decision needs to be high and resilient against conflicting action alternatives (e.g., Kuhl, 1983). The second key requirement results from the vulnerability to failure experience. Greater behavioral variability enhances the likelihood of experiencing failure and might lead to negative consequences in terms of frustration and self-image. Therefore, individuals also need strategies to compensate for the negative impact of failure on self-esteem.

What are the means and strategies, humans can use to manage the described requirements of developmental regulation and to attain intended developmental outcomes? To approach this question, the life-span theory of control has adopted the dual process conception of primary and secondary control (Rothbaum, Weisz & Snyder, 1982) and elaborated in a developmental context. Rothbaum and colleagues (1982) have defined *primary control* as individuals' attempts to gain control by bringing the environment into

line with their wishes. *Secondary control*, by contrast, has been defined as individuals' attempts to gain control by bringing the self into line with the environmental constraints. The distinction between primary and secondary control is conceptually related to other models of adjustment like accommodation and assimilation (Brandstädter & Renner, 1990; Brandstädter, Wentura, & Greve, 1993), or problem-focused and emotion-focused coping (Folkman & Lazarus, 1980; Lazarus & Launier, 1978), although there are important conceptual differences (see J. Heckhausen, 1999; Poulin, Haase & Heckhausen, 2005).

J. Heckhausen and Schulz (1995, 1999; Schulz & Heckhausen, 1996) have postulated a functional primacy of primary control. This position holds that both primary and secondary control strategies are adaptive, insofar as they optimize the individual's long-term potential for primary control. Primary control supports this goal directly, given that the individual can profit from the positive consequences of successful goal attainment. The two functions of secondary control are 1) to optimize selective volitional investment and 2) to compensate for the negative emotional and motivational consequences of failure.

By integrating the distinction between primary and secondary control with the two fundamental requirements of human behavior (selectivity and failure compensation), the life-span theory of control defined four different types of control strategies: selective primary, compensatory primary, selective secondary, and compensatory secondary control. In addition, a higher-order process, referred to as optimization, is expected to regulate the adaptive use of the four control strategies. Table 1 illustrates the proposed processes of developmental regulation that are the basic elements of the model of optimization in primary and secondary control (OPS model; e.g., J. Heckhausen, 1999; J. Heckhausen & Schulz, 1995).

*Optimization* helps to select goals for primary control, which fit the opportunities and constraints of an individual. In addition, optimized goal selection should safeguard a certain degree of diversity. Finally, optimized goal selection supports the management of positive and negative trade-offs for different life domains and future development.

*Selective primary control* striving is defined as the investment of internal resources, such as

Table 1: OPS-Model: Optimization in primary and secondary control.

*Optimization*

- adaptive goal selection: long-term and age-appropriate goals
- management of positive and negative trade-offs for other life domains and future life course
- maintain diversity, avoid dead-ends

*Selective Primary Control*

- invest effort, ability and time
- learn new skills
- fight difficulties

*Selective Secondary Control*

- enhance goal value
- devalue competing goals
- enhance perception of control
- imagine positive emotional consequences of goal attainment

*Compensatory Primary Control*

- recruit others' help and advice
- use of technical aids
- employ unusual means

*Compensatory Secondary Control*

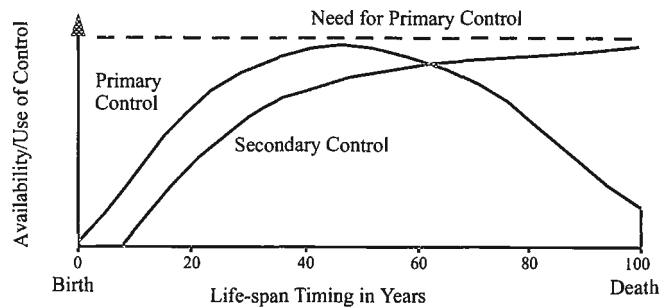
- goal disengagement (sour grapes)
- self-protective attributions
- self-protective social and intra-individual comparisons

time and effort, the development of relevant skills, or an increased effort when obstacles emerge. These strategies are aimed directly at the realization of chosen developmental goals. *Compensatory primary control* strategies are described as an active search for help and advice, the use of unusual means, and taking a detour for achieving a goal. In situations in which selective primary control is not sufficient to attain a goal, compensatory primary control is needed. Such situations might occur when individuals' internal resources are depleted or the opportunities for goal attainment are expected to become less favorable. *Selective secondary control* supports individuals' volitional focus on a chosen goal. This type of strategy is described as enhancement of the goal value, devaluation of competing goals, enhanced perception of control, or the imagination of positive consequences of goal attainment. Selective secondary control striving strengthens the individual commitment to chosen developmental tracks and therefore enhances the likelihood of persistence in goal striving and helps to identify and use favorable opportunities to implement personal intentions. *Compensatory secondary control* strategies are described as goal disengagement, self-protective attributions, and social or intra-individual comparisons. This set of strategies helps individuals to cope with the negative consequences resulting from failure in

two different ways. First, they directly consist of self-protective processes (e.g., attributional biases, downward comparisons). Second, personal resources can be protected by redirecting time and energy to other goals or life domains that involve more favorable opportunity structures for goal attainment (e.g., disengagement). In so doing, a person prevents accumulated failure experience and keeps being engaged in the attainment of other important goals (cf. Wrosch, Scheier, Carver, & Schulz, 2003).

Schulz and Heckhausen (1996) have postulated hypothetical life-span trajectories for primary and secondary control. Figure 1 shows that primary control is expected to increase in young adulthood, to plateau in middle adulthood, and to decrease in old age. By contrast, secondary control is expected to develop in early childhood and to increase over the entire life span. Secondary control becomes increasingly important in old age, because of its compensatory function in individuals who face developmental losses (compensatory secondary control). In addition, it can be assumed that enhanced commitment towards personal goals (selective secondary control) may support a persistent striving for goal attainment when internal resources (selective primary control) become increasingly reduced in old age. In a similar vein, Gollwitzer and colleagues (Gollwitzer & Moskowitz, 1996; Wicklund & Gollwitzer, 1982) argued that a

Figure 1: Hypothetical life-span trajectories of primary control, secondary control, and need for primary control.



strong commitment to goals stimulates compensatory efforts when failure is experienced.

Irrespective of losses in objective control potential, the need for primary control (J. Heckhausen, 1999) should remain stable across the life span (see Figure 1). It is expected that an increasing use of secondary control strategies protects the motivational and emotional resources and helps the individual to focus on age-adjusted developmental tasks. The empirical evidence for the hypothetical life-span trajectories for primary and secondary control, however, is only partly supportive. On the one hand, substantial evidence has demonstrated an increase of secondary control striving across the life course (e.g., Brandtstädter & Renner, 1990; Brandtstädter, Wentura, & Greve, 1993; J. Heckhausen, 1997; Peng & Lachman, 1993; Wrosch & Heckhausen, 1999, 2002). On the other hand, with regard to primary control striving, the findings from different studies are less consistent; they indicate either stability (J. Heckhausen, 1997; Peng & Lachman, 1993), or decrease (e.g., Brandtstädter & Renner, 1990; Brandtstädter, Wentura, & Greve, 1993), or increase (Wrosch, Heckhausen, & Lachman, 2000) across adulthood and old age.

#### **Developmental deadlines: Motivational responses to changing opportunity structures across the life course**

We have argued earlier that biological, socio-structural, and age-normative factors scaffold the developmental opportunities for realizing specific goals across the human life course. As a consequence of such age-graded influences, goals that are easily attainable in young adulthood can sometimes hardly be realized in late midlife and old age (e.g., child bearing). The

concept of developmental deadlines (J. Heckhausen, Wrosch, & Fleeson, 2001; J. Heckhausen, 1999; Wrosch & Heckhausen, 1999) specifically addresses this phenomenon of changing opportunity structures for goal attainment across the adult life span. Around developmental deadlines, opportunities for attaining a specific goal change from plentiful to sparse, while constraints change from minor to major.

The concept of developmental deadlines integrates the life-span theory of control with a motivational model of action phases (i.e., Rubicon model, H. Heckhausen, 1989). This integration is summarized in a new model that assumes different processes of developmental regulation when individuals approach a deadline, pass it successfully, or cross the deadline without attaining the goal. The model itself will be described below as the "Extended Model of Action Phases" (J. Heckhausen, 1999). We note that the concept of adaptive regulation processes around deadlines is not exclusively related to developmental phenomena. It could also be used as a theoretical framework to study human action regulation in a broader, more general context.

Developmental deadlines are defined as final reference points to realize a certain goal (J. Heckhausen, 1999; J. Heckhausen, Wrosch, & Fleeson, 2001; Wrosch, 1999). A typical example is the biologically based developmental deadline for child bearing. Beyond age forty, fertility in women greatly decreases while risk pregnancies increase in likelihood. Similar shifts from facilitative to inhibitory conditions can be found for various developmental tasks (e.g., settle into a career), as indicated by research on implicit and explicit age norms and deadlines for the timing of life-course transitions (Settersten & Hagestad, 1996a, 1996b).

Deadlines for different developmental tasks may vary in age timing and in terms of the

abruptness of the shift from conducive to inhibitory conditions. For example, some work-related deadlines like entering vocational training characterize young adulthood, whereas deadlines for the postponement of child bearing should influence individual development especially in middle adulthood. In late midlife and old age, for example, individuals confront deadlines for continuing work or being in perfect health. In addition, developmental deadlines vary in terms of their modifiability (malleability). Biologically based deadlines (e.g., having a child after menopause) are less subject to individuals' attempts of surmounting them. For biological deadlines, constraints can hardly be overcome by intense investment of effort and psychological commitment. Age-normative conceptions, by contrast, can be ignored, although often at a substantial cost. The individual can choose to take a non-normative path. Despite this variability in life-course timing and intensity of change in opportunity structures, deadline phenomena are related to a substantial shift from a favorable developmental ecology (more opportunities, less constraints) to an unfavorable developmental ecology (more constraints, less opportunities) with respect to a specific developmental goal.

Developmental regulation around transition points like intention formation or deactivation requires individuals to perform a shift in motivational behaviors. The Rubicon model of action phases (H. Heckhausen, 1989) segments the action process into four different phases: a predecisional motivational phase, a preactional volitional phase, an actional volitional phase,

and a postactional motivational phase. During the predecisional phase, the individual evaluates the pros and cons of different action alternatives. The formation of a certain goal marks the transition from a predecisional to a preactional phase. This transition point has been labeled by H. Heckhausen (1989) as "Rubicon passage," because it implies that the individual is now in a fundamentally different motivational mindset (Gollwitzer, 1996). In several studies cognitive indicators of motivational mindsets (e.g., informational focus, memory content) were investigated in subjects that were either in pre-Rubicon or post-Rubicon situations (e.g., H. Heckhausen, 1989; H. Heckhausen & Gollwitzer, 1987). H. Heckhausen and colleagues showed that individuals switch from a deliberative to an implemental mindset after crossing the Rubicon. In the preactional phase, the individual is concerned with searching favorable opportunities to implement the chosen goal. The function of the actional phase is then to implement the intention. In the postactional phase, the individual is evaluating the action outcome as well as the consequences for prospective action cycles (e.g., H. Heckhausen, 1989). This line of research gathered substantial empirical evidence for different motivation-based processes of action regulation before and after different transition points of the action cycle.

The issue of intention deactivation has so far been empirically neglected (Wrosch et al., 2003). Intention deactivation, however, is expected to be most revealing about the fundamental process of action regulation (H. Heckhausen

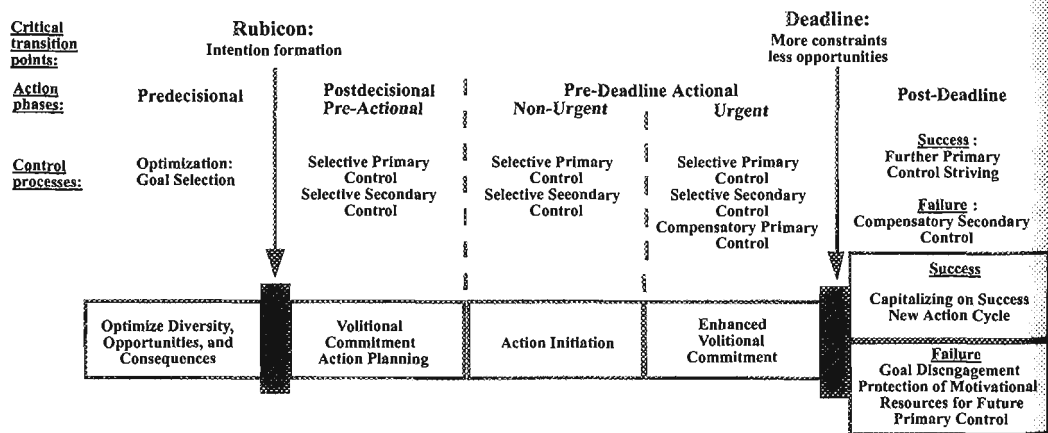


Figure 2: The extended model of action phases: Rubicon and deadline.

& Beckmann, 1990). In the context of age-graded deadlines, the detriment of opportunity structures requires the individual to adaptively manage hardly attainable goals and prospective development. To conceptualize adaptive regulation processes around developmental deadlines, we propose a model that integrates the deadline transition with the Rubicon model and specifies processes of adaptive regulation for different action phases. This model, as illustrated in Figure 2, is labeled the "Extended Model of Action Phases: Rubicon and Deadline" (J. Heckhausen, 1999; J. Heckhausen, Wrosch, & Fleeson, 2001; Wrosch, 1999).

The extended model of action phases describes action regulation on four different levels (see vertical hierarchy of levels in Figure 2). First, critical *transition points* are described as Rubicon and Deadline. Second, five different *motivational phases* are distinguished at the level of action phases. As in the Rubicon model, the Rubicon marks the intention formation and is defined as the transition from a predecisional phase to the requirements of volitional planning; the postdecisional or preactional phase. Going beyond the Rubicon model, the extended model of action phases divides the actional phase into two subphases: a non-urgent actional phase and an urgent actional phase. The non-urgent actional phase is characterized by a developmental ecology that involves plenty of time and opportunities before reaching a deadline (e.g., having a child in your early twenties). In the urgent actional phase, the circumstances have changed. The individual is approaching a deadline and might expect a decline of opportunities for goal attainment (e.g., having a child in your late thirties). The deadline itself is a transition from an urgent actional phase to a postactional phase (post-deadline). After crossing the deadline, the opportunities for prospective goal attainment have become considerably reduced and therefore do not warrant a successful effect of continued actions, but call for a deactivation of goal intentions.

Third, the extended model of action phases conceptualizes adaptive *processes of developmental regulation* for the proposed action phases. These processes are theoretically based on the different elements of the OPS model (optimization, selective primary control, compensatory primary control, selective secondary control, compensatory secondary control). Fourth,

the *adaptive functions* of phase-congruent processes of developmental regulation processes are specified. They are illustrated in the boxes of Figure 2.

In the predecisional phase, optimization processes like an age-appropriate choice of developmental tasks should support the individual's development insofar as a well-adjusted selection of developmental goals enhances the opportunities and consequences for goal realization. In addition, the management of trade-offs between domains has to be considered in the predecisional phase to reduce inter-domain conflicts. Moreover, concerns of maintaining diversity of action possibilities may help to design alternative action plans that become especially important when individuals fail to attain a goal.

Individuals enter the volitional phases by crossing the Rubicon (forming an intention). The three volitional phases of preactional, actional non-urgent, and actional urgent require various degrees of selective investment into the attainment of a chosen goal. In general, it is assumed that in volitional phases selective primary as well as selective secondary control is required to enhance the likelihood of goal attainment. Selective primary and selective secondary control strategies comprise processes of action planning, action initiation, and an enhanced volitional commitment. Especially, selective primary control strategies such as an investment of internal resources are directly aimed at realizing a chosen goal. Selective secondary control strategies, such as enhancing the goal value or devaluing non-chosen goals help the individual to motivationally focus on the positive consequences of goal realization and thus strengthen personal goal commitment.

Individuals who move towards a developmental deadline for a self-relevant goal should experience an increase of time pressure. Moreover, it is expected that they should be prompted to use control strategies characteristic of the actional phases (J. Heckhausen, Wrosch, & Fleeson, 2001; J. Heckhausen, 1999). Goal-directed efforts should be intensified as the individual experiences or anticipates the waning of opportunities for goal attainment. Therefore, during the urgent actional phase, individuals should show an increased use of selective primary and selective secondary control striving. In addition, compensatory primary control might prove to be an efficient strategy for compensating the lack of

remaining time by activating external resources (e.g., help and advice) and using unusual means.

After passing the deadline, individuals are confronted with a radical shift in their opportunities to attain a goal. Future developmental regulation is influenced by post-deadline processes, dependent on whether individuals have or have not attained the goal. On the one hand, individuals who have realized the chosen goal within the normative time frame should profit directly from this. The extended model of action phases assumes processes of capitalization on the attained success for prospective action cycles. Individuals can direct their resources to further goal striving in the same domain or may switch to developmental goals in other life domains. On the other hand, individuals who passed the deadline without attaining the goal should show a radical shift from urgent efforts of goal realization to goal disengagement processes, and compensatory secondary control in general. The adaptive role of compensatory secondary control in the post-deadline phase, after failing the goal, can be described in two ways (e.g., Wrosch, 1999; Wrosch & Heckhausen, 1999). First, the deactivation of the goal intention may redirect the individual's internal resources to other life domains with comparatively more favorable opportunity structures. Therefore, the deactivation process prevents a person from perpetuating degenerated intentions and experiencing accumulated failure experiences (H. Heckhausen & Beckmann, 1990; Wrosch et al., 2003). Second, the individual's emotional and motivational resources after passing the deadline without goal attainment need to be protected. Compensatory secondary control strategies (e.g., external attributions or downward comparisons) may protect the individual's self-esteem and strengthen the primary control potential for prospective actions.

#### **Empirical evidence for different processes of developmental regulation before and after passing a developmental deadline**

One line of research that has provided evidence concerning the consequences of missing a deadline investigated age norms for life-course events and transitions (Settersten and Hagestad, 1996a, 1996b). The authors studied the perceived existence of prescriptive age norms, the

reasons for age norms, and the consequences of missing them. These phenomena of age-related transitions are labeled by Settersten and Hagestad (1996a, 1996b) as "cultural age deadlines." The authors measured deadlines similarly to the assessment of perceived normative conceptions with respect to a certain life-course transition. For example, they asked, "When should a man be married?" to identify the marriage deadline for males. Despite the fact that Settersten and Hagestad's criteria for defining age deadlines are substantially broader than those used in our own research (e.g., change in opportunity structures, final reference points), the results of their studies provide relevant information concerning the proposed model.

Settersten and Hagestad (1996a, 1996b) could identify age norms for various family-related transitions (e.g., leaving home, marriage, parenthood) and work-related transitions (e.g., settle into a career, peak of work career, retirement). With respect to the reasons for age-related deadlines, sequencing and developmental arguments were reported most frequently. In addition, more relevant to the proposed model, perceived consequences of missing developmental goals within the normative time frame were reported. Although nearly fifty percent of participants perceived no consequences of missing developmental goals within the normative time frame, the most frequently mentioned consequences were developmental consequences, such as a negative impact on personal abilities, needs, and goals. These findings support our general assumption that developmental deadlines are relevant transition points for regulating personal development. The reason that more than half of participants did not mention any consequences of missing age-related deadlines can be partly attributed in the method used by Settersten and Hagestad (1996a, 1996b). The reported data are based on responses concerning generalized other people missing age norms and therefore are not necessarily related to respondents' internal regulation processes. Moreover, missing the ideal or normative age timing does not typically imply missing the event or life-course transition altogether as would be the case in our presented model of developmental deadlines (particularly for biologically-based deadlines). If mere postponement of critical life-course events is expected to cause serious negative consequences in 50% of the cases, what

would the drawbacks be for missing the event altogether? Thus, the findings from Settersten and Hagestad presumably underestimate the negative consequences of missing developmental deadlines.

Another line of research has explicitly examined the proposed model of developmental regulation (J. Heckhausen, 2000; J. Heckhausen & Tomasik, 2002; J. Heckhausen, Wrosch, & Fleeson, 2001; Schulz, Wrosch, & Heckhausen, 2003; Wrosch & Heckhausen, 1999, 2002; Wrosch, Heckhausen, & Lachman, 2000; Wrosch, Schulz, & Heckhausen, 2002). These studies are based on a different methodological approach (e.g., quasi-experimental design), investigating developmental regulation processes in participants who face objective differences in opportunity structures (e.g., different age groups, different types of health problems). For example, recent studies have shown that self-protective secondary control processes become particularly beneficial in older adults who are confronted with managing severe life regrets (Wrosch & Heckhausen, 2002) or high levels of health and financial challenges (Wrosch, Heckhausen, & Lachman, 2000). In addition, active engagements into attaining health goals have been shown to benefit those older adults who face acute physical health problems, but not so much those older adults who confront functional health problems (Wrosch, Schulz, & Heckhausen, 2002). Moreover, the deadline model has been applied to the transition from school to work. In longitudinal research, the use of control strategies has been examined in adolescents who are seeking apprenticeship positions before graduating from high school (J. Heckhausen and Tomasik, 2002). Finally two studies examined control processes before and after passing a developmental deadline with respect to the attainment of childbearing goals (J. Heckhausen, Wrosch, & Fleeson, 2001) and intimate partnership goals (Wrosch & Heckhausen, 1999). These studies can be considered as marking the first milestone in this research program and are discussed in the remaining part of this chapter.

### *Developmental deadlines for child bearing*

One of the most obvious developmental deadlines in the human life course is related to the timing of child bearing for women. Child bear-

ing is assumed to be one of the most universal and relevant developmental tasks (Havighurst, 1953) that individuals are expected to master in adulthood. However, mastering this task is dependent on a lifetime schedule determined by biological change. Beyond age forty, fertility rates in women exhibit a radical decline. J. Heckhausen, Wrosch, and Fleeson (2001) addressed this issue by investigating developmental regulation processes (goal setting and cognitive indicators of motivational mindsets) in three groups of women. First, childless women between age 40 and 45 were examined. It was assumed that these women have recently passed the childbearing deadline. Second, women without a child between age 27 and 33 were examined, assuming that these women had entered an urgency phase. Third, women between age 20 and 45 who had born a child in the last year were investigated as a success group. It was expected that women in the urgency group would invest more effort with respect to child bearing. By contrast, women who already passed the deadline should show disengagement from the goal of having their own children. For the group of women with a recently born child, the extended model of action phases would predict that they should capitalize their success in further action cycles (e.g., child rearing, second child). Therefore, the main difference was expected between the group of women that passed the deadline and the two other groups.

The findings of the study (J. Heckhausen, Wrosch, & Fleeson, 2001) generally supported the hypotheses. With respect to goal setting, women who already had passed the deadline reported more frequently goals that were not related to children and fewer goals addressing child bearing and child rearing. Women in the urgency group, by contrast, reported more frequently goals that were related to child bearing. Finally, women with a young child reported high levels of child rearing goals.

In addition, a cognitive indicator of motivational mindsets was measured in terms of incidental memory (J. Heckhausen, Wrosch, & Fleeson, 2001). The underlying procedure involved sentences that had to be recalled after the presentation of a distracter. Women in the urgency group recalled more sentences related to children, independent on the valence (positive, negative) of the sentences. In addition, sentences that were related to compensatory secondary

control strategies (e.g., attributional biases) were more frequently recalled by women who had passed the deadline. Moreover, women who had failed the deadline recalled more sentences related to attributions that avoided self-blame for childlessness compared with women having an infant child. The finding that women in the urgency phase not only recalled positive but also negative words at a higher frequency may be somewhat surprising. Apparently, the urgency involved in having their own children had a general salience effect on all child-related stimuli.

In a second study, J. Heckhausen, Wrosch, and Fleeson (2001) examined the use and function of specific control strategies in groups of women who had and had not passed the deadline for having their own children. As expected by our model, women who did not pass the deadline reported particularly high levels of selective primary, compensatory primary, and selective secondary control, whereas women who already had passed the deadline reported particularly high levels of compensatory secondary control. In addition, among those women who already had passed the deadline, those who failed to disengage from the goal of having their own children (phase-incongruent control strategy) reported particularly high levels of depressive symptomatology. The latter finding seems to be particularly important, because it points to the conclusion that there are substantial individual differences in the use of opportunity-adjusted control strategies. In addition, these individual differences were reliably associated with indicators of subjective wellbeing (see also Wrosch & Heckhausen, 1999).

#### *Developmental deadlines for partnership relations*

Another study examined developmental regulation processes around partnership deadlines (Wrosch, 1999; Wrosch & Heckhausen, 1999). The theoretical rationale of this study is based on findings concerning different opportunity structures for partnership realization in young and older separated individuals. For example, the objective remarriage expectancy following a divorce is above eighty percent for a 30-year old individual, whereas a 60-year old individual has a probability of less than twenty percent to marry again in his/her remaining life time (e.g., Braun & Proebsting, 1986). The reason for this

dramatic age-related change of opportunity structures is mainly based on socio-demographic constraints, that is a greatly reduced marriage market in older ages (Klein, 1990). The proposed extended model of action phases would assume for separated individuals in young adulthood that they are far from passing a partnership deadline, given that they have enough remaining time and favorable opportunity structures to build a new intimate partnership. Therefore, we expected to find substantial efforts to realize a new partnership. Separated individuals in late midlife, by contrast, often can hardly realize a new partnership, because they face a constrained partnership market. Therefore, we expected that older separated adults would disengage more fully from partnership goals and redirect their resources to other domains with more favorable opportunity structures.

The partnership deadline study (Wrosch, 1999; Wrosch & Heckhausen, 1999) investigated the following developmental regulation processes in recently separated individuals in early adulthood (21-35 years), and late midlife (49-59 years): goal setting, partnership-related control striving, and cognitive indicators of motivational mindsets. In addition, recently committed individuals with a similar age range were examined as a comparison group.

The findings strongly supported the predictions (Wrosch & Heckhausen, 1999). Separated individuals in early adulthood reported more gain-oriented partnership goals than separated individuals in late midlife. In addition, younger as compared to older separated individuals reported a higher control striving aimed at the realization of a new partnership (i.e., selective primary and selective secondary control). In contrast, separated individuals in late midlife reported more compensatory secondary control, especially goal disengagement, as compared to their younger counterparts. Moreover, the findings with respect to the cognitive orientation of recently separated participants, measured in terms of incidental memory (recall of positive and negative aspects of partnerships), indicated that older separated adults showed a more pronounced orientation towards negative aspects, whereas younger separated adults turned to a comparatively more positive orientation.

Even more importantly, the study demonstrated age-differential effects of compensatory secondary control on emotional adjustment of

separated adults, across a longitudinal time span of 15 months. Whereas older participants improved their emotional wellbeing if they invested high levels of (phase-congruent) compensatory secondary control, younger participants suffered decline in emotional wellbeing if they disengaged from partnership goals (use of phase-incongruent control strategies). These findings demonstrate the adaptive value of opportunity-adjusted control striving. In addition, they lead to the conclusion that those individuals who do not adjust their control processes to the opportunities for goal attainment might show poor developmental outcomes.

### Conclusion

This chapter addressed adaptive processes of developmental regulation around developmental deadlines. We have proposed that, around developmental deadlines, opportunity structures change and thereby require the individual to increase efforts of goal attainment before approaching the deadline and to disengage from the respective goal after the deadline has passed. The results of the reported studies demonstrated that developmental deadlines organize individuals' developmental regulation processes. Individuals adapt their control-related behaviors to the respective opportunity structures of their developmental goals. Favorable opportunity structures afford motivational processes directed at maximizing primary control. By contrast, situations with severely constrained or absent opportunities call for motivational processes that support emotional stability and facilitate disengagement from unattainable goals. Accordingly, the findings support our assumption that individuals shift their control striving from urgent realization efforts before passing a developmental deadline to goal disengagement and compensatory secondary control after passing a deadline. In addition, the reported studies have demonstrated the beneficial effects of opportunity-adjusted control striving. Those individuals who adjusted their control-related behaviors to the opportunities for goal attainment improved their subject wellbeing. In contrast, opportunity-incongruent control striving was shown to be related to low levels of subjective wellbeing.

The research paradigm of developmental deadlines has proved to be useful in studying de-

velopmental processes. The paradigm should thus be employed in the study of developmental transitions in other life domains and phases of the life span. In particular, control-related behavior around developmental deadlines should be studied longitudinally. A longitudinal approach would allow to investigate micro-sequential processes of adaptive control behavior around developmental deadlines and thereby may reveal functional relations between individuals' use of control strategies, outcomes of behavior, and psychological adjustment. Several such studies are currently underway in domains of work, health, and social relations. Thus, by using the proposed theoretical model, future research may provide relevant information about fundamental processes of action regulation around critical transitions across the human life course.

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# Are We at the End of the “Century of the Child”?

## Historical Changes in Theorizing on Child Development

Willem Koops

### Introduction

Many of the 19th century founders of (developmental) psychology were in favor of eugenics, and held strong beliefs in the “Natural Development” of children, as well as in the “Objective Progress” of science and reality. All of this is rooted in the 18th century Enlightenment philosophy, as well as in the 19th century evolutionary biology.

Firstly I will analyze these 19th century ideas in the well-known book of Ellen Key on the “Century of the Child” (Key, 1900). This book in a sense summarizes the essentials of the “common sense”, as well as the scientific approach of the child of the 20th century.

Secondly I will critically discuss the tenability of the three core ideas. And I then will ask if it is possible to finish Ellen Key’s “Century of the Child” as soon as possible.<sup>o</sup>

Lastly I will stress the importance of developmental psychology in the postmodern restoration of an unprejudiced communication with the child.

### Ellen Key and the “Century of the Child”

Ellen Key (1849–1926), a Swedish teacher, writer, and activist, wrote in 1900 an often quoted series of essays, entitled *The century of the child*. The book became an international bestseller. According to a dissertation by ‘t Hart (1948) the book functioned as a “revolutionary, romantic protest” and was as such typical for the spirit of that time. For us modern readers, however, it is rather difficult to detect any *élan*. The book has mostly been quoted because of its title, analyses of the content are rare. I will therefore first try to summarize it.

Ellen Key’s book starts with an essay on “The Right of the Child to Choose his Parents”. With this paradoxical title she wants to express that it is the child’s right to have *high level genetic ma-*

*terial*. She agrees with Francis Galton that “civilized man, so far as care for the amelioration of the race is concerned, stands on a much lower plane than savages, not to speak of Sparta which did not allow the weak, the too young, and the too old to marry, and where the national pride in a pure race, a strong offspin, was so great that individuals were sacrificed to the attainment of this end” (Key, 1909, p. 19–20). Ellen Key is of the opinion that the natural sciences, in which must be numbered psychology, should be the basis of juristic science as well as pedagogy. “Man must come to learn the laws of natural selection and act in the spirit of these laws” (p. 46). She thought that society should interfere to restrict marriage and she therefore strongly supported the new law in Germany and the United States of America, which required as an obligatory condition for marriage, a certificate of a medical witness with complete data as to the health of both parties (In the U.S.A. this condition still exists!). For Ellen Key this was a good first step on the way to a more stringent regulation (p. 60), which wasn’t realized during her lifetime, but regrettably it was during that of the next generation, in Hitler’s Germany (1933–1945).

By the “Century of the Child” Ellen Key meant above all an age devoted to eugenics. The other essays are more or less derived from this most important first chapter. As far as her ideas on child-rearing are concerned, they too show a naturalism taken to extremes. She defines child-rearing as “the system of allowing nature quietly and slowly to help itself, taking care only that the environmental conditions help the work of nature” (p. 107). Referring to Rousseau, she states that the great secret of education lies hidden in the maxim “do *not* educate” (p. 109). The art of natural child-rearing consists of “... avoiding immediate interference, which is usually a mistake, and devoting one’s whole vigilance to the control of the environment in which the child is growing up, to watching the education which

is allowed to go on by itself" (p. 113). Ellen Key points out emphatically that she is in the tradition of Montaigne, Locke, and Rousseau, with as climax the modern scientific elaboration by Herbert Spencer.

Finally, a few more words on school education. According to Ellen Key, kindergarten and elementary school education must be replaced by schooling at home. Here too she repeatedly points out that children's play in the attic or on the beach stimulates the imagination infinitely more than games structured by adults. It can be no coincidence that the originality of great minds like Goethe goes hand-in-hand with *irregular school attendance*. Teachers and parents must be trained in child psychology in order to be able to follow the spontaneous development of their children (p. 239). To summarize: "... Undoubtedly a 'Deluge' of pedagogy must come, in which the ark need only contain Montaigne, Rousseau, Spencer, and the modern literature of the psychology of the child" (p. 257). It is clear: natural development is a guideline which has an antagonistic relation to the traditional schooling.

I cannot go into Ellen Key's biography here (Nyström-Hamilton, 1913), but if I did have the space I would be able to show that her ideas mainly seem to be generalizations of her personal experiences, often dressed up in a scientific sauce, brewed from Darwin's theory of evolution or a subjectively perceived version of it.

I would like to now take a closer look at the three constituent elements of her ideology – eugenics, the "natural" course of development, and the salvation to be gained through science.

### Eugenics

To Francis Galton (1822–1911) must be ascribed the dubious honor of being the inventor of the science of Eugenics. Herbert Spencer (1820–1903), who regrettably had enormous success in causing evolutionary ideas to be included in the social sciences, provided the philosophical framework for this; the 19th century biologists – whether or not inspired by Charles Darwin (1809–1882) – provided the experimental genetics. We should understand that our contemporary aversion to eugenic ideas is due to their associations with the loathsome ideology of Nazi Germany. But at the end of the 19th cen-

tury and at the beginning of the 20th century eugenics was still acclaimed everywhere. People agreed completely with Nietzsche that modern man must be seen as "a bridge form *Untermensch* to *Übermensch*", as Ellen Key wrote enthusiastically (Key, 1909, p.39). Practical suggestions for eugenics in a rather shameless form are to be found in an abundance of American eugenic publications around the turn of the century. North America is therefore – before Nazi Germany – the only Western country where soon after the turn of the century the practice of eugenics became a reality: in many States there was compulsory sterilization for the mentally *handicapped, rapists, criminals, etc.* (Haller, 1963; Kevles, 1985). On the basis of the so-called racial scientific research a widely read American author (Woodruff, 1909, p. 77–78) stated that the North West European race must produce the proper masters of the world. And as the most optimal "blending of European people" has taken place in the United States the dominant position in commercial and military world affairs is reserved for the American people. But as we know, before it reached this stage the so-called German race made an attempt at world dominance. The eugenic measures used by Nazi Germany are well known: criminal negative eugenics in the form of the Holocaust and repulsive positive eugenics in the form of promotion of racially pure German reproduction, such as in a brochure by Wilhelm Stüwe (1936), disseminated by the "Racial policy office of the NSDAP", Gau Thüringen, Weimar. A work on the "Reichtum an erbgesunden Kindern" (Richness of genetically pure children) with an enthusiastic epilogue by H. Himmler.

We cannot hold it against our 19th century colleagues that they could not foresee the fascist consequences of their thinking. However, what we can criticize in the stance of even such relatively enlightened 19th century colleagues as Ellen Key is their naive belief in the beneficial effect of science, in the possibility of an objective ideal doctrine. Insight into the laws of heredity for example, cannot lead automatically to measures restricting the freedom with regard to human reproduction. Apart from a biological scientific basis genetic measures also require a moral one. Neither biology nor psychology, however, can solve moral problems for us. And the answer to the question of why we go to the trouble of breeding pedigree cattle and race-

horses, but not an improved human race, is simple: people are not animals. And if there is a science whose practitioners must be aware of the consequences of this simple insight then that is psychology. And that psychology can therefore least afford to derive human values from scientific data. In short, there is *not a single* objective reason for accepting an eugenic doctrine of perfecting man through science.

### The "natural" course of development

Although the 1880s are usually referred to as the starting-point of scientific developmental psychology (Parke & al., 1994), contemporary perspectives on children and adolescents have, of course, much deeper cultural and historical roots (Koops, 1991). In the book by Philippe Ariès (1962), which can be called a classic, on the social history of school and family, it is suggested that the child was only "discovered" in the modern age, that is, after the middle ages. In medieval civilization the Hellenistic ideas of education had been lost. As soon as the child was weaned it became the natural partner of the adult, so to speak. There was a negligible difference between the worlds of children and adults and there were therefore no transitional problems, such as adolescence, which was to become increasingly problematic between the 16th and 20th centuries. Ariès backed up his vision with documentation in an impressive and unparalleled manner.

The development I refer to can be well illustrated with the help of artworks (Koops, 1996). According to Ariès it can first be stated that in the Middle Ages children were reproduced by artists only as pocket-sized adults. From around the 14th century, the Christ child becomes increasingly child-like in depiction, in combination with an increasingly maternal Saint Mary. In the 15th and 16th centuries the "genre painting" gradually developed, in which the child is apparently depicted for its charming and picturesque qualities. Perhaps the most dramatic change in the attitude to children took place in the 18th century, and Rousseau is generally seen here as the troubadour of the new attitude (Rousseau, 1763). His work on the education of the boy *Émile* encouraged mothers to look after their children themselves instead of leaving that to others, and there was a reevaluation of

breastfeeding. Perhaps we can even say that thanks to him tenderness to children became fashionable. This new Rousseauian attitude is to be found in many paintings on both sides of the Channel. A very fine example of this is Jean-Baptiste Greuze's *La Mère Bien-Aimée* from 1769 and in Sir Joshua Reynolds' *Lady Cockburn and her children*, from 1773. Two paintings with a very striking abundance of motherliness (Rosenblum, 1988). But in general in the 18th century we find many attractive, sweet children depicted. Nineteenth century Romanticism even added to this, if that were possible, and via the so-called *Jugendstil* (which literally means "youth style") extended even to adolescence, which at that time also began to take on dramatic forms for the first time (Koops, 1996). Philip Ariès' history has not gone uncriticized (a.o. Pollock, 1983, 1987; Koops, 1996); particularly his interpretation of the child in art has been sharply criticized (Brobeck, 1976; Fuller, 1979; DeMausse, 1974). I will not go into that here, but confine myself to noting that the entire modern "history of childhood" arises from Ariès' work, and his critics are also his students in so far as they believe in the cultural and historical relativity of thinking about children.

Such an Ariès-like cultural and historical perspective turns the traditional history of developmental psychology and pedagogy completely upside down: instead of a gradual progress in our treatment of children caused by science there are changing cultural and historical ideas of the child, of which science is the result rather than the cause.

Thus the names of Montaigne (1533–1592), Locke (1632–1704) and Rousseau (1712–1778) for example are happily suggested as milestones in the advancing modernization of our approach to children (this is implicitly the case in Ellen Key's texts). Montaigne is then presented as the first thinker since the Middle Ages to propose a natural education. The wide world, nature, is the student's book (Montaigne, 1580; reprinted 1969). Locke is then the one who with his famous "tabula rasa" idea offers the fitting epistemological background: the empty slate with which the child is born is written upon by the impressions it acquires, and which can be directed by the educator (Locke, 1693). Rousseau is therefore the climax of the Enlightened treatment of the child: He believes that the natural age-related development determines how Locke's im-

pressions work upon the child, which forces the educator to show far more humility to nature than Montaigne and Locke were aware. Whereas Locke for example still believed that children should be treated as rational human beings, Rousseau declared that "... Rationality is not the first but the last fruit of an education and that to begin with rationality is to begin at the end" (van den Berg, 1961, p. 23). Rousseau suggested that pedagogy must be child-centered and that there are age-related phases to which education must be attuned and furthermore – also extremely essential – that the child must only be offered knowledge when the child needs it or shows an interest in that knowledge. Rousseau's ideas have had a powerful influence on the German educators, who are known under the name "Philanthropists" (Basedow, 1723–1790; Salzmann, 1744–1811; and Campe, 1746–1818), who organized education and child-rearing according to the motto "Nicht viel aber mit Lust" (Not much, but with pleasure), and also via extremely influential pedagogues like Pestalozzi (1746–1827), Fröbel (1782–1852) and Montessori (1870–1952), all devotees of the Rousseauian motto "vom Kinde aus" (from the child itself) (Prins, 1963).

Perhaps the most effective promotion of the Rousseauian standpoint was its linking with Darwin's theory of evolution (and its dissemination through Spencer) and the Genetic Psychology of the American founder of empirical developmental psychology, Stanley Hall, which grew out of it (Borstelmann, 1983; Kessen, 1965; Koops & van der Werff, 1989). The 19th century theory of evolution provided an empirical scientific basis for the progressive thought of the 18th century Enlightenment. Darwin's ideas led to the child being seen as a natural historical museum of phylogenesis and of the cultural history of man (Borstelmann, 1983). That provided Rousseau's child with biological roots (Kessen, 1965; Hopkins, 1989).

The integration of Rousseau and the theory of evolution, and the impetus to empirical study of the development of the modern child à la Emile comes from Jean Piaget (1896–1980), who for many years was director of the research institute "l'Institut des Sciences de l'Éducation Jean Jacques Rousseau" in Rousseau's birthplace of Geneva. All the characteristics of Rousseau's thinking can be recognised in Piaget's theory: education and child-rearing must *follow* devel-

opment, not set it in motion; there are qualitatively different age-related phases of development; rational discussion with children is pointless, as long as they have not reached the phase of formal operations; there is a clear anti-intellectualism and anti-verbalism to be seen in Piaget's theory; the child constructs, in interaction with the environment, cognitive structures: language and formal thought are not causes, but results of development.

From the background of cultural history, like that of Ariès, it is tempting to see the entire so-called modern idea of the child from the Rousseau-Piaget tradition, as a debatable, more or less casual result of cultural-historical developments, as an idea which has no claim to anything like scientific objectivity. The developmental thinking of the Enlightenment and its "biologising" (Morss, 1990) in the 19th century are the fruits of the very same social and cultural self-interpretation of Western man, to which meaningful alternatives can be imagined. In this respect we must shed the remains of a thinking in terms of a doctrine of human perfectibility through science. We must shed the remains of a thinking in terms of scientific Progress.

### Salvation by Scientific Progress?

The beautiful etching on the title page of the renowned *Encyclopedia*, by Diderot, d'Alembert and others, portrays the exaltation of knowledge, of reason, which reigns in heaven with all the other symbols of knowledge and science below it. The objective of this Encyclopedia is: "... to make our descendants more developed and at the same time more virtuous and happier" (Prins, 1963). This is typical of the optimism of the Enlightenment: scientific knowledge leads as a matter of course to a better sort of people. The scientific faith in progress is also to be found in Ellen Key. As soon as we take the available biological knowledge sufficiently seriously then salvation will appear on the horizon.

What is wrong with a belief in the perfectibility of man through science, in the spirit of Ellen Key and many other nineteenth century thinkers? I would like to present two objections:

- (1) science does not lead automatically to a higher moral plane; and
- (2) there is no reason to assume that reality is constantly developing in accordance with

the laws of nature to something finer and better.

These objections to Enlightenment philosophy are by now so generally accepted that many contemporary intellectuals see the Enlightenment as defeated. With the help of a penetrating and fiery essay by the philosopher Alain Finkielkraut (1991) I want to categorically protest against this, to avoid throwing out the baby with the bath-water.

In his book *La défaite de la pensée* ("The undoing of thought") Finkielkraut showed the unfortunate consequences of the introduction by the German philosopher Herder of the concept of *Volksgeist* in 1774. After Herder, the concept of culture is no longer connected to science, the concept no longer refers to the pushing back of prejudices and ignorance, but expresses the irreducible singularity of the unique soul of the people (Finkielkraut, 1991, p. 18). In the words of Finkielkraut: "Since the beginning of human memory, or more precisely from Plato to Voltaire, human diversity had come before the tribunal of universal values; with Herder the eternal values were condemned by the court of diversity" (p. 16). Herder's German Romanticism provided what Finkielkraut expressively called the "familial warmth of prejudices" (p. 27). The *Volksgeist* was, after an expression of Rénan, "the most dangerous explosive of the modern age" (p. 46) and was to lead to two world wars.

After the second of these wars the United Nations met, in London, to establish a special branch devoted to science and culture, the UNESCO. Its role was going to be to protect thought against the abuses of power and to enlighten men in such a way as to prevent their ideas ever again being led astray by despotism and obscurantism. In doing so the political notables and the intellectual experts in London were instinctively linking up with the spirit of the Enlightenment. However, with one essential alteration, which is playing tricks with us up to the present day. The universal subject – "Man" – of the *Déclaration des droits de l'homme et du citoyen* (The declaration of rights of man and the citizen) was replaced by concrete persons, in all the diverse forms of their existence. We owe this chiefly to a text, *Race et histoire* (Race and history), which Claude Lévi-Strauss wrote in 1951, commissioned by UNESCO (Lévi-Strauss, 1971). First of all, Lévi-Strauss claims that the concept of race has absolutely no scientific

value. The difference between groups of people arises from "geographic, historical and social circumstances", not from "the anatomical or physiological constitution". His second point is that we should fight against ranking cultural differences hierarchically. "The many forms which humanity assumes in time and space cannot be arranged in an order of increasing perfection: they are not beacons on a triumphal march, nor stages or phases en route to the highest form of Civilization: the Western" (p. 56). That is exactly the temptation that the enlightened philosophers succumbed to: placing human communities on a value scale where they themselves occupy the highest place (p. 56). This objectionable idea became the basis for colonialism, and the related 19th century ethnological science was also based on it. But since the ethnologists have discovered how complex the traditions and lifestyles are in the so-called primitive societies, they no longer go along with this, as Lévi-Strauss made clear. Ethnology became *cultural anthropology* and the general concept of man from the Enlightenment made way for a non-hierarchical diversity of culture-bound characters. The essence of Finkielkraut's essay here is that it makes clear that Lévi-Strauss inveighs so bitterly against hierarchization that he also abolishes in passing the universality of Enlightenment thought. And Lévi-Strauss gathered a following. In imitation of structural anthropology all human sciences hunted down ethnocentrism in their own fields, and that led to what Finkielkraut calls "The Second death of humanity" (p. 59). The present-day fanatics of cultural identity further the exaltation of the collective soul, an exaltation which arose with the concept of *Volksgeist* and reached a climax in racial theory and Hitlerism (p. 76–79).

This history of Western thought is also applicable to thinking about children. First there is the progressive thought of the Enlightenment (Rousseau) which states that the child itself, through a natural education and development, reaches the highest step: that of a mature Western cultural person. This concept is then biologised in the 19th century: during its development the child runs through phases from primitive to developed, and thus recapitulates on the individual level the development of the human species. After the second world war this idea of hierarchically arranged phases was gradually abandoned and finally age groups

were seen as groups with their "own" culture. However, there are also signs that developmental psychology is recovering from this Volksgeist-style interpretation: more than ever in developmental psychology universal possibilities of communication are being sought among very young children. In what follows I will now sketch a bird's eye view of this history and hopeful future of developmental-psychological research.

### Recent research in developmental psychology

Modern scientific developmental psychology is based on the Rousseau-Piaget tradition. Worldwide postwar research however has shaken this foundation. And that is probably the most interesting contribution of scientific developmental psychology to Western culture of the twentieth century. Here follows a short account of the main themes.

Although a number of Piaget's books had already been translated into English in the 1920s, until 1950 his work was only known in small circles in both the USA and Europe. As a consequence of the so-called "cognitive shift" in American psychology at the end of the 1950s, within a few years a veritable American, and later also European and Asian, army of so-called neo-Piagetian researchers sprang up, which until the beginning of 1980 dominated the leading developmental psychology journals and books. However, we cannot say that the enormous quantity of published data has provided an unambiguous empirical basis for the Piagetian developmental theory. To the contrary: the lack of consensus continued to grow on four fronts: a) lack of definitional-conceptual consensus; b) problems in the representative sampling of task domains; c) insurmountable problems in constructing developmental scales and d) problems in defining standards for judging training effects in so-called training studies of children's thinking (Kingma & Koops, 1989; Koops, 1991).

In the 1970s many researchers became so disillusioned that they dropped Piaget's biologicistic developmental theory and exchanged the "organismic" metaphor for the computer metaphor. But that was not an immediate success. The central problem, as Kail and Bisanz (1982) pointed out, is that "... information processing is not in-

trinsically developmental" – a computer does not necessarily develop.

The new "information processing approach" no longer focussed with verbal techniques on the introspection of the child, but analyses elementary processes, which go too fast (in terms of milliseconds) for introspection. This new "fast process research" produced data, with the help of the methodology of "mental chronometry", which seriously undermined Piaget's theory. An early and fine example was Trabasso's well-known research into transitive inference (Trabasso, 1975, 1977). Whereas for Piaget transitive reasoning was symptomatic of development of a more mature cognitive phase – that of concrete operations (between 6 and 12 years roughly) – Trabasso showed that this transitive reasoning is based on general cognitive processes, which can already be found in pre-school children. In general, attention shifted from ontogenetic developmental phenomena to *non-genetic*, age-invariant, mental processes. And in this way much research went into a negative direction: it was attempted to show that cognitive competencies described by Piaget are already present at a very early stage of development. Many a successful developmentalist ended up as a baby expert.

In the 1980s the methodology of mental chronometry was partially replaced by the analysis of brain potentials and attempts were made to penetrate to the neuro-physiological substratum of the basic mechanisms of information processing. But that alternative too, still very much in vogue at the moment, leads, up to now, predominantly to anti-Piagetian results.

The new direction of research in developmental psychology of the second half of this century has meant that the traditional Rousseau-Piaget vision of the young child as an *incompetent*, *irrational*, *sentimental*, extremely *immature* being is increasingly being relegated to the realm of fable. Anyone who wants to get a quick impression of how much more the baby has available than a few simple reflexes and how much further the learning capacity of the baby reaches than simple conditioning only needs to leaf through Volume 2 (Infancy and developmental bio-psychology) of Mussen's 1983 *Handbook of Child Psychology* (and the new edition to be published in 1997). It shows that the field of "infancy research" is the most dynamic in developmental psychology, in which large quantities of striking

discoveries are being made. I hasten to add that since 1983 there has been another exponential growth. From a constantly swelling stream of experimentally obtained data it emerges that babies possess cognitive operations, and are capable of concept formation, symbolic representation and abstraction and that there is much more continuity between preverbal and verbal cognitive capacities than has been assumed during a long time (Harris, 1983; Papoucek & Papoucek, 1989). From the pioneering work of the Dutch developmental neurologists De Vries, Visser and Prechtel (1982) we must even conclude that babies have rather mature complex motor patterns rather than simple innate reflexes.

I want to look briefly for a moment at a recent and exciting line in this research of young children: the recent research into what is called "The Child's Theory of Mind" (Wellman, 1990). It was traditionally assumed that young children have no idea of the operation of the human mind and that they confuse internal mental states (such as desires, dreams and thoughts) with external physical objects and material states (Piaget, 1929; Keil, 1979). Exciting recent research makes it increasingly clear how advanced 3 to 5-year-olds can reason about the mental states of themselves and others. So much advanced that most researchers think that the "folk psychology" of 3 to 5-year-olds is not essentially different from that of the mature Western encultured person. At the age of 3, children appear to be already able to distinguish sharply between mental and physical worlds. If they are told a story for example about a boy who *has* a dog and a boy who *thinks* about a dog, then 3-year-olds can judge correctly which dog can be touched and stroked, and which cannot (Harris & al., 1991; Wellman & Estes, 1986). They also have insight into the subjectivity of thoughts: for example, they understand that certain biscuits, which they like, can be found disgusting by others; Flavell and his colleagues demonstrated this in their famous "yummy-yucky" experiments (Flavell & al., 1990).

In order to understand how behaviors can be caused mentally, children must understand that people behave in reaction to their *assumptions* about the world, not so much in reaction to "objective" facts. That is why the research into false beliefs is so important. It has now been convincingly shown in many studies that 4-year-olds

understand false beliefs (Perner & al., 1987). If you show them a sweet tin they will predict that there are sweets in it. If they are then shown that there are in fact pencils in it, they can then predict that a naive observer of the closed tin would still have the false belief that there are sweets in it (Gopnik & Astington, 1988). In some recent studies by Wellman and colleagues it could be demonstrated by creative, subtle experimentation that insight into "false beliefs" is already present in 3-year-olds.

I have to be content with these few remarks and examples. Hopefully they justify sufficiently my general conclusion: that the classical Rousseauian assumption that young children differ fundamentally from adults and that a natural course of development of around 12 years is needed to bring them to that mature state, is now more than ever, doubtful. As ethnologists came to realize that primitive peoples do not display so much primitive preliminary phases of the Western encultured person, it now appears also that developmental psychologists must conclude that young children too share far more humanity with the Western adult than was assumed two hundred years ago. And that seems to me the greatest success of twentieth century developmental psychology: thanks to its scientifically organized and controlled, inventive communication with children important preconceptions about children's incompetence are being abolished.

It is not possible here to go extensively into the practical implication of modern developmental psychology for child-rearing and education. Nevertheless I want to say very briefly something about at least one area: that of education.

Paradoxically, the distrust of institutionalized education and child-rearing which can be traced back to Rousseau, has constantly accompanied the institutionalization of popular education in the 19th and 20th centuries. Ellen Key offers a fine example of what I mean. This teacher and popular educator was, as already mentioned, in principle opposed to a supply of learning material structured by adults. Essentially, she wanted to depart from a scientific and thus mature arrangement of the learning material, in order to lay it out in terms of the child's needs, something which has unfortunately increasingly taken place in our century. Because, as was repeated and repeated, the child has to be able to develop

"naturally". That is the background to the usual modern teaching, which is child-centered, and which above all wants to link up with the development which occurs spontaneously.

"But," it will be asked, "has not all this really led to a successful education in several Western societies?" I am afraid not. For my argumentation I just refer to the most interesting cross-cultural research into the quality of education, which we currently possess: that of Harold Stevenson and his colleagues at the University of Michigan in Ann Arbor (Stevenson & al., 1990; Stevenson & Stigler, 1992; Stigler & al., 1990). I will try to give a very brief summary of this work here.

Methodologically extremely careful cross-cultural comparisons, with the help of tests from which as much "cultural bias" as possible has been eliminated has revealed dramatic differences between Asian and American educational results. Already in the first grade of the elementary school Japanese and Chinese children achieve much, much more, in the mathematical area especially, than American children. This difference increases sharply during the other years in elementary school, and as has recently become clear, in high schools too. The explanation of this cannot be found in differences in intelligence, or in the educational organization of the classes, nor in differences in the size of the classes (in Asia one and a half times to two times as big as in the USA), or in more extensive training of teachers (dramatically shorter in Asia than in the USA). Asian children also appear to enjoy school more and be less anxious.

There are some explanatory interpretations available for the differences found, which are a topical issue in the USA and are also causing serious worry to the policy-makers in Washington. Asian education is organized more according to the demands of the subject matter than is aimed at in teaching attuned to the needs of the child; a natural developmental process is not assumed, but instead there is an unlimited faith in the effect of practice. In brief, it is my firm conviction that it boils down to the fact that in Japan and Taiwan there is not the inhibiting effect of the Western Rousseau-Piaget tradition, which forces education and child-rearing to restraint and a hesitant passivity. Finally, because of the foregoing I am afraid that education in many European countries (my own country, The Netherlands, included) is essentially no better than

the American. Real improvement in this situation can, to my mind, only be achieved by once more seeing the increasingly infantilized student of our increasingly "renewed" school as the pocket-sized adult which he appears to be, equipped with cognitive competencies which make mature, scientific insight possible. Let us hope that in the 21st century the disastrous infantilization can be stopped!

### Conclusions

There is one point we can all easily agree upon: the 20th century practice of 19th century eugenics must never be repeated. "Nie Wieder." Nor will it be difficult in our present-day, post-modern, and also anti-intellectual climate to agree that a belief in the perfectibility of man through science, à la Ellen Key, is indefensible. However, I am afraid that it is much more difficult to have my proposal to end the "Century of the child" accepted.

Since the 18th century the self-interpretation of Western culture has been dominated by developmental thinking, by thinking in terms of Progress. Children too in particular were understood as developing non-adults. Their sentimental value grew to unprecedented heights (Zelizer, 1981), we are full of understanding for The Child and we do our absolute best to disturb their so-called natural development as little as possible. We tend to foist a "culture" of their own on children and adolescents and we even allow commerce to exploit this culture. It is difficult to get rid of this, in my opinion exaggerated, child-centeredness. Also because since the 19th century so much of the child's nature is rooted in the dominant metaphors of evolutionary biology.

Piaget's work, which has been vital for developmental psychology, made it possible – through its accessibility to empirical analysis – to carry out critical developmental psychological research. Where Piaget himself had to pay a very high debt to the Rousseau tradition, now, after a hundred years of research in developmental psychology, it has finally become clear to what extent we have exaggerated the nature of childhood. The very young child turns out to be far more human in terms of cognitive competencies than we thought, and turns out to share with adults an essential interhuman understanding

("Theory of Mind"). Finally, the child turns out to be much more like the pocket-sized adult, which is precisely what educational ideologies have not wanted it to be since the 18th century. Finkelkraut wants to restore universal humanity horizontally, that is, between cultures. Research data from developmental psychology restores universal humanity in the vertical plane, that is, between age groups within cultures.

Thanks to the rational and objective analysis of behavior, psychology continues to make a contribution, which in the long term can be considered beneficial for the optimisation of interhuman communication, and which keeps intact the idea of universal humanity. In that sense developmental psychology has its roots in the Enlightenment, but without the disputable assumption of Progress and "natural development." Let the Enlightened interhuman communication be promoted as early as possible, because as we developmental psychologists hope, it's important to catch them while they're young. Let us definitely close the door on Ellen Key's "Century of the Child." Postmodern developmental psychology, which is nevertheless based on the rationality of the Enlightenment, is ready for its important humanitarian task in the 21st century!

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**Part V.**

**Time for Learning**



# Time for Learning

Jean-François Perret

If there is one experience that is common to everyone, it is the time needed for all types of learning. The acquiring of any kind of knowledge or skill takes many hours, weeks, or even years; for example, it takes many years to learn a trade or profession. What do we know about the temporal dimension of these learning processes? What different types of time are involved? In what ways are learning time and development time linked to each other? What are the concepts of learning time that underlie our educational practices? Apart from testing at specific times to measure the knowledge acquired at different ages, what do we know about the processes by which that knowledge is constructed in the long term, over weeks, years, or even a whole lifetime?

This chapter refers to three contributions which, in different ways, shed light on our understanding of the temporal dimension of learning. They refer to a variety of educational situations with different timescales and different conceptual approaches. What they have in common is that they show how the learner's own time is an entity that cannot be separated from time specific to the educational situations in which knowledge and skills are transmitted in our society. They show that time for learning is inseparably linked to other times, such as time for teaching (as described in the contribution by Schubauer-Leoni), media time, where the different types of media used for communication within an educational course impose their own timings (Perriault), and also the time related to different stages of an individual's personal and professional life, which are increasingly uncertain and discontinuous (Dominicé).

Studying the temporal dynamic of learning itself involves a number of the challenges related

to education, particularly the problem of the educational significance of time use in school. This has been the subject of great controversy, and in the world of education it is sometimes felt that any discussion will just end in deadlock<sup>1</sup>. In particular, such a debate opposes two orders of reality, i.e., school time and the student's own time. School time is the time allocated for learning according to a timetable which has evolved over several hundred years, closely related to the development of different times for work and leisure within society (Carré & Caspar, 2000); the student's own time is the time needed for the student to learn<sup>2</sup>. Framed in these terms, the two orders of reality tend to be seen as mutually antagonistic. School time, a heritage from the past, is seen as a constraint on the progression of teaching and learning, and is seen only as disturbing the students' own personal time. This has led to a continual search for greater flexibility in academic timetables to ensure that as far as possible, they suit the tempo at which each individual learns (Fotinos & Testu, 1996). It is interesting to revisit under this perspective of timetables, time use, and attention to the individuals' rhythms, a number of the educational projects implemented over the last two decades to introduce greater individualization and differentiation in teaching.

Seen from this point of view, school time and the time framework it imposes are perceived as constraints or even shackles that obscure its original function of providing a structure. It is no more than allocated time, an envelope that defines a space where teaching activities will take place, and so provide opportunities for learning. In the field of education, hypotheses relating to the effect of the time framework itself

<sup>1</sup> See e.g., the dossier "Les rythmes scolaires" in *Le Monde de l'Éducation*, 169 (March 1990).

<sup>2</sup> Since the 1960s, this concept of the personal time required has been the basis for all research into more individualised learning, and in particular into the teaching of mastery learning. This is demonstrated most explicitly in Carroll's model as presented by Huberman (1988); the model suggests that what a student acquires in a given time (usually, within an academic year) should not be the criterion of competence, but rather, the time a student needs to arrive at a predetermined level of competence.

on learning have up until now been little studied; the relationship between academic time and actual learning has often been limited, by default, to a quantitative approach, as if it were possible to establish a relationship of simple proportionality between the number of hours allocated to the learning of an area of knowledge, and the extent of the knowledge acquired which ought to result from this.

This is where the contribution by Maria Luisa Schubauer-Leoni *et al.* is so important. In order to explore the relationship between *personal time* and *institutional time*, the authors introduce an intermediate level of analysis, didactic time, which deals with the process of advancing within the teaching program. This advancing is the teacher's prime responsibility; it is a complex process which consists of introducing new knowledge at suitable timepoints, to extend the knowledge previously studied, and which from that point on belongs to the class memory. As the authors say, "didactic time is created from the dialectic between *old knowledge* and *new knowledge*."

The students are the teacher's partners in this advance. What they learn over the course of time is closely related to the passing of didactic time itself. However, learning time does not follow the same pattern as didactic time. We are only too aware that progress in learning does not follow the linear nature of teaching programs.

In addition, didactic time cannot be conceived outside an institutional context. Its passing itself assumes the implementation of a teaching program within an allotted time. It has been shown, in particular from the survey carried out by Husti (1994), that a preoccupation with not losing time is shared by students as much as by teachers. To some extent this preoccupation actually becomes the engine of didactic time, and in this sense, *institutional time* is seen to have a structuring role.

This structuring role is probably easiest to discern in the extreme case where it is completely absent, for example in the many teach-yourself courses available. Such courses very often advance by stages, which paradoxically are called lessons. They suggest that anyone can easily learn a new language in 90 lessons, the piano in 20 lessons, photography in 16 lessons, etc. Experience shows that in the absence of any defined relationship or institutional framework, students soon find they are out of their depth with these courses,

unless they have a quite exceptional tenacity and capacity for personal organization. Didactic time needs a teacher and students to bring it alive, because any form of learning involves socio-affective as well as cognitive elements, as we have observed in the context of a technical college (Perret & Perret-Clermont, 2001).

The desire to introduce flexibility into the places and times where learning takes place is probably most clearly shown in the field of distance learning. The various e-learning projects currently being developed as part of a university course are designed to offer direct access to knowledge so that students can work in any specific area of knowledge independently, freeing themselves from the constraints imposed by regular attendance at scheduled classes or weekly exercises. This has now become possible because any help required can be made available at any time on a "just in time" basis. It should be noted that this idealized vision of totally flexible study activity is not shared by the vast majority of students. Surveys have confirmed this; students currently enrolled at university have expressed major reservations about doing away with weekly classes or exercises in favor of more independent study (e.g., Perret & Schubauer-Leoni, 2002). The most common reason given was the fear of losing opportunities for oral communication, which are irreplaceable in that they seem to make the knowledge expounded in them more alive than is possible with written communication. But students also expressed a fear of losing the security of a time framework marked by collective times that provide a structure for the week's work.

In fact, the distance learning systems currently being tried out in university courses require very precise planning of study activities, following a schedule that shows the student what they have to do at each stage to ensure regular progress in their studies. In some ways, the timing and discipline involved in distance-learning courses are far more of a constraint on the student than the traditional course framework. Advocating distance learning as a way of freeing yourself from constraints of time and place is just an empty slogan. What is involved here is in fact a transformation of the system of constraints, particularly time constraints, but there is no question of just doing away with them.

Jacques Perriault's contribution begins by tackling this question of the new temporal dy-

dynamic involved in communicating knowledge through distance learning, based on a case study. This involved a system designed to allow several groups of students located in five European universities to follow a distance-learning course simultaneously, with the key factor being common meetings conducted by interactive video conferencing. The author analyzed these multi-site meetings by remote communication. It was shown that managing verbal exchanges in this situation was a very demanding task; the method of communication and the design of the interactive system imposed their own tempo and created "temporal compression," as the author puts it, which the participants were strongly aware of. In particular, for this specific situation, the analysis demonstrated how important it was for students to be able to manage cognitive tasks in parallel (simultaneous listening, co-operating, formulating questions, etc). It is also interesting in this type of situation to see who is responsible for advancing the work. In the last resort, students' questions for experts in the subject being taught were managed by a coordinator on the platform, who selected them and forwarded them at an appropriate time, to maintain a coherent debate. The process of coordinating this question-asking process was based more on the model of television broadcasts than on a traditional class situation. However, in this situation too there is one person (a trainer? a coordinator? a discussion leader?) whose key role is to decide whose turn it is to speak and to move the debate forward, within a defined model and within a timetable which by its very nature must be fixed (video conferences lasted for an hour and a half).

It is not only younger students who want a framework for studying; they would tend to want the familiarity and reassurance of a traditional timetable, as they have not been taught how to study independently. The adults described by Pierre Dominicé who were in continuing education also frequently asked for this type of framework, even though this type of learning is based on a completely different timescale. Apart from early periods of training, the biographical approach adopted by the author measures learning processes in terms of an individual's whole lifetime. In a constantly changing socio-economic and professional situation, careers become increasingly uncertain and disjointed with frequent changes of direction, which involve the individual in further learning

each time. In these circumstances, the act of learning is not defined as such simply because it is part of didactic time or an educational program with a defined course. The time in question is the time of life events and the psychosocial transitions which adults have to deal with, reconstructing themselves each time with the help of new ways of understanding and taking action (Baubion-Broye, 1998).

Requests for support expressed in this situation are different from those expressed by younger students; adult students need to find reference individuals whose role includes the important task of explaining possible forms of learning in the light of knowledge and skills already acquired, which the adult may not necessarily be fully aware of. Starting to learn something new always involves taking risks; obviously there is the risk of not achieving it, or only partially achieving it, but there is also the risk of having to change one's way of doing things and one's thinking. This risk is easier to cope with if someone experienced and confident feels that it is not unreasonable. What Dominicé has shown us, from his wide experience as a researcher and educator, is that lifelong learning is far from being a smooth, flowing process.

In conclusion, we would like to make three points about the temporal dimension of learning.

- (1) The educational situations analyzed are related more closely to the dynamics of learning than to the learning process itself. Experimental laboratory situations traditionally make it possible to isolate specific learning processes (e.g., learning by imitation, memorizing, problem-solving, thinking, discussion, comparing points of view, etc). When a wider timescale is used to analyze actual situations of teaching and learning, a number of cognitive activities are actually found to be involved. Learning new knowledge and skills implies a succession of times for listening, thinking, imitating, reading, questioning, writing, memorizing, practising, and discussing. Activities are sometimes conducted in a group, sometimes individually, and they may be closely guided or carried out independently. In addition, knowledge is not developed cumulatively by adding successive information or skills, but by integrating them. Learning interweaves both pro-

spective and retrospective thinking, or to put it another way, times for discovery and times for reviewing previous experience. It is through these multiple practices, through sequences that are codified to a greater or lesser extent according to the rules, expectations or educational plans involved, that new knowledge is formed over time.

In this sense, it is more appropriate to use the term "learning dynamic" than "learning process." By linking the situations and activities that it assumes, a learning dynamic is necessarily a long-term entity, and its temporal dimension therefore becomes a fundamental part of it, as a time for cognitive restructuring.

- (2) Our second point is that a learning dynamic does not seem to have its own specific time, but is always interwoven within other times. It could be said that any approach to learning dynamics has to be "situated." As our authors have shown, learning time is part of the didactic time guided by a teacher, or the time imposed by video-based communication systems, or one of the high points of an individual's journey through life. Like Pineau (2000), we can analyze these various nestings of multiple times in terms of synchronisers.
- (3) The last aspect is that because of the multiple cognitive and socio-cognitive activities that it involves, a temporal dynamic of learning appears to require a professional figure in all situations, a person who has the difficult task of organizing, facilitating, explaining or even ensuring the advancement of learning. The learning dynamic considered here, specific to different educational contexts, requires the involvement of a more expert, more highly-skilled individual, who attempts to create over time the conditions in which new knowledge can be constructed. These

conditions are designed to encourage the learner to reappropriate the questioning of their knowledge, and this reappropriation will in turn involve that individual in a dynamic of knowledge.

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# The Intention to Teach and School Learning: The Role of Time

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The title of this chapter emphasizes the need to examine the temporal dynamic between learning and teaching. We approach this dynamic in two ways; first, we look at the teaching and learning of mathematics and attempt to build a model of the situations in which culturally and socially established knowledge is transmitted, and to define a theoretical framework to describe how these situations come about and function. Secondly, we draw on psychological studies that try to understand how children function cognitively and socially in different contexts of experience. We relate these studies to observations of learning and to factors inherent in the intention to teach. In conclusion, we discuss the convergence between studies of teaching and learning and studies of psychological functioning, to try to clarify a number of theoretical points relating to the temporal dimensions of learning in situations where knowledge is being imparted.

## The problem of time in the teaching and learning of mathematics

### *The passage of time in the classroom constrains the process of teaching and learning*

The approach to the study of teaching and learning which we call 'the science of didactics' can be defined as the study of the *conditions of access* to specific knowledge in institutions devoted to teaching and learning. It is based on the hypothesis that the development of knowledge is

fundamentally social in nature, and seeks to understand changes in the respective positions of both teacher and student within the teaching and learning process. In studying these dynamics, educational research<sup>1</sup> has developed theories about the relationship between *personal time* and *institutional time*, and a number of specific concepts have recently been developed to do this (Chevallard & Mercier, 1987; Brousseau & Centeno, 1991; Mercier, 1992, 1995; 1997; Sensevy, 1998).

Some points of reference are needed to situate the study of time within the field of educational research. In particular it should be borne in mind that the knowledge to be taught is often explicitly described in teaching programs and manuals. One effect of writing knowledge down in the form of a written text is to separate it from the people who originally produced it, and from all the problems that gave rise to it. In addition, when knowledge is reconstituted as a text for teaching purposes, it takes the form of a succession of ordered parts that can be incorporated into a program for the acquisition of knowledge<sup>2</sup>. The teacher's task is to bring these items of knowledge to life by giving them a new context through which the teacher is able to "personalize" the knowledge for the students. So the text, which was originally written down in programs, manuals, and other teaching documents, is interpreted by the teacher, who reorganizes the text of the knowledge into a teaching objective. So the teacher creates a particular sequence of written texts and oral communications, in order to impart that knowledge to the students. The

<sup>1</sup> Namely: didactics of mathematics (Chevallard, 1981; Brousseau, 1998) and of other topics (Bronckart, 1997).

<sup>2</sup> Although the characteristics of this "sort of text" have not been examined in depth within the context of the teaching and learning of mathematics, following Canelas Trevisi (1997) and Bronckart (1997), we are aware not only of the interdependence of the properties of each text and the properties of the context in which it was produced, but also of the importance that should be given to the different levels of organisation within the text itself. In particular, the level of "textual infrastructure" contains the sequential or linear organisation of the thematic content of the text, which unfolds according to a given succession of content units, and the level of textual cohesion devices describes their contribution to maintaining thematic continuity and coherence.

students in their turn are prompted to tackle the questions and problems presented to them in a certain order (a new process of personalization and contextualization), in order to learn the knowledge targeted by the school. The whole process that renders knowledge teachable and learnable has been studied in research into the teaching and learning of mathematics and christened "didactic transposition" (Chevallard, 1991; Conne, 1981; Mercier, 2002)<sup>3</sup>.

### *Student learning time is governed by didactic time*

So, every day, new knowledge is presented to the students, which results in the knowledge that was current in the classroom up to that point being relegated to the status of old knowledge. This dialectic between *old knowledge* and *new knowledge* leads to the concept of didactic time. However didactic time is managed by the teacher, and does not itself constitute student time. The relationship between student time and teacher time is very complex, requiring the student to establish two types of relationship

The first is an *informal and personal knowledge relationship*. It develops as the student solves the problems, and becomes aware that he or she needs a new use of his or her current knowledge. This is a personal and informal type of relationship, and is common to everyone who is learning. The second relationship is a *formal and public knowledge relationship*, which is established within and by social interaction with the student's peers and with the teacher. As this relationship emerges it allows the student to verify that his or her knowledge is sufficiently solid to be named, demonstrated, and therefore shared with other students and the teacher.

In terms of educational theory, it can be said that the learning process advances through the constant interrelating of a private and a public dynamic; the subject enters into a relationship with the subject of the learning through his or her own private and personal relationship of knowledge. However, in order to progress, he or she has to socialize this initial personal relationship to the knowledge. Through communication with others, a more formal and public knowledge relationship emerges, a social relationship

that is not yet institutionalized as such. The *task of institutionalization* is the responsibility of the teacher, who publicly and officially recognizes the emergence of certain knowledge relationships as compatible with the mathematical knowledge targeted in his or her teaching. So under the responsibility of the teacher, each new item of knowledge takes its place in a structured whole, made up of all of the items of knowledge previously produced in the class. This becomes the *didactic memory* of the class (Brousseau & Centeno 1991).

### *The search for a didactic contract*

The processes described above are generated by a system of reciprocal expectations that has been called the *didactic contract*, which governs the relationship between the teacher, students, and knowledge. However, this set of expectations proves to be more of a paradox than a determining factor in analyzing teaching and learning, as Brousseau points out (1996, p. 86): "[...] the more the teacher [...] reveals of what he/she is looking for, the more he/she tells the student exactly what he/she must do, the more he/she runs the risk of missing the chance to promote and objectively observe the very learning that he/she must actually target." Following Sarrazy (1995), we feel that this paradox could be stated by the teacher as: "Trust me, if you dare to use your own knowledge, you will learn." The student might then reply: "Since I am doing what you ask of me, I know what I had to learn."

The didactic contract is based on a set of stable rules, such as the principle by which it is assumed that the teacher's questions are those that will allow the student to approach new items of knowledge. However, the agreement that binds the partners in the teacher-student relationship is not, in essence, a contract that is drawn up and signed once and for all, but a covenant (Amigues, Zerbato-Poudou, 2000). It would be more appropriately described as a "process of searching for a hypothetical contract" (Brousseau, 1996) that characterizes school teaching and learning which binds the participants together in the teacher-student relationship throughout the duration of a given class, as we have shown (Schubauer-Leoni

<sup>3</sup> "The transition from knowledge regarded as a tool to be put to use, to knowledge as something to be taught and learned, is precisely what I have termed the didactic transposition of knowledge". (Chevallard, 1988)

1986, 1991, 1997; Schubauer-Leoni & Leutenegger, 1997; Mercier, 1997).

Within the framework defined by academic structures and organizations, it could be said that teachers and students are formally required to observe a certain form of cooperation with regard to the subject matter being taught and learnt. However, the teacher-student approach does not underestimate the difficulty involved in making an asymmetric relationship of this type last for any length of time. The relationship exists primarily to make it easier to manage the uncertainty caused by the necessary and repeated breaches<sup>4</sup> of a contract that is constantly changing. So the concept of didactic time helps in understanding the progress of teaching over time, which is measured both by the succession of new items of knowledge taught and by the teacher's ability to recognize what knowledge has been acquired by the students.

With reference to the theory of teaching and learning (Chevallard & Mercier, 1987), we have so far considered only the relationship between two interrelated temporalities, namely student learning time and the didactic time which provides its framework. However, analysis of the process of teaching and learning involves other temporalities which govern the first two within a specific hierarchy. *Student learning time* and *didactic time* are situated within the *institution's academic time* and then within *society's time* and finally, within *physical and cosmic time*. These different levels of temporality are defined with reference to the times above them in the hierarchy, while still leaving a certain amount of room for manoeuvre<sup>5</sup>.

### The historical background to the emergence of academic time

Modern teaching institutions began to emerge as such in the sixteenth century (Chevallard & Mercier, 1987), and were based on the authority of astronomical time, and clock time. This is amply demonstrated by the external organization of courses during the academic year, the

length of terms, timing of formal assessments, the unchanging study calendar, and periods of study marked by the bell. This organization is what produces academic time. However, this institutional time, closely regulated by astronomical and physical time, will not automatically be relevant to projects involving the individuals inside the institution, as an institutional project presupposes an internal product that is capable of measuring the advancement of the project itself. As Ferdinand Gonseth said (1964), "Every system produces its own time," and he showed how this time is measured by measuring what the system produces. So a traditional watch produces a circular mechanical movement where the arc on the face is a measure of the amount of time (giving a mechanical evaluation of time), whereas a sundial produces the movement of a cast shadow (giving an astronomical evaluation of time). Gonseth presents the axioms which make it possible to synchronize diverse systems and unify the notion of time. One of his findings seems particularly germane to our proposal: the physical systems appropriate for measuring time verify the axioms he presents, but the times of non-physical systems cannot be synchronized. Conventionally, it is only possible to subjugate these systems to the authority of physical time, which therefore acts as a universal equivalent. So for several centuries now, physical time has been used indiscriminately to measure human work, daydreaming, or a lovers' quarrel.

For its part, the school generates time using the internal product on which it is based, i.e., using knowledge. The passing of time is measured in a mathematics class by the progress being made in presenting the *text of the knowledge*. This is the formal implementation of the school's purpose with regard to its pupils. As a result, didactic time turns out to be both progressive and cumulative, and this organization of time enables the teacher to satisfy the tacit undertaking by which he or she is authorized to ask students questions to which they do not know the answer so that they can learn how to answer them, and so learn. As knowledge is organized linearly, the teacher should at all times be in a

<sup>4</sup> The need for and repetition of breaches of this contract are linked precisely to the fact that knowledge has to evolve as teaching progresses, which inevitably modifies the terms of the contract, although this cannot be stated explicitly.

<sup>5</sup> With regard to society's time and the institution's academic time: consider the constant debate in society as a whole about daylight savings time, or about school timetables and changing the of school holidays.

position to show the students how, by using the knowledge they have already been taught, they could themselves have created the desired relationship to the new item of knowledge.

#### Student time and the conditions needed for learning

Each student's *learning time* is made up of the series of new objectives with which the student is faced, both the subject matter actually being taught, and other items of knowledge which are relevant to *the study* of the subject matter being taught. Learning time therefore involves a much wider range of personal knowledge relationships than those strictly referred to in the text of knowledge at any given time. This is why learning time has to be re-enacted at a later date, revising and reconstructing it so that old relationships to relevant learning objectives can be adapted to their new uses. Learning time cannot be superimposed on didactic time; this proves that didactic time, in which items of knowledge are simply cumulative, is not the same as learning time, which requires a reorganization of knowledge already learned.

Research into the teaching and learning of mathematics has clearly shown that although learning time is governed by the framework of didactic time, it is the product of the student's own intentions and actions (in particular, see Mercier, 1992; Sensevy, 1998). The didactic contract requires of the student new levels of performance for each item of knowledge taught; if discontinuity during presentation of the text of knowledge regularly gives the student the impression of being in a position where the didactic contract is being broken, it is the new knowledge that will resolve the crises of that apparent contract. In other words, in accordance with the definition given earlier of the informal and personal knowledge relationship, we can say that the student learns by taking personal responsibility for the problems he or she deals with. Individuals who make use of their relevant knowledge do not organize it linearly, so a student who embarks upon problem solving has to reorganize the "toolbox" available to them. Sometimes a more substantial reorganization of a discipline is

required, and this is the role of *study*, which allows the student to revise the material. When a student studies, goes over his or her notes, reviews them and reconstructs the contents in some way, he or she simultaneously introduces the concept of time inherent to the learning process: this is student learning time.

Studies by one of the present authors (Mercier, 1992) and by Sensevy (1998) have shed further light on learning processes by showing that students who learn benefit from *sharing the intention to teach*. In this case the student puts himself on the teacher's side, in an activity that generates time, time which is useful both in the constructing of knowledge by the student, and for advancing the text of the knowledge, which is the responsibility of the teacher. These studies have also shown that the individual has to find his or her own route through this pattern of alternating between semi-expertise and partial ignorance. Students convert by themselves a personal and informal knowledge relationship into a more formal and public one. Doing so, the students set in motion the spiral in which the student frees himself or herself from their status as a student each time learning takes place successfully, while returning to this status a moment later when faced with his or her lack of knowledge on approaching a new item of knowledge being taught. The real and symbolic gain must justify the investment. In fact, this gain seems all the more likely when the student contributes to creating the need for new learning objectives by asking himself or herself questions, by usefully evoking other situations through which the knowledge was produced at some point during the course.

In a "traditional"<sup>6</sup> didactic contract, the reactivating of old knowledge is exclusively the teacher's responsibility, while in a scenario where the aim is to share the intention to teach, the teacher offers the student not only a situation that poses a problem, but also the responsibility for generating the behavior that makes connections between his or her private memory and the institutional memory of the class (Brousseau & Centeno, 1991; Sensevy, 1998, Matheron, 2001). Shifting the student's position to that of the teacher further requires that the teacher continue

<sup>6</sup> In attempting to reduce the ambiguity which arises in the dynamic relationship between the teacher's management of knowledge to the student's management of it, the traditional system of teaching tends to lose sight of the meaning of this knowledge (Johsua & Dupin, 1993, p.257).

to use forms of behavior that allow him or her to retain a specific role in the didactic contract. In *this type of scenario, studied by Sensevy (op cit.)*<sup>7</sup>, it is once again the teacher who specifically organizes the conditions which enable the student to shift from his or her traditional status towards a position which allows him or her to share the intention to teach with the teacher (Sensevy, Mercier, Schubauer-Leoni, 2000).

The studies already referred to the conditions under which mathematics are learned in class were based on the operation of experienced practice in producing mathematical knowledge. According to Brousseau (1996; 1998), a theory of teaching and learning situations has now made it possible to model the dialectics (of action, formulation, and validation) that characterize the emergence of specific mathematical knowledge. These situations initiate a relationship with mathematical truth that is based on both collective memory (which organizes states of knowledge) and the time the researcher (here, the student) puts aside for studying the subject. This theoretical model also recognizes as a factor the control of the community (i.e., the class) which discusses and possibly accepts the stages along which the study progresses; this is *institutionalization* (Brousseau, 1996).

#### **Between student learning time and class time: the work of the teacher**

This complex problem is related to the temporalities involved in implementing an intention to teach mathematical knowledge. We will illustrate it using examples taken from a study by Donck (1996) which concerns the professional knowledge that can be identified in the relationship between a teacher trainer and a teacher trainee. This provides a particularly interesting opportunity to

observe the emergence of discourse on the management of didactic time<sup>8</sup>, as the participants reveal certain features of their theories and knowledge about teaching and learning, through their comments and advice to teacher trainees.

#### **The problem of time in trainer/trainee interaction**

Starting with a corpus of interviews between a teacher trainer and a teacher trainee immediately after a mathematics class of fourth year primary school students, we shall attempt to show how the temporal problems involved in this situation enable us to interpret the content and dynamics of the class. Research carried out by one of the present authors (Donck 1996) questions the nature of the professional knowledge acquired both by experience and from theory that is involved in the relationship trainers have with trainees in the work environment.

In this type of interview, which is part of a training course involving close partnership<sup>9</sup>, the teacher voices her train of thought when they were observing an activity which the teacher usually carries out with more success than the trainee is achieving. We therefore expect a *commentary on what the trainer considers to be "effective action."* It follows that the trainer should tell the trainee what the clues are that will make it possible to anticipate difficulties and decide on a corrective course of action. In the interview transcribed below, the trainee has failed (relatively speaking), and the trainer explains the criteria that, in her opinion, have not been met. So the trainer is describing elements of her knowledge about teaching, by stating how the conditions required for learning to take place should be organized. Note that with regard to the particular question of how the class should be con-

<sup>7</sup> Two major scenarios were studied by this teacher and researcher: "Constructing problems with fractions" and "The fractions journal". The aims were:

- to reveal conflict between students' contradictory interpretations;
- to help with group work
- to facilitate dialogue among students
- legitimisation, which can lead to institutionalisation, e.g., through appropriate comments and particularly profitable work by students;
- to help the establishment, through this work, to establish common meanings (emblems) which can be incorporated into the didactic memory of the class" (Sensevy, 1998, p.116)

<sup>8</sup> In France, teacher trainers are teachers who have acquired this particular qualification through an examination. Teacher trainees then sit in on their classes during the teaching practice stage of their training.

<sup>9</sup> The trainer is accompanied by the trainee throughout each stage of the student teaching.

ducted, there are a very large number of questions and comments about time.

When this excerpt took place, the trainer had asked the student teacher (S) to give his overall impressions and provide a critical analysis of his work, and the trainer (T) then states her opinion outright, without allowing the student teacher to interrupt.

[...]

1 T - but insofar as / in my opinion / insofar as the children // you had just revised what a multiple was and the fact that they had understood / couldn't they have given you multiples of three straightaway without you going over division by three again/ there's nothing left/

2 S [yes / [yes/

3 T [because/ then/ you could have saved time / as it's not the most important part of what you're trying to do / to tell them that today we are going to work on multiples of three / you know what multiples of three are / well then do them for me / for example write them down for me up to sixty straightaway/

4 S - [yes / [yes/

5 T - [and they would individually have got all the multiples of three up to sixty / I think it was unnecessary / it was a waste of time to go over division again because they knew it was a multiple and in that case that it was divisible // I think there you could have saved time // at that point / they would have found the first twenty multiples / it was interesting because you ended up at the same point / at sixty / the first twenty multiples / (inaudible) / saves you time /

6 S - [yes / [yes/

7 T - [you didn't need to use the cards any more / because they had understood / at least at that stage and that allowed you to save some time / right there on the main point itself // recognition / resemblance and difference between / how to recognise /

8 S - yes / yes /

[...]

We can easily spot the theme "time," given that the word appears five times (once in the third speaking turn, three times in the fifth and once in the seventh) in this short excerpt from

the trainer's discourse. The time in question is clock time, that is, the part of the hour allocated to this activity. We can also see that in this case it is always a question of saving time, and that not saving time is wasting it. But the theme of time, whether saved or wasted, is omnipresent. The expression "straight away" also shows that the teacher must have a sense of urgency.

So we see that time is gained or lost along with knowledge, and more specifically, that the teaching of a given item of knowledge causes time to be lost. This is expressed in the following observations by the trainer: "...multiples of three straight away without you going over division by three again / there's nothing left..." (because they could have given you all the multiples of three straight away) (turn 1); "...you know what multiples of three are / well then do them for me / for example write them down for me up to sixty straight away..." (turn 3); and again: "it was unnecessary / it was a waste of time to go over division again because they knew it was a multiple..." (turn 5). Going back over knowledge that is assumed to have been learned already, i.e., division, stops didactic time and causes clock time to be wasted. If the student can perform the action straight away, it is a waste of time for the teacher to return to the tool used for the action. By the same token, student activity based upon knowledge already acquired is a waste of time: "...you didn't need to use the cards any more ..." (turn 7). Student activity is therefore only of interest if it consumes didactic time, that is to say, if it is related to a new item of knowledge which must then be capable of becoming an acquired item of knowledge for the students.

#### *Why does the trainee waste clock time?*

Not all backtracking is necessarily damaging. The trainer states: "... you had just revised what a multiple was and the fact that they had understood ..." (turn 1); it can be positive, if the students are required to "... give multiples straight away ..." This point is made again later on: "... because they knew it was a multiple and in that case that it was divisible // I think there you could have saved time // at that point / they would have found the first twenty multiples / it was interesting because you ended up at the same point / at sixty ..." (turn 5). Going over knowledge already acquired should be limited to recalling what is actually needed to enable stu-

students to carry out the prescribed task successfully. The “correct” way of achieving this goal is related to the respective responsibilities of the teacher and the students since, as the trainer explains (turn 3): “... you could have saved time ... by telling them that today we are going to work on multiples of three / you know what multiples of three are / in that case, tell me them / write them down for me, let’s say up to sixty, straight-away...” The trainer lets it be known that when it is a question of manipulating known objectives, the teacher should delegate the responsibility for action to the students. However, she does not explain the reasons for the effectiveness of this type of teaching method, which she has tried and tested throughout her working career. As an expert in the practice of teaching, she feels herself that it is up to the teacher to limit the work to only those actions which are useful for the task at hand: “... they would have found the first twenty multiples / it was interesting because you ended up at the same place / at sixty...” (turn 5); and again: “... this was not the most important part of what you’re trying to do ...” (turn 3). Within the logic of didactic time, revising diverts the teacher’s attention from the task in hand; knowledge being revised does not lead to progress if it does not immediately equip the students with the tools necessary for the new action they are being asked to perform.

So what exactly is at stake in the discourse on time that “must not be wasted,” that it should require such emphasis? Clock time, which the teacher has to be so careful not to waste when working on old knowledge, could be used to give life to the new knowledge. This new knowledge is indeed what is at stake in teaching; didactic time (the time by which progress in the knowledge is measured) has to advance: “... that allowed you to save some time / right there on the main point itself // recognition / resemblance and difference between / how to recognise... ” For in parallel with the fact that teachers should not cause the students to lose didactic time by holding them back on what they already know, they have to see that they can progress in didactic time by giving them time to get to grips with the new knowledge. A few minutes later, the trainer repeats this essential point.

T – I think that at that point you wanted to go too quickly / you were too quick / I mean that this was the important point / you should have got rid of the problem areas /

[...]

T – you agree, don’t you / that’s what we have done from the start // at that point you had to give them time to think / let them mull the situation over // and you didn’t give them this mulling over time / you know like I do every time/

S – yes / yes /

According to the trainer, an experienced teacher is therefore one who spends clock time on items of knowledge that advance didactic time (which are new, and therefore problematic), and who spends little clock time on items of knowledge which it is assumed have been taught and learnt, and which slow down didactic time. Students should have time to work out what is new in order to keep up with the pace suggested by the teacher, who is supposed to gain this time by reserving the manipulation of known learning objectives for the student’s own time. This illustrates the characteristics of the roles assigned to the teacher and to the students, which translate into two distinct ways of knowing (two “epistemological registers,” as Johsua & Dupin put it (1993)).

Another interesting observation emerges from these reflections, namely that for an experienced teacher, mastering didactic time is enough to produce satisfactory learning time for a sufficient number of students. Perhaps it is the linear logic of didactic time that lies behind teachers’ inclination for behavioral and associationist theories of learning, which have so often been observed in research (see Del Notaro, 1993; Bitton, 1994; Fluckiger, 1994; Schubauer-Leoni & Leutenegger, 1997). When teachers integrate into their practice theories that see learning as an accumulation of items of knowledge, they feel that these theories tie in with the equally cumulative progress of teaching time. From this perspective, consistency between teaching time and learning time would seem to be more readily attainable than in learning conditions in which the relationship between learning time and linear didactic time is discontinuous or even completely broken.

### The theory of didactic time and the teaching profession

If didactic time were managed competently and calmly by the teacher, would this lead to a rational organization of the teaching objectives, and

so to reasoned and effective access by students to the knowledge being targeted? As we have seen, teaching and learning theory regards teachers as a participant with two tasks to be carried out simultaneously: they must ensure the visible and stimulating advance of didactic time, as this is the institutional aim of his or her activity, while at the same time organizing that advance in such a way as to facilitate *the study* of the text of the knowledge by the students. In the current state of knowledge about teaching and learning, it is felt that progress by students requires personal reorganization of knowledge that is already understood (this is completely different from automatic repetition of the text of the mathematical knowledge), in order to integrate new knowledge that could help the learner with new issues. The student is responsible for this work which produces learning time, and which is based on the specific learning behavior of *study* (Chevallard, 1988, 1997). However, it should be remembered that from the point of view of the institution, these heavy demands in terms of learning do not in any way prevent the situation arising where the student may manage to give the expected answers at the right time without necessarily having developed an understanding of the knowledge. This observation is based on various studies (Schubauer-Leoni, 1991; Schubauer-Leoni & Leutenegger, 1997; Mercier, 1997), and raises further issues about the clues that tell a teacher that a given piece of knowledge has been acquired and understood by a particular student, at a given time in his or her teaching plan. Without leaving the question of didactic time, we think that this is a key issue in the teacher's management of the didactic contract.

In any case, it would be naive to believe that a teacher simply has to negotiate another institutional contract in order to give each student enough time to achieve *spontaneous* learning. From the perspective of teaching and learning, condemning the tyranny of didactic time does not help in interpreting what those who teach teachers have to say about what it takes to teach.

#### **Temporal dimensions in a psychosocial approach to the learning process and the transmission of knowledge**

Taking as its starting point the psychological issue of learning both general instruments of

thought and the cultural message transmitted by the academic institution, the social psychology of the transmission of knowledge covers some of the same areas as analysis of teaching and learning.

#### **Taking account of the observer's position when observing teaching and learning**

In a critical extension of the operative and psychogenetic approach to knowledge, the social psychology of knowledge transmission (Perret-Clermont, 1996; Hinde & al., 1988; Schubauer-Leoni & al., 1989, 1992) has shown how the individual makes him or herself the co-author of their own intellectual development, and identified the microhistories they use to do this. In the light of this research, Anne-Nelly Perret-Clermont has once again raised the question of the difference between learning and development (1993), discussing the use of these terms from the points of view of both epistemology and methodology. She shows that in the case of learning in its strictest sense, during which the child acquires new knowledge, the role of interindividual relationships is generally underestimated. Development is still usually considered to be based mainly on internal transformations, which are assumed to allow new, and most importantly, untaught, forms of organization to emerge within the subject. Through this critical examination and the large body of research that has accompanied it, she has contributed to demonstrating that knowledge is eminently social in nature. These studies have produced an analysis of the thinking spaces that correspond to the methodological paradigms underlying not only classical studies of learning, but also the devices that are being developed by current thinking in the social psychology of knowledge transmission.

This type of theoretical framework has provided the basis for a psychology that attributes a specific function to the conditions under which knowledge is developed and brought up to date. Studying the child as he or she constructs knowledge with others (peers or adults) throughout the interpersonal histories that make up his or her life, at home, at school, in the street, etc., allows us to see the difference between learning *per se* and development, which is not a product of the subject him/herself and which is dependent on "the relative positions of the observer

and the observed" (Perret-Clermont, 1993, p.49).

Generations of studies (Perret-Clermont & al., 1991) have shown how far the project and the research intention prove to be constituents of the behavior and attitudes of both experimenter/observer and subjects. Time is produced by the history of the experiment which connects a number of phases which, depending on the individual study, may include a pre-test phase, a test or learning phase, and one or more post-test phases. The subject interprets this temporality as an ingredient of *the communication contract* that unites the participants. In various studies (Grossen, 1988; Schubauer-Leoni & Grossen, 1993; Schubauer-Leoni & al., 1992) it has been shown that ten minutes of testing is enough to give the subject an opportunity to form a more or less precise idea of what is expected of them under the circumstances. Depending on the initial objective of the research and the context (family, school, leisure, etc.) to which subjects refer back in order to attribute a cultural meaning to the objective, their interpretation of the experimental contract will lead them to act according to the tacit rules in place within the institutions concerned, i.e., the rules which govern the practices relating to this objective, according to the subject's experience. The relationship that the subject establishes with the objective, i.e., the knowledge that it produces, will therefore be closely linked to the development over time of the researcher's reactions to the subjects' actions (Grossen, 1988; Schubauer-Leoni, 1988). In other words, depending on the contractual clues made available to subjects throughout the encounters, the subjects learn with unequal efficacy to act in accordance with the rules in effect at the time. From the very first studies on the social construction of intelligence, the theoretical perspective has been widened to include the social psychology of learning in school situations, "in order to grasp the complex determinants of communication which affect the development of responses by students in this type of context ..." (Perret-Clermont, 1996, p. 239).

### **The social psychology of experimental research situations**

Constituent elements of students' responses that have been identified include, in addition to the

objective about which they are being questioned, the function of the researcher or teacher who is asking the questions; the dynamics of gestures and speech used in the interactive exchanges; the function of the place – physical, symbolic and interpersonal – in the constitution of what Rommetveit (1974) calls intersubjectivity, and the institutional environment in which the interacting participants communicate. In this theoretical context, items of knowledge are never regarded as "purely cognitive" but as intrinsically social. As the subject modifies his or her relationship with a learning objective about which they are being questioned, they can develop not only a new knowledge of the learning objective itself, but also a greater intelligence about the system of relationship with the world in which the "well thought out" learning objective is involved. This is why a child who is said to have understood shows his or her understanding in the expected ways.

As discussed elsewhere (Schubauer-Leoni & Ntamakiliro, 1994), the space and time for thinking which characterizes a research interview about a learning objective requires the subject to act at two closely related levels of rationality, i.e., that of the knowledge itself, and that inherent to the conditions of acceptability of their responses. The work of thinking on these two inter-related levels itself takes place on two levels, since the subject deals with the learning objectives privately, while he or she is required to manifest publicly what is considered acceptable under the current circumstances, both in the form of physical actions regarding the objectives and through verbal behavior and body language.

This approach has been influenced to a considerable extent by the preoccupations of a "psychology of learning." It has begun to identify those aspects of time that are dependent on the sharing over time of the intentions of the researcher who is leading the interaction. They are therefore not under the sole control of each subject's internal organization. This has led to the identification of a phenomenon of which many psychologists are unaware, namely that as the subject of the study is unable to share the presuppositions of the psychological culture on which the questions and actions of the psychologist are based, and as the subject is likely being questioned during school hours and in school buildings, they will import into the context of the experimental the rules of cognitive function-

ing which they have worked out during their experience as a student. So the researcher's questions that have been carefully designed to be diagnostic will be interpreted as being related to an intention to teach, and will therefore provoke learning or provide an opportunity to show what has been learned. We set out to study a child who is learning, and within the timespan of the experiment, we find we have a student who thinks he or she is being taught! (Schubauer-Leoni, 1986; Grossen 1988; Perret-Clermont & al., 1996).

So developments within contextual and social psychology are concerned with learning while attempting to determine experimentally the extent to which learning is a function of an intention imposed by a third party, marked by an institution, and creates the direction of the learning. This line of research has grown out of the Piagetian tradition which has been improved in order to free the child from adult-centeredness and demonstrate the fundamental role of the child's own action in the construction of knowledge. It demonstrates the role of both peers and adults in organizing the conditions that enable a child to learn and so to develop, so giving these roles a new meaning, in line with the Vygotskian hypothesis that *teaching is the condition of development*. In passing, we should mention the observation by Schneuwly (1995: 26) that it is the child-centered nature of psychology which appears to be the cause of the misuse of the Vygotskian term of *obuchenie*, which is translated as "learning" or even "school learning" although Vygotsky intended the term to mean "... a bilateral process carried out by the teacher (teaching) and by the learner (learning)..."

### The individual and personal learning

In the field of education, the persistence of a child-centered viewpoint is stated with renewed emphasis in the leitmotif "put the child at the heart of the educational action" coupled with the injunction "help the child to progress at his/her own pace" – a "natural" pace, of course. This approach is based upon a belief in the spontaneity of the dynamics of construction of knowledge, whereby it is considered sufficient just to let learning unfold in an interpersonal and institutional universe in which neither the conditions for existence nor success are specified. Yet if we

took seriously the psychological studies that insist on the fact that education leads to the (necessarily artificial) development of humankind, we would better understand why these currents of thought lead to the conclusion that it is not sufficient to wait for the "child's desire to learn", to encounter "natural learning situations", but rather that it is necessary to offer students situations which are ahead of their development and which can create the necessary "tension" for learning, situations which give the individuals being taught opportunities to encounter questions that are useful to the advancement of their knowledge of what they are taught and its objectivization into knowledge.

From this perspective, the continuous movement in time which knowledge represents is constantly in a state of crisis due to local disruptions brought about by the effects of learning and teaching. There are two dynamics within the course of the student's life, the dynamic of cognitive development and the dynamic of the learning of knowledge, and the student must take account of several other tempos within them, i.e., the tempo of teaching, which is imposed by the teacher's choices (restricted by the institutional and cultural structure of the knowledge to be taught), and the tempos that govern the social practices in which the individual develops in other environments (family, sport, recreational and cultural practices), which are governed by institutions other than the school.

So if we assert that each individual is always responsible for his or her ever-increasing mastery of the world, we have to accept that they will not come to recognize this responsibility through paradoxical injunctions, and even less so, through abandoning themselves to mechanical or astronomical clock time, but will realize that it is educational institutions that will help them to accept this responsibility.

Once we use different experimental methods to examine the artifices by which actual individuals, irrespective of sex, social group or national culture, enter (or fail to enter) into the act of questioning and responding to what they are offered, we begin to gain an understanding of how certain constraints intervene in the temporal economy of research or in teaching interactions. The concept of the *differential didactic contract* (Schubauer-Leoni, 1986) emerged through studies of the social psychology of the relationship between teachers and students, and makes it pos-

sible to give a status to the sets of differentiated expectations on the part of the teacher, who also unknowingly and repeatedly intervenes in the *class's educational history*. The concept of the *differential didactic contract* then enables us to understand how specific relationships teaching objectives, with differing degrees of responsibility, are offered to different students.

## Conclusion

While recent developments in the teaching and learning of mathematics have proposed the study of the “gestures” of teaching and learning as specific forms of social interaction (Sensevy, Mercier, Schubauer-Leoni, 2001), it is important to note that analysis of social interactions has become a necessary part of certain psychological approaches, and have thereby succeeded in redefining the conditions of learning while at the same time presenting a new challenge to the principle of *transmission* of knowledge through a simple person-to-person transfer from the teacher to the student. Study of the temporal dimension of the various elements observed lies at the heart of these issues. In combination with social psychology research into the transmission of knowledge, studies of teaching and learning question those psychological approaches which tend to describe subjects as essentially being governed by the clock of their personal cognition. Although psychology sees itself as a science of the subject, and even though it has generated theoretical accounts of the subject located within a framework of others and of institutions, the discipline still tends to lack a theoretical account of knowledge and of the transformations that this knowledge undergoes under the constraint of being transformed into a text, which is imposed on it by the various institutions that create it (these being the concerns of the theory of didactic transposition). However, we have observed that educational and social psychology studies both raise questions which are consistent with each other, and can do so without losing sight of their respective agendas (Schubauer-Leoni, 1996, 1997); advances made in one discipline tend to support progress made in the other. This is an encouraging scientific situation, as experts in psychology tend to be too ready to think that they have said everything required about the process of learning once they have in-

tegrated both interpersonal and institutional social dimensions into their analysis of cognitive interactions, and experts in the teaching and learning of mathematics too often think that they can suddenly act as jobbing psychologists in order to relate to the student in the context of teaching and learning.

So in order to advance our understanding of the dynamics of both teaching and learning, we would emphasize the value of working towards a *teaching and learning interaction “clinic”*, to improve our observation and understanding of the processes of constructing that intersubjectivity which is after all unique in its own way. In time and under the aegis of institutions, these processes are the ones that create private and public knowledge relationships. These are the processes that ultimately lead to the situation where one student will feel able to take his or her place in the teaching intention, while another will wait to be shown the way (Schubauer-Leoni et al., 1999; Mercier, 1997; Leutenegger, 2000).

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# Time in Knowledge Building Processes with Interactive Videoconferences

Jacques Perriault<sup>1</sup>

The present study is devoted to observations of interactive videoconferences for distance learning purposes. Nowadays university instructors more and more frequently introduce distance and technology-based learning sessions in traditional courses. This "hybridization" of two traditionally different approaches of accessing knowledge emphasizes the crucial role played by time in media-based learning processes. The process of knowledge building is indeed interspersed with additional routines and procedures inherent to the medium itself. It now appears more and more clearly that students have to master these procedures if they want to build up knowledge through medias.

Two main kinds of technology-based devices for access to knowledge have to be distinguished:

- The first one includes computer-based learning devices, where a student interacts with a computer without human assistance: computer assisted instruction, CD-Rom and data base look-up, for instance, are items in this category. Since the early studies by Papert (1979), machine-student interactions have been explored by numerous researchers (for recent developments, see Grossen & Pochon, 1994, 1995).
- There are fewer studies about the second kind of device, which will be explored later. This second category relates to telecommunication facilities that link students at distance with instructors or experts, such as visioconferences, interactive videoconferences, Internet forums, etc.

An interactive videoconference is broadcast through broadband channels, via satellite. On the broadcasting site, some experts, instructors, and students are gathered in a studio. The duration of the session is strictly fixed: 1 h, 1h 30

min, max. 2 h. Groups of tutors and students attend broadcast lectures and panel discussions on TV screens in university rooms. They are allowed to submit questions by telephone or fax. "Submit" is the appropriate word because the questions are selected on the broadcasting site by an expert, who selects and transmits them to the expert panel. A moderator on the TV set manages the whole broadcasting time.

Two years ago, with Luc Jaecklé<sup>2</sup>, we observed a group of students attending distance courses through videoconferences. Highly contrasted types of behavior on the part of students during the videoconferences drew our attention to the role played there by their time evaluation and time management.

Many students indeed declared in our enquiries that they were frustrated by the lack of time to prepare the questions and to understand the answers given at distance by experts. As a matter of fact the broadcasting device did not allow them to ask for clarifications. Direct observations confirmed that:

- some students were actually highly stressed during broadcasting sessions;
- some of them participated very actively, while others obviously had given up. Active participants worked together in small groups including either peers only, or peers and tutors.

## Time and learning

Up to now, the role played by time in such processes has been little explored in the scientific literature, both in learning processes and mass media communication studies.

Experts in education have paid little attention to the role of time in learning processes. Time is

<sup>1</sup> June 1997 – with the collaboration of Luc Jaecklé. I am grateful to my colleague Luc Jaecklé for the main role he played in observation of groups attending at videoconferences and also for his criticism and comments.

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considered on a very general level: for instance Wang, Haertel and Walberg (1990) refer to time as a number of units that students have to manage. Therefore, at the end of the 70s, Papert had published an exciting longitudinal study of a dozen children programming recursive models with the help of LOGO language (Papert & al., 1979). This study showed that different children needed very different amounts of time to integrate the same set of software primitive functions.

On their side also, researchers in media communication have delivered few studies concerning the role of time in mass-media reception. TV time is generally considered as a permanent flow of pictures and speeches. Authors like Blum, Doane, and Boulestreau stress that the temporal dimension of TV is an "insistent presentness" (Blum, 1980; Boulestreau, 1997; Esquenazi, 1997). Blum therefore remarks that the syntactic function of television frequently hides the semantic one.

Psychology and cognitive research, on the contrary, devote more attention to perception, evaluation, and management of time, mainly using the three following approaches:

- (1) Psycho-physiological models concern physiological thresholds of perception. For instance, Carré, Ragot & Fano (1992) have recently established that subjects estimate synchronicity between a picture and a sound inside of an interval of 40 ms. In our research on students following video- and visioconferences, Misseri & Fualdes (1996) stated that a breakdown of 5 seconds occurring in a visioconference is largely overestimated by students and that this overestimation decreases with the duration of the breakdown.
- (2) Information processing models are based on metaphors imported from data processing techniques, like "information processor" and "timer" (Thomas & Weaver, 1975). Authors like Poynter (1989) and Zakay (1990, 1993) distinguish the following three approaches:
  - the "memory approach" assuming that information stored in the memory serves as a basis for time estimation;
  - the "attentional approach" based on the hypothesis that a "cognitive timer" counts the subjective units accumulated during a time interval;

- the "contingency approach," where several factors have an influence upon the empirical estimation of time, one of them being the complexity of the task. Zakay states that if more attention is devoted to a complex task, a lesser amount of it remains available to manage time.

The notion of change plays an important role in these theories. Based on a remark by Gibson that if events are perceptible, time is not, change appears as a benchmark to delimitate intervals in the duration. According to Poynter the change approach "*assumes that judgment of interval duration is based on the ability to remember the sequence of events experienced during an interval and to infer inter-event duration on the basis of the "intrinsic characteristic of that which remains in memory"*".

- (3) Situated models intend to grasp much more complex situations than those we have observed. We agree with Michon (1990), when he writes: "*Time is the conscious experimental product of the processes that allow the (human) organism to adaptively organize itself so that behavior remains attuned to the sequential (i.e., order) relation in its environment*". That definition includes many factors which allow the human actor to attune itself to the surrounding world, such as (Michon, 1990): planning of future actions, temporal structure of speech and language, perception of events, etc.

Michon refers to a French philosopher of the last century, Guyon, who defines memory as "*simply the way effectively and efficiently to use strategies with which we organize representations of knowledge*." The notion of organization strategy implies abilities. This linkage between memory, strategy, and competence has proved very useful as seen below.

#### About the observed disturbances in time evaluation and management

The videotransmission sessions observed concerned students reading for a "diplôme d'études approfondies" in Law, five years after the

baccalauréat. The course broadcast by satellite dealt with European environment law. The entire course lasted about 13 hours. Interactive sessions through videoconferences and telephone conferences took up 25% of the whole time.

Students had never used such media to access knowledge before. Their representation of teaching was based on a traditional reference to the duration of time, i.e., one hour as time interval unit, and to established changes inside of a course: instructor's speeches, questions, answers, etc.

### *Time evaluation*

Our definition of time evaluation is close to the one given by Frances, i.e., what a person can hear and see of what is shown to him or her (Frances, 1985). We add to this definition, evaluation of the inner timer of the device, such as perceived by the subject. The majority of students found the following things to be much too short:

- duration of the videoconferences, even if 40% of them declared that their attention dropped in the course of them;
- time allocated to interactions between groups and panel.

Moreover, they perceived the videoconference duration as segmented in rigid time intervals. As an example, a girl asked a question by microphone that she had prepared with her local tutor. Dissatisfied with the reply, she asked to dialogue further. The moderator refused because, in agreement with the control room, he had immediately moved on to the next site. During the following session, the same student again prepared a question. Unfortunately she did not have enough time to send it. She declared after this second session that from now on she would prefer traditional courses.

Some concepts reviewed below help describe such time evaluations:

- The broadcasting site has its own rhythm, as if it were *de facto* regulated by an inner local timer, which imposes a given time-scale to the whole communication device (broadcasting site, viewers' groups). For technical reasons such as total duration of the broadcast, management of discussion time, number of questions, etc., the control room generates periods of time devoted to specific activities (speech, interaction with

a given site). These periods of time have two features, which progressively appear as contradictory to participants: they are of variable durations but they are not flexible.

- Distance viewers, during the interactive phases, perceive communication gaps as changes. From immediate past experience, they try to infer what Poynter names an "inter-event duration." Unfortunately they don't know how many questions are sent to the site and how long the expert's answers will be for each of them. Changes in processes as perceived by students suggest that they provoke incorrect time anticipations and misuse of time intervals. A student expecting an answer at distance anticipates an interval of time that is much longer than the real interval of time. He is not adapting to the process, i.e., to correctly evaluating the rhythm of changes. This generates a feeling of frustration.
- Making of a hypothesis on how to perform a satisfying exchange in a short time therefore appears to be the main task of such a session for students. As we shall see below, to participate in distance learning is much more complex than it appears at first glance. If we follow Zakay, we can assume that conflicts may occur between performing a complex task and time management. Moreover, to perform the task successfully, as we can also see below, implies specific competences and strategies.

### *Time management*

The main observations related to time management by instructors and students on reception sites are as follows:

- more than half of the group followed both expert speeches and interactions with some delay; and
- some students were viewing in a group, whereas others did individually. Those students working in group collectively faced time constraints, while those working individually did not.

Activities such as tuning oneself in to the media-based learning device, identifying time changes, analyzing complexity and building strategies took them a lot of time. That can explain some observed delays, which effectively add to the time necessary to deal with delivered

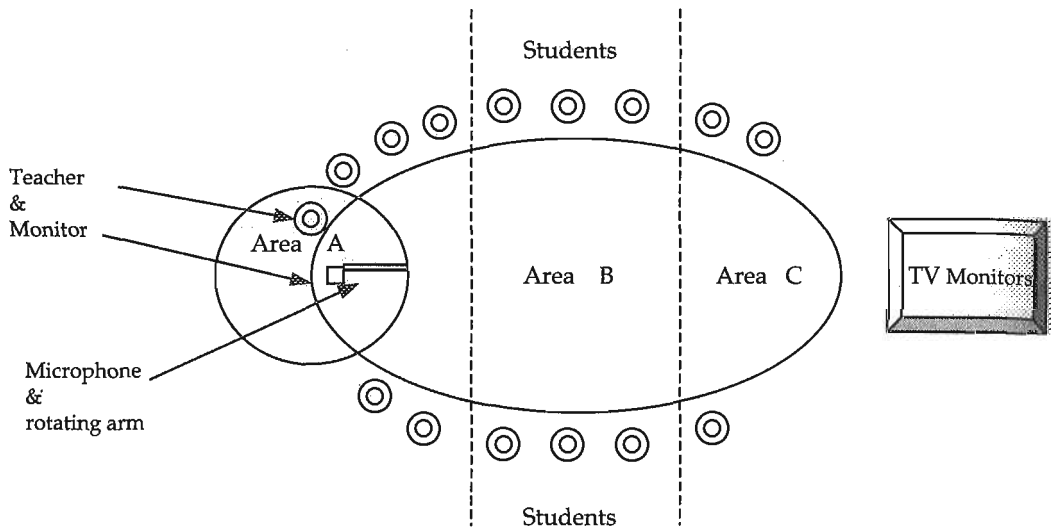


Figure 1

information. Other factors also influence time management, namely the layout of the classroom and the conflict among reference models generated by the communication device itself set against the controlling influence of habit.

The local layout of the “classroom” contributed to make the cognitive task more complex and consequently increased difficulties managing time. The site was organized as follows: fifteen students were sitting around an oval table (see Figure 1). Instructor and Tutor sat at one extremity of it. The microphone was near the two instructors. It was set on a rotating arm about one meter long. Two TV screens were at the opposite end of the room. This device in fact delimited three areas of activity. Area A was the most active, because of the instructors and the possibility to reach the microphone directly. In area B, students also were very involved but had to stand up and to move, to speak on the microphone. Students in area A and B were the most involved in preparing questions during the videoconferences. In area A, this preparation was always collective, with many interactions during which instructors helped and/or expressed approval. In area C, students looked rather uninvolved, although they were right next to the TV monitors but far from the really interactive areas (A, B). In fact the interactive zone was delimited by the instructors’ proximity, reinforced by the technical device.

The distance communication device itself induced quick shifts in paradigm, from a knowledge delivery process to something like a TV game show. This occurred when the group located in area A decided to transmit a question. Out of those who conceived the question to be read on the microphone, some participants mainly focused on its possible acceptance by the panel. When the question was transmitted by microphone to the control room, an increasing attentional peak in the entire group could be observed. If accepted, i.e., read again aloud on the TV screen because it was broadcast everywhere, attention was at peak. Immediately after, common stress decreased quickly and very few students, apart from this one who asked the question, heard the experts’ answers.

Such shifts of attitudes suggest that two models are conflicting in this process:

- a traditional model of teaching, in which a teacher delivers a continuous flow of notions and organizes an exchange of questions and answers – this model allows flexible time, since it is managed by the teacher himself; and
- the mass media model, where attention is focused on events, whatever their contents. Unlike the TV model of time (cf. Blum before), the flow is here discontinuous. It is rather a string of changes and breaks, regulated by a rigid technical inner timer. Stu-

dents realize, just like TV viewers, that there is no place to negotiate time allowance.

According to their schooling habits, students disliked interrupting the continuous flow of educational speech. Some courses were given without videoconferences, but a video recorder was at disposal and tutors showed videotapes. Teachers asked many times to stop and to rewind to have another look at interesting sequences. Students clearly resisted this proposal. The hypothesis suggested is that students tried to avoid such changes and preferred a continuous flow, to which they are habituated from their life at school.

Although they didn't clearly perceive this conflict, students tried to manage and to balance these two models, which explains, for instance, that they were reluctant to interrupt a sequence on a videotape.

### Some features of a contextual model

Referring to Block (1990), the following features of time management behavior were present here: information processing strategies and levels of processing.

#### *Information processing strategies*

Strategy implies abilities and procedures. The following specific and slightly deviating abilities have been observed:

- taking notes when simultaneously watching at the screen: such an ability is not required to watch TV;
- asking information of neighbors: the school model forbids such an interpersonal communication; and
- making comments *mezzo voce*: the school model represses that.

Some procedures suggest a complex strategy. One student had erratic behavior. Observing how other students were following the videoconferences, he took notes and had private conversations. His understanding of English was rather poor, but he asked his neighbors questions from time to time. His comments showed that he had reached the right level, through a meta-communication analysis.

We can assume that one of the aims of strategy is to gain time. For beginners, such as in the

present case, to participate in a videoconference appears as a very complex task (see Zakay, 1990) and generates a strong cognitive load. Some students tried to reduce this load so that they could manage rigid time intervals better. The first videoconference let them get an idea of how to manage usable time, even if this idea was still rather vague. The hypothesis is that this initial idea was based on personal experience, taking into account: 1) frequent changes occurring during the TV session, and 2) rigid time intervals of unequal lengths (Poynter, 1989). Let us remember the definition of time by Fraisse (1984) including succession and duration, defined as an interval between two successive events. The suggested hypothesis is that students perceive the allocated time as reduced by the communication device, because of its irregularity and their consequent difficulties anticipating. In such circumstances, the aim of their attempts then would be to let it drag.

#### *Levels of processing*

In a bottom-up view, from students to studio set, a participant at a videoconference, be he an instructor or a student, is concerned with several levels of processing:

The first level relates to the educational message, which implies:

- Identifying each type of sequence: information, dialogue at distance with disseminated groups, exchanges between panel experts vs. dialog between experts and panel students. Some students were unable to distinguish panel students from experts, because of a foreign language and also because of a mass media stereotype like "if somebody is on the panel, then he is an expert."
- Understanding information provided and distinguishing it from comments. That is all the more difficult, since experts themselves frequently mix the two kinds of messages. For instance, an expert presented two conceptions of the concept of ecology, one being "natural," the other being "cultural," without explaining that this opposition came from his personal opinion.

A second level concerns the global structure of the communication device. Identifying that level implies understanding the protocol and building an inner spatial representation of the whole communication system. At the beginning

of the session, a geographical map on the screen pointed the reception sites. During the first broadcast, the site of Poitiers was left out. This failure was strongly criticized by participants and generated misunderstandings of the whole system. Many students spent time asking others why Poitiers was not indicated. During this time interval, the interactive situation had moved along, and some students no longer had spatial benchmarks to situate themselves in the temporal process.

As a matter of fact the videoconference channel implies three constraints:

- it is impossible for a speaking expert to adapt his speech to viewers, because he cannot observe their reactions, he receives only their voices via telephone;
- viewers do not have the opportunity to interrupt the speaker to get immediate necessary explanations (visiophoning does not have such filters of communication); and
- each student eventually has to interact with others to understand information correctly. This implies that each participant clearly identifies how each of his neighbors can help him: dialogues, translation of a word, etc.

A student involved in such a videoconference has to manage much more levels of information than in a traditional course. He has to 1) build up a representation of the whole “virtual” communication system, 2) identify protocol, actors and types of messages, 3) perform that under more drastic constraints than in a traditional classroom.

The suggested hypothesis is that he performs that better if he has abilities for:

- multilevel analysis: Multilevel analysis ability helps him both to identify the whole videoconference system and the locations of the students groups inside of it;
- parallel processing: This ability enables him to do two things at the same time, for instance to help prepare a question, taking into account the previous ones from other universities. More simply, this ability also allows him to take notes when watching a screen; and
- group work: As a matter of fact, a communication system based on new technologies for information and communication is very complex and requires many abilities at the same time under drastic time constraints. Those students interacting inside a group

share the cognitive load imposed by the communication device that way. A significant potential interest of such devices as interactive videoconferences lies precisely in the opportunity for people to learn in a collective way.

## Discussion

A first limit of this analysis lies in the fact that it does not take into account the semiotic factors and meaning procedures. It is highly probable that some sets of information, and/or some keywords are the cue to predictive semantic analyses of speech which help to gain time and to better isolate essentials of the broadcast message (semiotic cut). In further studies such interactions should be explored.

A second limit lies in the fact that this kind of modeling considers only one-to-one interactions between experts and students. It nevertheless offers significant help: the notions inherent to the three approaches: memory, attention, contingency, worked out by Block, Poynter, Zakai appear as relevant analytic tools to isolate significant features in time evaluation and time management. Concerning media devices, the notion of an inner timer appears very fruitful. Referring to the students, relationships between strategies, abilities, procedures, and time management seem to be consistent and need further exploration.

To build up a model of time management during a synchronous learning process could be undertaken. An interactive videoconference device has its proper inner timer. At first glance, such a timer appears to beat units resulting from a compromise between broadcasting constraints (limited time, storyboard, etc.) and educational ones (experts’ and instructors’ speeches). This timer splits the allowed time into intervals of various sizes according to the type of action: expert speeches, interactions between the studio set and groups at distance, etc.

Management of time plays an important role in interactions between broadcasting site and groups of students, stressed by a general feeling of frustration due to lack of time. The time management strategies of the students appear to focus on two targets:

- to maintain the information flow coming from expert or instructors as even as possible; and

- to iteratively evaluate gaps between time anticipations and effective time for learning interactions. Experience should probably help students to anticipate better. In the same way they would acquire new abilities and elaborate new strategies for a better resistance to the time compression inherent in the communication channel. As a matter of fact students are living the conflict between the two models. Such an issue leads to consider how interactive devices could better take time evaluation and time management into account.

The temporal structure of interactive videoconferences appears as a twofold social construct: one facet depends on the broadcasting site, the other on viewers. The interval unit of time experiences for users, instructors, and students depends on multiple factors: a technical timer included in the device, the strategy of the moderator, representations, the procedures and abilities of the students. It also depends on how many groups actively participate, i.e., ask questions, in comparison to the total duration of the session. This involvement depends in turn on the competence of experts and on how they arouse interest. The ongoing learning process includes identification of changes, evaluation of time intervals and regulation attempts, for instance resistance to time dragging.

Some features of this construct are those listed by John Michon, as seen before: planning of future acts, such as preparing a question, temporal structure of speech, which plays an essential role in identifying temporal structures, for instance, frustration feeling. Other important features are abilities, procedures, and socio-cognitive interactions. Concerning this last issue, Michèle Grossen & Luc-Olivier Pochon (1994, 1995) are exploring the concept of "space of interaction." Future studies should focus on the temporal dimension of it. The hypothesis is that the temporal structure can be defined as an adaptative process developed by individuals and groups, through which they attempt to adapt their behavior to their present environment (Michon, 1990).

## Conclusion

This provisional analysis suggests a hypothetical notion of a temporal micro-universe to be tested

in situations where humans are faced with technical timers while functioning in an interactive mode. The concept of space of interaction by Grossen and Pochon is very close to this. The notion of a micro-world had been proposed years ago by Marvin Minsky and Seymour Papert, but without insisting on its temporal component. For that reason, the term "micro-universe" is here preferred.

This hypothetical notion should be applied and explored in various situations in which humans build up social units of time, when faced with specific technical timers. Examples are to be found in communication applications, such as telephone calls or conferences via visiophony (Misseri & Fualdes, 1996); also in other fields like highways, for instance, where drivers have to maintain a correct distance from the car ahead and to respect speed limits. In such a situation, the local time unit strongly depends on multiple factors such as the ones listed before.

Regarding the use of interactive media for education, problems of time evaluation and time management must be considered when elaborating devices and methodology. This study merely constitutes a snapshot at a given date of an innovative educational process. It is highly probable that instructors and students will quickly learn to manage time better when using such communication devices. Nevertheless, students who do not prove to have the ability to attune themselves to the present constraints of information and communication technologies may very well face an increased risk of problems at school, including simply dropping out.

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# Learning in Adulthood

Pierre Dominicé

Being intellectually recognized by scientific criteria remains the greatest problem of scholars in the academic arena. The field of learning, for years, has been considered as applied scientific territory occupied by psychologists. Piaget has been a pioneer who has inspired a school of thought with a strong trend in the psychology of education. He remains a father figure who has opened a wide range of important epistemological clues related to learning. His contribution is central for any researcher in this area. Even in the domain of adult learning, which is quite new scientifically speaking, Piaget has influenced the way theoretical questions about adult learning difficulties, raised during the sixties in the mine-field of eastern France, have been solved. Workers used to their manual labor had reasoning difficulties as they returned to the classroom to follow programs of continuing education organized for them to combat unemployment. The workshops taking place today, under the title of “logical reasoning” are for those adults who have a low level of education derived from this decade. The concept of “explicitation” taking place in an interview as it has been developed by P. Vermersch (1995) is an example of a methodology inspired by a Piagetian frame of reference. I, myself, do not belong to what could be called the Piagetian school, but the contribution of Piaget has been central for me as a student and remains a very important frame of reference. As an outsider I share the point of view of Robert Kegan (1982), who recognizes his debt in *The Unrecognized Genius of Jean Piaget*, without identifying himself as a Piagetian.

Adult learning, as a new field of research, has been organized around the problems raised by adult learning difficulties in the context of continuing education. The generalization of continuing education for adults at work has considerably extended the domain of formal learning. Having diplomas or improving a curriculum vitae by adding new qualifications or diplomas has become an obligation for adults who want to

keep an unstable job or look for a better position. Teaching adults, offering guidance to adults, and tutoring adults are new tasks that require new professional qualifications. Adult learning, its characteristics and processes has become an important topic in most training programs for adult educators. However, the newness and the complexity of the questions raised by the ways of learning of adults makes me very cautious about any kind of quick conclusion “sold” as instrumental learning to adult educators. Instead of prescribing how to act with adults in a class or a workshop, I prefer to offer a frame of reference that might help adult educators become, as D. Schön has brought forward, reflective practitioners. A pedagogical statement becomes relevant when an educator is able to translate it in his or her own terms. A pedagogical application coming out of a scientific framework has no meaning unless the specific characteristics of a particular program are taken into account. Ideas about adult learning only make sense to adult educators if they can relate these ideas to their own experience.

Adult education has become part of a market. Selling good products and efficient programs is what seems to matter the most today. Theoretical statements are often taken by educators as an abstract way of looking at pedagogical issues. Educators are mostly expecting tools for action and simple answers to their questions. Researchers at the University, if they want their views to have an impact on educational practice, should introduce frames of reference which could help adult educators have their own way of thinking. Presenting challenging questions regarding their practice is, for example, a way to facilitate educators’ thinking. In the light of what I have said, I will now offer three areas of reflection coming out of my experience in the field of adult education, first as a researcher, secondly as a teacher, thirdly as a consultant in the field of University continuing education. I will first present ideas coming out of more than ten years of research done with a biographical approach inspired by

the methodology of life history. I would then like to reflect, as a practitioner of adult education, on the challenge faced by a new generation of learners. Finally, I will consider the present situation of continuing education in a critical perspective. Time will be the common theme that will bind together these ideas. Time will also be understood as a key question for a better understanding of the mind of adult learners.

### The biographical process of adult learning

For adults, learning is a construction. The sources of learning are interconnected in an adult's life. Adults learn according to what they have learned before. Their way of thinking is the result of previous stages of learning. There is a process of learning that takes its own form through a diversity of relationships, life events, and experiences attached to infancy, as well as school years and professional life. In their biographical narratives, school history is always described in great detail. Adults remember the time they spent mastering formal learning. They also recognize how little remains from their school years. They remember their teachers, their friends, and their social behavior as they were disturbing the class, cheating in an exam or missing a class for no reason. In their education biographies, they go through difficult memories of having had bad grades, facing a strict teacher, failing an exam or a diploma. For adults with little school background, the memory of bad grades and school failure could be very damaging because they often enter continuing education with a fear of failing. It is almost as if they were back at school as the same person they were ten or more years ago.

Students who have a better school background discover later through life experiences, the meaning of what they have learned at school. Research that I recently conducted shows this mechanism clearly. At first adults criticize the time they feel they have "wasted" at school. When they analyze deeper what they know, they realize how much the meaning they give to different events in their life is related to what has remained from their school years. As one student wrote in her narrative: "our life experience, our personality, our religion, our culture are not integrated into schooling and are not part of formal learning... Learning is a whole in human

life. Why is formal learning divided into compartments, into drawers? How can one learn or acquire knowledge if the learner's understanding is not taken into consideration?" Looking at her school years, this woman is absolutely right. As life goes on, however the system begins to work. Experience tends to put the pieces together. In the research mentioned above, for the adult learners involved it became obvious that the existential dimension of learning tends to reconcile formal and experiential learning.

The educational biographies that I have introduced in my own teaching at the University of Geneva (Dominicé, 1990, 2000), and different biographical approaches I have explored with adults, made me aware of the complexity of adult learning processes. Adults have built their ways of learning according to the different paths of their lives. Telling their narratives helps them realize how they have learned what they really know. They become conscious of the type of learning made outside of school and the training curricula. They discover how much their learning is due to personal and emotional investment. Considering the books and articles I have published about educational biography, I will not describe here the biographical methodology I follow, but I will present my research as part of a trend of thought in the world of adult learning theories.

Many different approaches converge on the developmental view of learning. Considering the adult way of thinking as the result of a process puts learning on the side of constructivism. Knowledge of the different stages or phases of life contributes to the way adults think. In one of his last books, J. Mezirow (1991) analyzes adult learning through its transformative dimensions. "The formative learning of childhood becomes transformative learning in adulthood" (p.3). Mezirow identifies meaning schemes and structures through which experiences take the form of learning. We know, within the context of meaning and perspective the learning process is influenced by the presuppositions, the codes and the culture of the learner, who might go through a process of change and reach a "perspective transformation." This type of understanding of adult learning is close to other "metacognitive" views. The question of "cognitive educability" has often been raised with adults who had to face learning difficulties, sometimes related to mastering today's advanced technology. How an

adult is able to follow a self-directed learning process or how an adult is able to be open to a new work culture is also often discussed among adult educators. Learning, for many adults, implies change and involves therefore, resistance and fear based on previous experiences. Learning takes time because it requires acceptance of necessary transitions before abandoning the security of the past and jumping into the unknown, even if the past has kept a painful memory.

Time to learn is also related to the social dimensions of personal history. As B. Charlot, E. Bautier and J.Y. Rochex (1993) have clearly underlined in their research, there is a cultural relationship to school knowledge for students. Students are not primarily motivated on the basis of their own interests. They invest in school learning with the cultural support of their social background. The same is true for adults. They have a representation of knowledge deeply rooted in their social origins. Their self-image is socially constructed. The way they imagine their future, the way they are willing to go beyond the obstacles of formal learning or are ready to spend time on continuing education has to do with the legacy of the culture in which they were raised. Life takes its shape finding the right distance with inherited cultural models. For many students, academic knowledge implies a social relation. In Switzerland, for example, very few women have studied for a doctoral degree and second-generation migrant workers often have difficulty feeling at ease with academic culture.

Based on Kohlberg's social psychology, the idea of social stages of development has also inspired adult learning, according to the research done at Harvard Graduate School of Education by H. Lasker and C. DeWindt. Self-directed learning also has to be understood as a process that may need time and stages of development. The ability of adults to be autonomous in their way of learning depends on the context of learning, namely where it takes place. Adults often need to adapt to norms and rules before they are able to define what and how they want to learn. They feel obliged to be informed how far they are able to conform to teachers' expectations before they feel free to be more creative. The idea of a self-directed learner has long been taken as a basic principle of andragogy. It is true that adults learn on the basis of their experiences, but it is a myth to believe that their life

experiences ensure their ability to spontaneously conduct their process of learning by themselves.

To the contrary, new programs offered over the years for the improved guidance of adults' continuing education should be understood as a sign that self-directed ability of the adult to learn has to be taken as the result of a process. When they register in a program of continuing education, adults do not necessarily know exactly what they want. They have expectations about their future, but they often dream about it. They do not realize how heavy studying for a new diploma might become. They want to repair the deficiencies of their past education. Sometimes they wish to grow in order to better face the conflicts they meet in life, but most often they do not know how. This is probably why needs assessment has become, for professionals, a common practice. Learning in adulthood requires time, time to clarify needs, time to assess previous learning, time to renew eagerness for knowledge. Adults often know more than they realize, but without guidance they might waste the time spent for their continuing education. As with younger people, adults need time to learn how to learn.

### **Learning new biographical horizons**

As the French poet Aragon has written: "le temps d'apprendre à vivre, il est déjà trop tard" (the time to learn how to live, it is already too late). Despite the fact that adults have always had to adapt to new historical contexts, the present world situation obliges them to have a different perspective about their future. Economical, and often political, crises modify projects and life careers. It is no more possible to think about one's life as a long-term process. Adults have to choose the opportunities they find. Biography has lost its chronological scheme. Emancipation from the value system of one's education does not have the same meaning for the younger generation as for my generation. Today, we urgently need to find the right resources in order to face the unknown territory of the future. As Peter Alheit puts it: "biography itself has become a learning ground where transitions must be anticipated and managed, and where identity possibly is but the result of difficult learning processes. Life courses apparently seem to become a kind of unplanned laboratory

that serves to develop capabilities which provisionally do not figure in any curriculum" (1992, p. 187/188).

This new biographical perspective sets new work assignments in terms of new qualifications. Professionals are expected to master the stress due to a more competitive lifestyle. They have to manage the interpersonal misunderstandings resulting from structural reorganizations. They must remain competent and save time whatever schedule is imposed on them for their continuing education. Social qualifications have become the first criteria for selection when many job applications offer similar "curriculum vitae" content.

On a more personal level, new learning has also become necessary for adult life, such as personal psychological balance, stable family relationships, or enriching social life. As R. Kegan has explained in his last book (1996), adults have to deal with, "the mental demands of modern life," such as parenting and partnership, work and self-expansion. We can look "at contemporary culture as a kind of "school" and the complex set of tasks and expectations placed upon us by modern life as the "curriculum" of that school" (p. 3). When R. Kegan writes about new technologies, he warns us that the experience of what is called the information highway may be one of exhaustion, if "we are unable to assert our own authority over the information" (p. 5).

The narratives of students based on their life history that I have heard and read these past years clearly reveal the importance of this mental demand. The time has therefore come to question again our school curriculum in order to underline the gap between the curriculum of modern life and most training programs preparing them for the workforce. The obvious lack of meaningful cultural references in the education leading to adulthood should be recognized. Today vocational training must include components of self-reflection. Professions centered on human relations, such as teaching, nursing, or social assistance, are not the only ones that badly need personal development. Most jobs in the tertiary sector today seem to carry the same kind of human expectation toward the employees. Self-knowledge should be regarded as part of adulthood, as a new and major task if adults want to have the capacity to meet new work requirements. Adult educators who have a Piagetian

heritage will then have to solve a new epistemological problem, as the object of knowledge will be, at the same time, the subject of the learning process!

Perhaps the concept of development itself has to be questioned since the structure of one's life seems to call for new types of stages. Life will be more fragmented. The financial instability of the economical market will perturb social projects and disturb political decisions with consequences affecting adults in their daily life. The biographies of young adults will have to be built taking into account losses and discontinuity as unavoidable phases of life. Older adults will have to go through the traumatic experience of denying references and beliefs that have become part of their biography. They will have to learn to adapt to breaking and breaching as transitional stages in their biography. The meaning of hope will shift from achieving a life project to realizing more transitory objectives. Adults facing unemployment and adults suffering from chronic diseases had to learn to live with a provisional agenda. Most adults will have to go through the same process much earlier in their life. What R. Kegan calls, the mental demands of modern life could be called, in a similar way, the cultural demands of new biographical issues.

#### **Time to learn and its political dimension**

Continuing education has been, these last years, one of the headlines among the political statements supported by politicians in Brussels and elsewhere. The concept of "life-long learning," which has emerged already at the Council of Europe during the sixties through the concept of "permanent education" or through the idea of "recurrent education" at OECD, is now invading the political discourse. Today it is officially recognized that adults should learn all their life. Adult learning will have to become a biographical process. Seminars, classes, distance learning should be offered to adults in order for them to qualify, at the international level, for more demanding jobs and at the personal level to face a more complex social life.

If I take the example of my own country, Switzerland, there are, at the federal level, no laws and, at the state level, very few statutory positions that give everyone a real opportunity to learn beyond compulsory schooling or basic

vocational training. Continuing education remains more noticeable for managers and qualified workers. An adult who wishes to improve his or her curriculum vitae has to do it at his or her own expense in terms of money and time. Needs assessment for continuing education is done on the basis of an audit or a financial analysis. Adults must submit to economic priorities and learn how to structure their life according to the organizational imperatives of an administration or company. If, during the sixties and seventies, what is called Human Resource Development took continuing education as a way to guide adults in their career, today's continuing education has become, as school used to be, a rationale for helping the selection of the most qualified. As Freire wrote in his book on the *Pedagogy of the oppressed*, education is a banking system for which investments have to be made profitable. The new methodology of evaluation that recommends the implementation of quality control is a new and subtle version of the same old social command imposed on education.

Again time is money. Learning takes time, therefore it has to be instrumented in such a way that professionals can learn quickly, "just in time." Distance learning will help adults to study at home and watch a screen during the weekend or late at night. Continuing education might then become part of the exhaustion adults feel as they reflect on the mental demands put on their daily life. In a recent piece of research done for the Swiss National Fund for Scientific Research (FNS), it became obvious that neither teacher nor learner had enough time to accomplish the program. Taking classes late in the day, following classes in-between a heavy work schedule and a demanding family does not help adults to be present to their learning activities. They go to classes and they do their homework, but very often they have to drop a program for lack of time or they do not take the necessary time to master what they have to learn. Adults with a low level of schooling, training, and qualifications, even if they find continuing education programs adapted to their needs, fail to find the time to learn correctly. They develop tactics of learning and cut the program short with, as their only goal, the desire to obtain the diploma in order to make their vocational life more stable. The encounters and interviews we have conducted and analyzed during the research with

adult learners helped us understand the price they were paying for their lifelong learning choice, "to go back to school" (Dominicé et al., 1998). When adults decide to register in a program of continuing education, they often, paradoxically, lose the time to learn anything but the prescribed content of formal knowledge and techniques.

It is therefore hard to believe that adults will find the time to learn at a more personal level to better understand who they are and how to relate more closely or adequately with their partner, family, and friends. Many adults have a breakdown, fall ill, or lose their jobs before they are able to take care of themselves or find ways for others to help them take care of their life. For example, I have observed in programs of patient education that diabetics are often not responding to preventive advice because they do not believe they have to be careful and protect themselves against accidents that could badly injure them. Learning to repair seems easier than preventing learning. It comes after a problem arises, after a divorce, after a heart attack, after helping a child who has suffered psychologically or has become a drug addict. In addition to considering the cost involved for adults themselves as well as the insurance companies or the state budget, the time has perhaps come to question the goal of education. Such a basic question might make sense at a time when many adults seek social renewal of our value system.

Innovation always comes from small groups of committed people who believe that what they do is worth the time and energy. However, political support becomes essential for any enlargement of an innovation. Unless political decision makers enter the scene of adult education, there will be no real opportunity for adults to transform their biography into a learning process. If I take the adult students I am now teaching at the University of Geneva and who are primarily teaching, as adult educators, for example in the field of nursing, foreign languages, social work or different topics related to vocational training, they have quite often undergone group dynamics, personal therapy, and a variety of courses and seminars centered on interpersonal relations, conflict management or career guidance and portfolios for adults. They come with a culture of learning which includes personal implication, listening to others and interpretation of texts. They have discovered the complexity of

any solution. Whilst they tend to put academic knowledge at a high level, they rapidly understand that *scientific knowledge will not necessarily provide the right answer to any theoretical question that might arise*. They understand that much of learning comes from the learner herself or himself. What I experience with adult students is not at all the case elsewhere. The culture of learning remains, for most adults, the school culture of norms and rules.

The adult's way of learning claims the mediation of others – counselor, teacher, instructor. Most adults need help as they start a program and during the program as well as after the program at the time of the follow up. Accompanying adults has become a necessary part of adult learning. Adults educate themselves but they do it with or through others. As they return to studying, adults look for self-confidence. They need the support of others to establish one's authority upon their self-directed learning. It might take time or it might come rapidly. All will depend on their learning style based on previous training and past experiences. At a time of budget cutting there is not much hope for the development of such new professions in the field of adult education. This is why political decisions *have to be made in order to translate continuing education into political priorities*.

### Culture as new area for lifelong learning

The field of continuing education has been reduced, particularly during the last decade, to the world of work. Better qualifications, mastering advanced technology, and a new organization of labor are the main topics. The will to attain such objectives have led governments and the management of private enterprises to set aside budgets for an enlargement of the programs offered for professional, continuing education. The high rate of unemployment and the difficulty for young people to find a stable occupation has modified the place taken by a career in an adult's life as well as the definition of work. As P. Alheit writes: "the social institution of life course organized as it is around employment history, is becoming increasingly diffuse." As an example he mentions: "as recently as 1940, the average American adult spent only 7% of his life time in retirement. At the end of the 70s, the figure was 25%" (Alheit, 1995, p. 57). This transformation

of the definition of work, as well as other biographical changes, explains why it has become *urgent to enlarge the purpose of continuing education to new areas of life and to a broader perspective of adulthood*. I will briefly describe three directions where adult education should regain its ground.

As I said the complexity of life is an agenda in itself. "Biographies are becoming more complicated, more individual, less "normal," but at the same time more colorful, autonomous, and self-willed" (idem, p. 59). With R. Kegan, I believe the "mental demands of modern life" require that we set aside time for learning how to live one's adulthood. Because of what happen during a lifetime and the crisis one experiences, adults badly need cultural resources capable of helping them accept these experiences and give meaning to them. The wondering of everyday life calls for emotional sources of energy and hope. The lack of community or collective project, aside from partnerships or family relations leads many isolated adults to a state of despair. Churches, political organizations, associations of various kinds do not play the educative role previously held for many generations of adults. There is, today, a kind of cultural vacuum around the adult's "Lebenswelt" (world of daily life). Mass cultural production, such as media, music, and movies help adults to be busy and to have their leisure time, but it does not provide much support for everyday life. These issues should be taken seriously as they justify the call for a renewal of adult education.

The gap between generations used to induce conflict. This was the case for my generation. We are now facing a silence gap. Different generations share public life spaces such as public transportation or department stores, but do not speak to each other. However, the dialogue between generations might become a clue to discovering cultural resources. Young people have been raised according to the values of an older generation. They need to clarify, as they become adults, what they reject and to what they give meaning. They have to assess their own values and their own cultural world by confronting their view with those of previous generations. The question of the meaning of possible roots, whether there is a lack of roots or, on the contrary, too much cultural command from the past, is present in the mind of a lot of adults. Many adults do not know how to identify with their

cultural heritage. My generation rejected the cultural models and norms on which they were educated. On the contrary, young people are often, today, looking for limits and rules. This antagonism between generations could be the sign that education should not only be understood as the task of parents or educators who have to raise young children and teenagers, but education biography should be considered as a task which has to be shared by adults of different ages and should be carried out in a dialogue between generations.

My last word comes with some open questions. What are we expecting from virtual learning? What are we going to do with the resources of such new technologies as Internet? Will adults learn quicker because they will have to learn more? Should we learn an international language in order to communicate at a world level? Will some adults feel too old to learn or will they have a difficult time adapting to new forms of learning? Will adults remain young enough to be open to understanding what has to be learned in a changing society? What has been learned in the past, what will remain meaningful? The challenge is great, difficult but fascinating. It seems that learning in adulthood will be a plural and continuing process. Adults will have to belong to different generations, keep their roots in the knowledge and culture of their education, and at the same time pursue new scientific discoveries and tools created by technology. The creative dimension of adulthood will have to be found by the right mix of cultural legacy and a fabrication of the future. This could serve as a basic concept for new horizons not only in adult education but for education in gen-

eral. Perhaps the time has come to consider adults and young people as partners in the same adventure, as co-learners belonging to two different origins of the same emerging world.

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## **Part VI.**

# **Pluritemporality of Humans and Their Artefacts**



# Trains of Thought

## The Fifth Dimension of Time and its Fabrication<sup>1</sup>

Bruno Latour

### Prologue

“It’s sunny, this morning on the Neuchâtel lake, and windy and cold. What’s that bright little shape out there? Ah, a sailboard out there in the wind. It’s moving fast. How fast? I could use the lampposts along the quay to tick the time it takes him to pass behind each of them. With a good Swiss chronometer, a knowledge of how far the sailboard is from the land, an evaluation of the angle of its course – not an easy task given the erratic moves of the board – I could end up with a speed, that is a ratio of distance over time. Of course I really couldn’t because I’m pretty bad at calculating, even worse than at sailboarding. I can only play the observer on the edge. Oops, here he is in the water! There he is again, back on the board, on a different tack, even faster along the waves now crested with the white foam triggered by the fiercer swerving wind. Now that he is closer to me, I see a broad smile on his face. The surfboarder seems to enjoy himself immensely. He does not see time passing by. Strange to try to measure time while strolling along the lake, during the break of a meeting on Piaget. Even stranger to play the outside observer. Of course, I could calculate the surfboard trajectory, and obtain a ratio, a form, a speed, something that would neither be in time, nor in space. A timeless number. I too could reach, from the safe and solid ground of that most sturdy and stolid Swiss city, the sure grasp of a formalism. But then, would something be missing? What, what exactly would be missing? No hurry here. Take your time. The meeting is full of psychologists, of phenomenologists. They

talk about “lived” time. Careful. They have an axe to grind. They want to criticize scientific time, the atemporal and atypical coordinates of what they call science. (Here he has fallen again, brought down by a sudden gust! Here he is again, darting away now.) Is the surfboarder moving like an arrow in “lived” time and space? Unlikely. “Lived,” one of these empty words that have no opposite, and are given a semblance of profundity because they appear to attack the cold and timeless and spaceless apparatus of dead reason. If I had managed to calculate the speed of that darting sailboarder, in what way would I have abandoned the “lived” world of this sunny day in Neuchâtel? I would have needed a watch, and a benchmark, and posts, and rulers, and a staff of helpers, and theodolites, the whole equipment and crew that Ed Hutchins describes so well when he shows the number of operations necessary to steer a dreadnought into San Diego harbor (Hutchins 1995). In what sense are these operations not “lived”? And yet, in the end I would have obtained a speed, that is a timeless spaceless figure, a form, a ratio, on a piece of paper, held in my hand, inside my world, along the beach, under the sun, on the campus. So then, at no point would I have left the world. I would have added to the Neuchâtel lake another piece, another feature, an observer setting up apparatuses to calculate surfboard speeds. But then the surfboarder (now barely a spot on the horizon) is not adding “fun” to the calculated speed. He is not adding the “lived” feeling of a sunny morning, to the accurate definition of a timeless and spaceless instant and place. Why are all these psycholo-

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gists comparing the “lived” time to the “real” time, the “subjective” time to the “objective” time? My calculation of speed, I mean my apparatus, my institution to extract speed from the surfer, is inside the world where he sails fast, and is not the depth feature on which his own psychological world would be built. How could I be so arrogant as to imagine that my calculation defines the primary quality of everything else? How could I be so forgetful of watches, and staff, and poles, and rulers, and crews, and compasses, and serious Swiss helpers? Especially here, just a few hours after having visited the Museum of Time in La Chaux-de-Fonds? No, the watch is not the depth feature of the horizon, but is added to the world, and so is this tenacious and ingenuous industry cuddled in its mountain valleys, bringing so much wealth to this doll-house university. But then, if I am right, in what sort of world is the surfer moving? (Now, his dark speck and triangular wing are growing fast again straight towards me.) No, no, he is not in a human, subjective, psychological, mental time-space. I want no part in this painting job, where the “lived” world adds false but warm colors to a real but bleak reality made of measurements. (He is still grinning, going fast towards the beach as if he wanted to skateboard onto the campus green straight from the lake, enjoying himself immensely. At the last second, he briskly veers away and he is gone again). Enjoyment. That is the space-time in which he resides and moves. He is no more moving in space than he is in time. He is not adding a subjective morning to real mornings. Subjective lakes to real lakes. He explores the multiplicity of ways of being, he goes from some to many, from boring to alert ones, from a little wind to a fierce gale, from a low intensity to a higher intensity. Yes, that’s it, he is moving into enjoyment, intensity, ways of being, alterations, and if I want to calculate his speed, I can, but I won’t define the depth of his world, the backdrop of all existence, I will simply add a color to the many colors there are already, maybe a grey, a dark color, but still a color. And thus, and thus, my dear psychologist colleagues, there is no need to turn towards the mind, or to subjectivity to escape from the cold and objective time to find the rich “lived” world of meaning. To find richness, one only has to turn towards the world itself, to the wind, the foam, the sun, the snow-capped mountains in the

back, the earnest miniature city behind the harbor. “Objective” time and “subjective” time are like taxes exacted on what peoples the world, they are not all that these multitudes do and see and mean and want. We are not forced to choose forever between losing the feeling of time or the structural features of the world. Processes are no more in time than in space. Process is a third term, as if the surfing were moving into ways of being, exploring its alterity, its alterations. A third term! My poor fellow, are you growing tired of always trying out third terms, only to hear your audience object: “Yes, but time is not a mere social construction?” Who said so? Not me anyway, but nobody listens. Their love-hate affair with science has blinded them to any other possibility. If it is not objective, then it is subjective. If it is not subjective, then it is objective. Chances are that if they understood that I am not a social constructivist, they would recoil in horror: “But this is abject metaphysics!” Well, too bad, I’m afraid it is. (The surfer is back now, folding his equipment, packing it up, seems happy). Time to resume the session and hear more about the many differences between the “lived” notion of time and “real” time ...”

### The paradox of the twin travelers

To meet together in order to celebrate Jean Piaget’s centenary, we need some *measure* of time – for instance, his birth certificate as recorded by the well-organized Neuchâtel bureaucracy, the computing of days and months calculated by the Annals of astronomers and various Bureaus of Longitudes, and we also have to rely on a venerable Western tradition that stresses anniversaries and prefers nice round numbers like 100 or 1,000 to more exotic ones like 88 or 133 or 666, and that puts special emphasis on someone’s birthplace instead of, for instance, the city where his books were first published or from which his first grant was awarded... Simply to gather at the right time, 1996, and at the right place, Neuchâtel, it is already clear that we need maps, institutions, recording devices, and traditions of ritual.

If I remind the audience of these trifling details, it is not to be impolite and criticize the title of this symposium – Mind and Time – just when it begins, but to stress in this paper that “time” is not something that is in the “mind” or that is

“thought” by a mind, but something rooted in a long material and technical practice of record keeping, itself merged into institutions and local histories. In philosophical discussions about time, the work of inscription and the fabrication of times – in the plural – is all too often forgotten. To recover time we need to delve into the machinery of measuring it, for which Neuchâtel and its region are known the world over. The amusing paradox of our international conference is to have chosen, in honor of the local hero, a theme – the measurement, recording, and fabrication of times – which is well known to the Swiss economy but which Piaget did his utmost to ignore, even to repress, during all his scholarly life. “How the fabrication of time *never* entered Piaget’s *mind*” could be the title of my somewhat embarrassed eulogy... I will not talk as a specialist on Piaget which, of course, I am not, but as a philosopher of science interested in understanding why close attention to the practice of fabricating time and space in science and technology has not done more to renew the philosophy of time. Piaget, in this respect, stands as having launched the most forceful intellectual enterprise of the century to ignore the fabrication of time and its consequences on philosophy.

In the first part of my paper, I simply want to set up what I will call the paradox of the twin travelers and draw a few lessons from these little thought experiments to open a third avenue between subjective and objective time. In the second part, I want to use some results from science and technology studies to see the impact they could have on the machinery of space and time formation. Finally, at the end, I want to interrogate the link between formalism and timelessness and imagine some of the reasons that could have led Piaget to insist so much on forms.

Imagine two twins. The first voyager sets off in a deep jungle and cuts her way with a hatchet along a trail which is barely visible. Each minute, she opens a few centimeters of a pathway, but she ages more than one minute. She sweats. Her body bears the traces of her efforts; each meter can be read in the bloody scars made by thorns and ferns. The path gets cut as she goes along, but she is lacerated as well. A suffering body strives among other suffering bodies, vines, grass, and woods. She will no doubt remember all her life every minute of this excruciating trip across the jungle. The reason she will remember it is that each centimeter has been

won over through a complicated “negotiation” with other entities – branches, snakes, sticks – that were going in other directions and had other ends and goals.

See by comparison how comfortable is the other traveler, her twin brother, who came to this conference, for instance, like me, by TGV! He sat quietly in his first-class air-conditioned carriage and read his newspaper, paying no attention to the number of places crossed by the speedy train which all looked to him like landscapes projected on a movie screen. He did not age more than the three hours of the trip. His body does not bear any trace of the voyage, except for a few wrinkles on his trousers and maybe a few cramps because he did not stretch his long legs often enough. He will not remember anything except having boarded the train instead of coming by plane. Only the articles he read in the newspaper might be briefly recalled. The trip for him was like nothing. All the atoms of steel, all the electrons, all the gates, all the switches, all of the efforts of the train companies, SNCF and CFF, were *aligned* in the *same* direction, going fast through space in time obeying to the millisecond the world-famous Swiss exactitude and the almost as famous French TGV quality of service. No negotiation along the way, no event, hence no memory of anything to mention. “An uneventful trip,” as he says to his friend when alighting from the train.

Why am I comparing these two twins and the way they age? Because I want to direct our attention to a phenomenon that is logically *prior* to the fabrication of times, and that consists in a relation between *transportation* and *transformation*.

For each move of the woman traveler she is modified and ages more than a bit, maybe to the point of losing her life. The male traveler is not modified a bit by the trip and only an anonymous bomb or, as we shall see, a strike might interrupt his smooth and speedy run. Thus, the first traveler will equate transportation (or displacement) with modification, aging, history, transformation, metamorphosis. The second will differentiate two apparently different phenomena: moving through space in time, on the one hand, and aging, living, suffering, participating in events on the other. Since the relation between transportation and transformation differs in both cases, the production of times and spaces, I want to argue, will be *entirely* different. The first voy-

ager will not differentiate space, time, and aging; we will call her indifferentiation processual. Her twin brother will see no difficulty in distinguishing what is displaced from the immutable framework *in which* it is displaced.

The separation between time and space on the one hand and entities, beings, or events on the other, is *not* a fundamental distinction, but one made by *some* travelers in some very specific and historically situated means of transportation (it is for instance hard to get this distinction in Chinese thought according to Jullien (1992)). Hence, in discussing time we may not have to pay an exclusive attention to the two main positions which have occupied modern philosophers. Time and space are not the Newtonian *sensoria* in which events occur and planets fall along ellipses. But they are not, either, the forms of our perception, the universal *a priori*s that our mind has to use in order to frame or accommodate the multiplicity of beings and entities. Far from being primitive terms, they are, on the contrary, *consequences* of the ways in which bodies relate to one another. We will thus link our meditation to the third tradition, the Leibnizian one, that considers space and time as expressing some relation between the entities themselves. But instead of one Space-Time we will generate as many spaces and times as there are types of relations. Thus, progressing along trails will not produce the same space-times as going smoothly along networks. It makes an enormous difference if those bodies are suffering bodies among other suffering bodies, or a relaxed air-conditioned executive in a bullet train.

What is this difference? Can we make it more precise? Yes, because I was wrong in the brief sketch I gave of the man's trip. In spite of his smooth voyage, something marked and shocked him, making the trip memorable for him. The train passed at 150 kilometers an hour without stopping in the very place, Culoz, where all the trains for the Alps and Switzerland used to stop a few years ago. He remembered the buffet, the decks, and the easy access it gave his family to go bathing in the Bourget Lake when he was a kid. What used to be an important *place* had become a non-existing, undifferentiated *instant* along the train path. The event here for our voyager was the very fact that nothing in this station could make this place eventful, memorable, remarkable in any one of the passengers' lives any more. They just zipped through with a strident

noise. More than that, the natives of this little town who, before, had the dignity of being able to stop the train, to board it or alight from it, now had their town cut into two halves and could not cross or stop the train anymore. Their ties across the station had earlier resembled the lianas of the first voyager, blocking the pathway, forcing the voyager to make detours, to accept delays, to wait for later trains; they now resembled more the open path left through the jungle by the woman cutting trees and lianas. This little station counted, it no longer counts. It interrupted the trip, it no longer interrupts it. It was a station, it is no longer a station. The rails, well aligned, now run in only one direction, from Paris to Geneva.

So the difference between our two voyagers comes from the *number of others* one has to take into account, and from the *nature* of those others. Are they well-aligned *intermediaries*, making no fuss and no history and lending themselves to a smooth passage, or full *mediators* defining paths and fates on their own terms? Are they more of the same – that is, intermediaries – or are they really others – that is, mediators? Timing depends on that sort of ontological difference, not on the mind's apperception. If other entities are necessary for our existence (and surprising at that), then times and spaces will proliferate. In the opposite case, times and spaces will rarefy to the point of becoming *one* time-space, or even, as we shall see at the end, no time and no space, only *forms*.

So we can now situate our twins along one dimension that takes into account the ratio of transformation over transportation or else the number of mediators compared to the number of intermediaries. But if we want to escape the usual opposition between subjective and objective time, we can go further and imagine a second dimension, so that we can obtain a richer grid to develop our discussion of time-space fabrication. To define this second dimension, we may connect our two twins' biographies in the same scenario and insist now on the *labor* necessary to reach one position from the other. Imagine, for instance, that the woman is an explorer sent by a company to explore the future path of the bullet train which is, a few years later, planned, designed, decided, built, successfully completed, and eventually used by her forgetful brother in his executive suit. Each locus, each site which, before, in the pioneering old days,

forbade or slowed down the moves of his sister, forcing her to age and suffer in order to make her way, have later been turned into well-aligned intermediaries which lend their forces, goals, wills, or ends to the path of the train coming fast from far away and darting as quickly as light. Each tree, house, hut, vine, is now cut in two by the path of the bullet train, and the train, *because of that, goes fast. Why? Because nothing interrupts it, or slows it down.* Speed crucially depends on the number of intermediaries relative to the number of mediators. The speed of the train and the uneventful trip of the passenger are entirely dependent on the complete *obedience* of the places that are traversed – and also, of course, on the smooth functioning of the train companies’ organization, running, as the saying goes, “like clockwork.”

Well, this is not exactly true, because our story can also go in the other direction. The inhabitants of the city that is cut in two by the line may decide to protest and to demonstrate by sitting on the tracks or even putting logs on the rails and setting them on fire (not in Switzerland, of course, that would be unthinkable, but let’s say on the French section!). Then what would happen? The passengers on the train would suddenly start to age. They would be stuck and blocked in this hitherto meaningless hamlet which has, because of this very revolt, become a place, a site, what we could call an event-producing *topos*. Hostages of fortune, the passengers will start to remember the trip. They will begin to feel the passage of time and to feel time going slowly or fast. They will begin to have the impression of a “lived” time and space that they didn’t feel before when the train was going fast, uneventfully. Buses will have to take them away from the station and they will lose hours because of the angry demonstrators who,

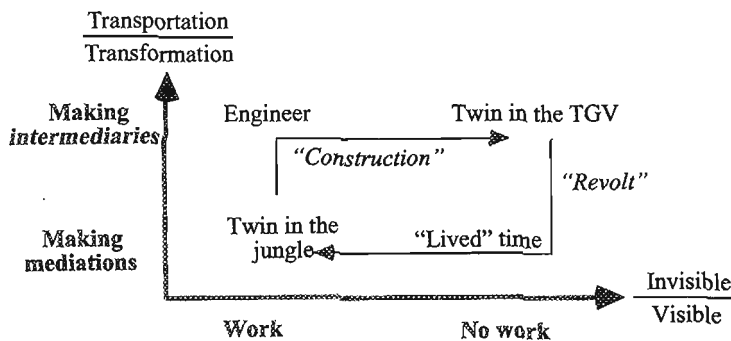
on the other hand, will have been “making history,” taking pride in their strenght, and realizing anew that they were not living in a nowhere place which one can cross at high speed as if it were simply a path leading further, but a memorable spot to be reckoned with, negotiated with. To use another cliché, angry demonstrators will be proud of having put their little village “on the map.” Let us pursue our story to its end. Imagine a revolt along all the points of the trip, at each station along the railway and then also on each of the roads taking the buses to get past the striker blockades. What would happen? Well, we would be *back* in the jungle we started with! Each centimeter would have to be negotiated and it would be impossible for anyone to go straight through without being deeply and lastingly modified. Each transportation would have to be paid for with a huge transformation, a lasting and memorable metamorphosis. (Although my story is a thought experiment, in the Amazon I have seen a former highway taken over by a jungle even more impenetrable than the original trail where Indians feared to tread).

My little story is now enriched by four situations:

- (a) the woman traveler in the jungle;
- (b) the man in his bullet train;
- (c) the progressive *passage* from a trail to a high speed railway network; and, finally,
- (d) the *reverse* passage from a network to a jungle where each move has to be discussed and won the hard way.

So we now have two dimensions to take into account in discussing space and time construction. The first one that defines the ratio of transformation over transportation, and the second one that defines the relative *visibility* of the work to be done in order to obtain a displacement. This gives us the diagram shown in Figure 1.

Figure 1



The first twin produces mediations, she sees and feels the work of transformation and is unable to differentiate space and time on the one hand, and moving bodies on the other; she does not differentiate her own suffering body from all the others through which she is slowly drugging either. The engineer is aware of the mass of work necessary to produce calculation, frames of reference, smooth transportation, but his energy is invested in making sure that the routine institutions on which these transportations depend are running "like clockwork." The second twin sees no difficulty in distinguishing a moving body from an intact frame of reference, since the work of the others has become invisible and since no transformation forces him to pay for his transportation – except, of course, the price of the ticket. For him, as for all the angelic philosophers of physics who play the role of the Queen of the Night (Stengers 1996), "time is like nothing." The passenger whose train has suddenly stopped because of the riot does not see more of the work of mediation than the Newtonian philosopher. But he feels the passage of time and the importance of space. Aware that something has gone wrong in the timelessness and spacelessness of before, he concentrates his attention on his "lived" time and space, as if this phenomenon were something psychological, human, subjective. Most of the debates in the philosophy of time will oppose the two train passengers on the vertical right of this diagram: The one for whom there is no time, and the other who harbors a subjective feeling for time. But if we alight from the train and concentrate our attention also on the institutions responsible for making sure that trains arrive on time, on the revolts where space and time are decided on the spot, and on the processes through which those institutions are built or those movements are squashed (Lolive, 1997), we should be able to add another dimension to the debates. What are the lessons that we can draw by thinking in two dimensions instead of one?

First, the distinction between subjective and objective time is only part of the story. It concerns only train passengers! In the notion of objective or scientific time, two entirely different phenomena are lumped together: the routine work of engineers inside huge institutions, and the feeling of a user who is *allowed* to completely *forget* the work of making time *because* the engineers are watching day and night over

his safe passage. Similarly, in the notion of subjective or "lived" time, two entirely different questions are confused: the surprise felt by a user when the smooth running of time machineries is interrupted, and the labor of those engaged in processes so little made routine that the difference between subjectivity and objectivity cannot even be recognized. Those who explore the intensity of multiple beings cannot be accounted for by a subjective definition of an internal state.

Second, time is not in itself a primary phenomenon. Time passes or *not* depending on the *alignment* of other entities. In a world made of intermediaries, of displacement without transformation, there is a time separated from space, an immutable frame to measure displacements and, by definition, no process. In a world made of mediations, of transportation by deformation, there are a lot of *times* and *places*. Deeper than time is the question of the obedience and disobedience of humans or non-humans.

Third, the notion of *event* cannot be differentiated into its spatial and its temporal component. If a place counts as a no-place it also counts as a non-event. Place is not a feature easier to understand than time. When a place counts as a *topos* it also counts as a *kairos*. Deeper than time and space there is another question about who or what counts. Which actants can interrupt, modify, interfere, interest which others, thus producing as many *topoi-kairoi*?

Fourth, to talk like the semioticians, there are always *three* shiftings simultaneously at work in each account: a shift in space, a shift in time, and a shift in actor or actant, the latter always forgotten in philosophical or psychological discussions. When I told you my little story of the woman traveler in the jungle, for instance, I sent you, the listener, along the three different axes at once: at another time, in another place, but also in someone else's character (Greimas & Courtès, 1979). Deeper than the question of time and space is the very act of *shifting*, delegating, sending away, translating. We should not speak of time, space, and actant but rather of temporalization, spatialization, actantialization (the words are horrible) or more elegantly, of *timing*, *spacing*, *acting*.

Fifth, and finally, the question of spacing, timing and acting should always be combined with that of their *intensity*. Is it an event or a non-event? Process is not in itself associated

with time more than space. It is not the fourth dimension, but a *fifth* dimension. We know that very well, as far as time is concerned, since we have used (at least since Husserl) the notion of “historicity” in order to differentiate it from the “simple” passage of time – measured by the watch (more of that later). But it should also be the same for space, although there is no term as widely accepted as for time. To differentiate the intensity of being in a space, a *topos-kairos*, instead of being simply located on a map, we would need a term as clearcut as historicity. When, as in the anecdote above, a no-place becomes a master place, a *chef-lieu*, a *topos*, we should be able to say that it gains “spacifcity” with an “a” – “*médiance*” as Augustin Berque has proposed (Berque, 1993), or “situatedness.” The same thing goes for the shift in actantiality. We should be able to have a word that differentiates the move from one actant to another – extensive repetition – from the modification of all the actants – intensive repetition. Unfortunately, there is no such term. Since we do not have such a triad of concepts, I would use the simple contrast of my little story between trail-making and network-following, between transportation *with* transformation and transportation *without* deformation, and will use the word intensity to trace this fifth dimension.

Writers like Bergson with his distinction between spatialization and duration, Péguy with his contrast between the history of historians and the history of events (Péguy, 1961), Whitehead with his insistence on process (Whitehead, 1929, 1978), Deleuze with his earlier work on difference and repetition (Deleuze, 1968), were obsessed by this question of the *intensity* of time in contradistinction to its *expansion*. The difficulty of using their insights to trace the fifth dimension of process is that they are engaged in a battle with what they see as a scientific definition of time and space and also because, to avoid what they see as the inherent spatialization produced by science, they always unfairly favor time over space, as if process was in any way more easily connected with the former than with the latter. What I want to do in the second part of this paper is thus to shift attention to the labor that goes into the fabrication of spaces and times – going from the right to the left of the diagram above – so that we don’t take scientific practice for the same thing as objective time and space; I also want to redress the imbalance between

space and time by using work recently done in technology studies .

### Processing time and space

If I have taken the case of a train and invented another paradox involving twin travelers, it is not only because I am a fan of the TGV, or a great admirer of the “Rätische Bahn” leading to the Nietzschean valley of the Upper Engadine, but also in honor of that most famous Swiss engineer from Zurich, Albert Einstein, obsessed by bullets, trains, and clocks. What I am going to say should be obvious to the La-Chaux-de-Fonds clock makers, to the Geneva train company managers, to the Zurich bankers: the fabrication of a certain type of space-time-actor crucially depends on our ability to *measure* intervals by relying on bodies which have the strange peculiarity of remaining *immutable* through *motion*: planets, falling stones, pendulums, bullets, scales, geometrical shapes, and, of course, trains, cars, satellites, accounts. As it has been studied by many scholars as diverse as David Landes (Landes, 1983), Otto Mayr (Mayr, 1986), Daniel Headrick (Headrick, 1988), Simon Schaffer (Schaffer, 1994), Wolfgang Schivelbusch (Schivelbusch, 1977), Eviatar Zerubavel (Zerubavel, 1985), and Geoffrey Bowker (Bowker, 1995), there is in our civilization a fixation on how best to transport something without deforming it, an infatuation for what I have called “immutable mobiles” (Latour, 1987). To the search for constants, for what can be carried around and resists deformation in spite of transportation, everything will be sacrificed, even, as in the case of Einstein’s relativity, the very definition of Euclidian space and clock-work time. Piaget, of course, shares this obsession to the point of having turned the ability to conserve constants through transportation into the very definition of intelligence and the best way to distinguish its successive stages. As we will see at the end, everything will be sacrificed by him, really *everything*, to this conservation of constants.

Instead of taking displacement without deformation as an obvious feature of what the world is like as so many philosophers of time and train passengers tend to do, I simply want now to use this rich literature on the fabrication of time and space to free the fifth dimension of time from

both its subjective and objective interpretation. How is the discussion changed when the work necessary to construct scientific facts and technical artefacts becomes visible again? The first thing to do is to elevate spacing to the same philosophical dignity as timing.

Far from being obvious common sense terms, spacing and timing are in fact quite difficult to tell apart. Through what sort of labor do we produce the difference between space and time? The question is not as trivial as it seems. For instance, the legendary wandering Jew could not distinguish the two, every spot along his way being also a date. Since he never retraces his step, never stays in the same place, never settles, never comes back, there is no meaning for him in the notion of "place" differentiable from "date" – except, of course, the City of Jerusalem that he will reach "next year." His itinerary would be made of "date-places," of a string of events. It is only because we come *back* to the same place over and over again that we generate the notion of a place, of a *topos*, that lasts and stays the same, while we have moved. The size of the castle of Chateauperron diminishes irreversibly in the distance as the wandering traveler moves away from it. It is thus as much part of time as the hour he spent walking by. It is only if the walker stops and reverses his step that the castle size reverses itself and grows again, and, then, that the voyager can conclude that this is a place and not only a date. It is in comparing the irreversibility of his aging body with the reversibility of the castle's size that there is a sense in the expression space *and* time, as in the usual definition of space as the "series of coexistences" and time as the "series of successions." "I have changed and the castle has not, thus there is a space, a somewhat longer lasting landscape inside of which I move and age," space offering the measure for time, and time the measure for space.

According to our principle above, we cannot say that the castle is *in* space since we claim that times and spaces – right side of the diagram – are generated by a certain type of work and the displacement of certain kinds of bodies that usually remain invisible. We should say that the voyager's displacement, by returning, has put the castle into space instead of time, that this type of move has, so to speak, "spaced" it. But why does the castle co-exist to the point of being there intact, two hours after the traveler has passed to the bottom of its mount? Certainly, this too has

to be accounted for. "Castles in Spain," "castles of clouds" would not have this ability. If everything changed at the same *tempo* as the wanderer, he would never be able to measure the reversibility of shape, even if he retraced his steps. He would have aged, but the castle too would be so different that he would never be sure that it is not another castle, another date-place. Even Heraclitus' proverbial river does not flow at the same speed as its embankment. This is where we encounter the importance of techniques which I will define here as a very peculiar way of *folding* times and actants of different qualities and tempos (Latour, 1994, 1996).

The castle of Chateauperron, across the foot of which the walker passed an hour ago, was renovated four years ago, was built eight centuries ago on an earth mound elevated thousand years ago, with stones generated hundreds of millions of years ago – we will leave aside for two minutes the question of the measurement of these different time scales. In other words, what makes the traveler encounter a place, a *topos*, is the connexion of actions taking place in different sites and times by various actants. The hard labor of the feudal villains hewing the huge stones and putting them into place is still present today as much as that of the ancient seas and telluric activities of the geological past, and as much as the more recent work by the courageous owner who fixed the roof and consolidated the walls – not to mention the Neanderthal cavemen who placed Chateauperron on the paleontologists' mental maps. Far from being a point in an isotropic space, the "*spacific*," "situated" site met by the traveler who comes back becomes a *connexion* of interactions dispersed in time, space, and action and reassembled, kept up, instituted in an event-producing *topos*. Because of the ancient, enormous, and continuous mass of work connecting various interactions over ages, the castle still holds, makes space, makes history, breaks the continuity of vision, bends attention, interrupts the travels of voyagers, and creates hierarchies, and thus the wanderer at its foot rightly feels that it differs from his own fast-aging flesh. He passes, and the castle does not. The castle co-exists, holds its ground, occupies space, creates a landscape, becomes a *chef-lieu*, whatever the expression, not because it is a spot "in" space, but because it is itself the event connecting interactions on a large spread of

space-time-actants. Here history was locally made and traditions continuously kept it in place. Thus, there is a place.

It might seem strange to define techniques as what connects interactions from different times, places, and actants, but this is a consequence of our attention to delegation and shifting. Let us take the very simple example of the mouse trap *I set up against the many mice that live in my house at the foot of the Chatelperron castle*. It took ten minutes for Korean housewives to make them last year in their sweatshops, a minute for the import/export trade company to order them by fax, three months to carry them in a container across the Far East trade routes. It took me a few minutes and a few francs to buy them at the local hardware shop last week; I am presently hooking a portion of Swiss cheese on the nail and, cautiously, setting the spring, making sure it is not my finger that gets snapped by the miniature guillotine... Tonight, the kinetic energy of the spring set in place by my cautious action will be swiftly unleashed in my absence as soon as a gourmet mouse starts sniffing the succulent Swiss cheese. How many actors present at once? Korean workers, French traders, wood from the mountain, cheese from the Alps, my action from yesterday delegated to the spring in this oldest of techniques, the trap. More primitive, more basic than a point in an isotopic space, is this subtle weaving together of interactions from many places, times, and types of material: the week-old mouse body, the month-old cheese, the age-old trap, *the five-year-old wood, the night-old action of the exasperated kitchen owner*, all of them contributing to this very humble *topos-kairos*, to an event-producing spot – and it is certainly an event for the mouse who will meet its death, hopefully, tonight ...

We never encounter time and space, but a multiplicity of interactions with actants having their own timing, spacing, goals, means, and ends. Nothing in the mind, nothing, but a lot in the know-how of those who, by clever technical action, can weave together types of actants that were incommensurable a minute before. What could be farther away than Korean sweatshops and Swiss cheese? Yet they are now connected by the shortcut of the mouse trap. Long before we talk of space and time, it is these sorts of connections, short-circuits, translations, associations, and mediations that we encounter daily.

But how do we register these many differences in timings and relative resistance? Through the various *instruments* invented by many scientific disciplines – in the largest sense of the word – to record and document them, and this is where we have to shift from technology studies to science studies. In what may be the most unfair account of science given by any philosopher, Bergson criticized scientists for being unable to pay attention to duration, to “*la durée*,” because, according to him, scientists always turn it into meaningless and timeless spatial delineations. Bergson would have addressed the theme of this conference – Mind and Time – in a much less polite way than I, since for him there is one thing the mind can never think of, and that is time. Extravagant claim, since scientists are the ones who made it possible to speak of the “*longue durée*,” of the eons of biology and geology out of which the very same Bergson made his “creative evolution.” Without Linnaeus, without Cuvier, without Lamarck, without Darwin, there would be no long history of life for Bergson to pit against the obsession with geometry and space. The very idea of an evolution unfolding over billions of years emerges out of no other site than the natural history museums and the collections of geologists. What Bergson puts aside when he makes the vain opposition between the warm and rich duration of time and the poor and cold spatialization of mind is the work of registering differences, the work of the clever scientists, another labor which philosophers have ignored as much as that of the able engineers.

Let me take a contemporary of Einstein and Bergson who has the advantage of being one of these clever scientists inventing traps, not for mice but for time, and who has the distinct advantage (for me) of being a compatriot from Beaune. When Etienne-Jules Marey invented his photographic gun to visualize at last the precise motions of doves in flight, it was certainly not to “geometrize” the passage of time (Dagognet, 1992). It was to produce time *as much* as space. More exactly, it was to produce something entirely different from both which we can call *synopticity*. In the same way as an attention to technical know-how completely subverts the definition of a time and of a space, since it wreaks havoc on interactions by creating events and topoi, an attention to synopticity, to what can be seen at once by the gaze of a scientist, completely redistributes the ability of the mind

of the scientists to know, to see, to imagine, to think anything at all (Lynch & Woolgar, 1990).

What is important about Marey looking at the successive images of the dove in flight impressed on the circular silver-coated plate is not, in spite of Bergson's condemnation, that he has lost the passage of duration, since it is precisely to lose it that he went to great pains to invent his photographic gun! If anything, he was utterly fed up with "*durée*," with uncontrollable, invisible fuzzy patterns of doves flying in the air without being seizable, fixable, catchable. (This is why, by the way, he never invented the movie camera, to the great shame of my Burgundian compatriots; what Marey wanted was to invent the *anti*-movie camera! Something that would turn movement into a succession of images synoptically and not successively visible).

The flying dove did not live "in time" before being killed by the gun "in space." The photographic gun does *not* kill, that's the trick. What is important for Marey is that the events of the flying dove occur now many times, there, in the beautiful summer sky, but also, hundreds of times at will, down there in the *Station physiologique* of the Collège de France. Marey is not losing the lived and rich *durée* of the dove for the poor and cold geometry of the dove. On the contrary, he is *adding* to the flight of the dove, something never observed by anyone on earth before, the enrapturing contemplation of the successive motions transformed, on the plate, into coexisting shapes. He has not "degraded" time into space as Heidegger would say; the leap is much more innovative and daring than that: the few flash seconds of the dove's flight have been transformed into an ever-lasting silver photograph that can be contemplated for hours and quickly scanned by Marey's gaze again and again, in search of structural features that will explain the muscles' position and the energy balance. For someone who observes scientists at work there is no more one time and space than there is for someone who observe engineers at work. The phenomena are much more stunning; they rely on the subversion, disjunction, displacement, rescaling, crossing-over of relations between spatial, actorial, and temporal features (Schaffer, 1988 ; Latour, 1995 ; Lynch, 1991). Science does not withdraw time from the world, it adds many spaces and times to it by constantly modifying scales, lengths, units in those strange sites,

the laboratory, the institute, the collection, which are utterly different from "a mind."

If this is the case, then, where does this obsession with a time-space frame "in which" entities would reside or which the mind would "impose on" things in order to apprehend them come from? No suffering bodies opening up trails through labor, as in the anecdote I recounted earlier, will ever produce that sort of space and time. But *no* engineer and *no* scientist at work either. And it is useless at this point to oppose, as is so often the case, the "lived world" of human subjectivity apprehending space and time with all the rich colors of intentions and affectivity on the one hand and, on the other hand, the scientific and technical objective world ceaselessly beating the isotopic and isochronic meaningless space-time. The scientific and engineering practice of subverting spaces and times through maps, charts, digs, traps, tricks, and knacks exceeds by far any subjective time and space described by phenomenologists. The subjectivity of space and time is not what is left when the objective space-time has been thoroughly described. It is only in some very peculiar circumstances that the two can be differentiated. Only the man in the TGV may distinguish transport and transformation, not the woman opening the trail with her hatchet, not the engineers of the train companies making sure trains do not run out of synch, not the scientists watching over the coordination of atomic clocks, and not Marey trembling at the idea that his photographic gun might give fuzzy, blurred or overlapping images.

But certainly, the space-time used to imagine the frame of all events has to come from somewhere? Its origin seems to reside in the peculiar nature of the *objects* used in the scientific disciplines to build their measuring instruments (Stengers, 1996). Whitehead once quipped that it is all very well to praise Galileo for his study of the inclined plane, but what if he had tried with bags of wheat instead of spherical billard balls! Try to detect a seven-year-old conserving from non-conserving kids using callabasses instead of beakers controlled by metrology and standardization – inspectors and instruments and institutional bodies are necessary there, as well as in the case of trains and clocks to hold them "up to standard" and coordinate action and certification (see Houdé, this volume). I bet that in Africa, away from their laboratories, most

Piagetian testers would qualify as non-conserving (Lave, 1988)! As I said above, there is an inordinate number of rigid bodies in the paraphernalia of laboratories. But this does not mean that scientists are *themselves* rigid bodies or have rigid geometrical minds! It means that, in the laboratory, to detect differences they use benchmarks. The circulation of those rigid bodies will locally generate a specific type of space-time like the circulation of any other body with different properties will generate other spaces-times-actants. This does not mean that we are *in* an isotropic space and an isochronic time, but that locally, *inside* metrological chains, there are *effects* of isochrony and isotopy, produced by the carefully monitored and heavily institutionalized circulation of objects that remain relatively untransformed through transportation: high-speed trains, rulers, standards, canons, weight, constant relations, bullets, ballistic missiles, falling stones, accounts, and various other rods, hands of clocks, gears, and structural isomorphies. All of that instrumentation, being very practical, very clever, very material, very local, but at no point saying anything about the mind's inner workings or explaining the ways by which no-place becomes event or events become non-event. The building of metrological networks for space and time is a crucial feature of Western history. It has to be documented, to be sure, it should be studied, respected, but it must *not* be confused either with an account of how our mind evolved, or with the understanding that other civilizations may have of time, or with the ontology of world-making.

I am well aware that we are here at the turning point (or maybe the breaking point!) of my chapter. Since this interest in the shift in times and spaces practised by technical action and scientific laboratories, and the attention on the instruments and their making instead of their results, cannot in any way be justified by demonstration, we have to choose here between philosophies. The first one would consider space and time in their isotopic and isochronic nature as being what the universe is made of, or, alternatively, what the mind needs to impose on the universe in order to make sense of it. In addition, as an afterthought, it might save for human subjectivity some other sort of relations that would explain how we relate emotionally to events and orient concretely in space, but all of this subjectivity will be understood in contrast to the objec-

tive space-time. Affectivity and effectivity will be clearly contrasted. Only the left side of the diagram will be considered and the right part will be taken as a purely instrumental aspect of no philosophical consequence for the elaboration either of the world or of the mind.

The second solution is to start from a phenomenon that is not in itself connected with subjectivity *or* objectivity, which ignores the quarrel between space-time as *sensorium* or as a frame of mind, and which begins with the *other entities* that are necessary for maintaining one in existence. It is the quality of this otherness and the "number" of others which become, in this philosophy, the crucial features. The key question is thus that of knowing if a transport, a displacement, a translation, a trajectory is either "paid for" in such a world by a small or a large deformation, transformation, metamorphosis. The major difference between the two outlooks is that, in this second view, the normal case of the first becomes the extraordinary rare *exception* of the second. That a mobile may travel without mutating is so rare, so miraculous, so expensive, that it has to be accounted for and explained in detail. And indeed, to account for the man in the TGV who does not age more than three hours going from Paris to Neuchâtel, one would have to take into account several huge bureaucracies, enormous networks, many clocks, flags, signs, and standards, a lot of electric plants, labor relations, and so on. Similarly, to account for Einstein's travels without deformation at the speed of light in spite of the acceleration of the frames of reference, one would have to count the whole establishment of physics, huge laboratories, most of astronomy, and quite a lot of the trains and embankments of Swiss railway authorities! In this second world, the measurement of times and spaces *makes* spaces and times whereas in the first, the instrument plays no other role than that of a practical means to reach space and time which exist independently either objectively or subjectively. In the second, instruments are mediators and shifters; in the first, simple means and intermediaries; they could, in theory, be discarded. In both worlds, the role of the mind as well as of ethics, politics, and religion will be entirely different, and this is what I now want to focus on briefly in the remainder of this paper. Why is the fifth dimension of time-space so difficult to register?

### Formalism: A professional hazard

What happens if, instead of focusing on the circulating rigid bodies, on the instruments, on the laboratory sites, on the changes of scale, on the institutions in charge of time and standards, on the know-how that goes into the experimental trials, one focuses only on the *results* of that smooth displacement? To continue with my favorite example, what happens when the man in the first-class compartment of the TGV ignores not only the famous “man on the embankment,” but also the inhabitants of the string of aligned stations and cities, the whole machinery and administration of train companies? He will really think that there is something like a displacement in time-space that does *not* require any aging, any transformation, something that is “paid for” nowhere by any costly network building. He may even start to think that isochronic time (measured by his watch in relation with the train’s clock) and isotopic space (signaled by the number-bearing milestones that flee regularly along the track) are normal features of the world. Please note again, that this will not happen if he boards an Italian train, let alone an Indian train, and it won’t happen either, remember, if there is a strike or any incident or even if the air-conditioning starts to malfunction slightly. But if everything goes smoothly, this traveler will take the *result* of the railway companies’ labor – smooth travel across space in time – as the normal *cause* of that huge organization. After having discarded as irrelevant the tracks, the trains, the switches, the bureaus of standards, the clockwork, the regulations, the timetables, and the whole menagerie, he will then be immensely tempted to believe that this whole system of isochronic and isotopic coordinates could be located, where? *In his mind!* That is the real great danger of train trips, they are too comfortable, at least in Switzerland. Epistemology is a professional hazard of first class air-conditioned train travelers. “Brain trips,” it should be called, a disease of modernity and lack of exercise, much like a bad back!

More seriously, science is either praised or attacked for what it *cannot* possibly provide: timeless formalism. As we saw earlier, there exist, of course, scientists working on forms, on rulers, on maps, on coordinates, on structures, but their work is not itself formal, ruled, mapped, coordinated, structured. Formalisms

circulate inside scientific networks with the regularity, efficiency, elegance, economy, of trains circulating on the “Rätische Bahn.” But in the same way as no one could even imagine trains keeping regular schedules without railway companies, no one should imagine that formalisms could go on circulating smoothly without the costly institutions known as Research and Development. It is as strange to turn isochrony and isotopy into mental or natural categories as it is to turn the work of establishing constants into what the mind would be particularly good at. The unequipped mind of a desocialized scientist will be immediately unable to prolong the life of any constant. This is why researchers, well aware of these practical constraints, ceaselessly devise instruments, time and space subvertors, data-traps, scale-inverting inscriptions, and thus produce a fabulously interesting history in their own sciences. They resemble much more the worried train company managers than the careless, well-fed, ignorant traveler. Even Einstein, in his own Machian account of general relativity, has deployed very explicitly the engineering work that goes into shifting from one accelerated frame to the next without losing information on the way (Einstein, 1920). His proverbial “mollusk of reference” produces an absolute space-time, but cannot possibly be seen as being itself *in* this absolute space-time.

The idea that a mind could make formal reasoning would be as bizarre as imagining a solitary scientist making a discovery or a naked male traveler’s body going by itself at 300 km/h from Paris to Neuchâtel. Only Superman or The Flash could do that. And yet, the very idea of a “genetic epistemology” goes even further than this thought experiment. It imagines not only that the mind undertakes formal reasoning through formal means, but that the whole history of biological life, from the earliest pre-Cambrian ferns to the superior cortex of primates, obsessively seeks nothing but the conservation of those formal relations (Piaget, 1967 [1992])! Thus formalism is not only taken as the pinnacle of human reasoning, but life itself is said to aim at nothing else. Here Piaget, the immanentist, takes apparently the opposite position of Bergson, the spiritualist, for whom life will remain forever foreign to *Homo faber*’s urge for geometry. In effect, however, his position starts from the same principle: Time and space can be said, unproblematically, to pertain to life itself.

But if we have been right in locating the production of times and spaces in certain types of circulation, registration and instruments, one certainly cannot attribute to life itself the timing that is due in large part to the biologists' and evolutionary theorists' practice (Kohler, 1994). To stick to mollusks (of reference), there is a huge difference between a snail in Neuchâtel's lake, and the same snail inside Piaget's collection. The first is more like the female traveler of my story: It is a suffering body among suffering bodies, without any instrument to register its suffering, its metamorphoses, its mutations, and all the risks it dares to take to stay alive. It is only the second, inside a range of other snails of slightly different colors and shapes, that will begin to offer, through the invention of a new form of synopticity, a registration of mutations in relation to the changing environment, itself represented by colors, labels, lentghts on millimetered paper. As Stephen Jay Gould has so beautifully demonstrated in *Wonderful life. The Burgess Shale and the nature of history* (the full title should not be overlooked) one cannot account for the history of life without the history of the life sciences (Gould, 1989). To jump away from the instruments, the collections, the natural history museums, straight to what life in itself aims at, is a sure path to failure, to the fallacy of granting to all living organisms a "way of life," an obsession with constancy, a mad search for structures, a fixation on conservation, that might well be – dare I say it? – representative of Swiss watchmakers, Swiss train managers, Swiss record-keepers, Swiss bank collectors, but that cannot, at least without more research, be lightly granted to snails, birds, stomachs, brains, kids, mathematicians, elephants, or whales... One can be allowed to forget for a moment that smooth displacement in time and space is paid for somewhere else by other people, but not forever. Even if "time is like nothing" during the train trip and inside the compartment, to think that this is also true outside of the train would be like trying to suddenly jump out of a TGV at full speed...

Fernando Vidal has shown the paradox of accounting for Piaget's thought by pointing out its environment (Vidal, 1994). If we were to believe naive contextualists, a Swiss biologist born in Neuchâtel, working for many years on natural history collections, in a rich country of bankers and clockmakers, crisscrossed by trains, cars, trucks, and planes, and later fascinated by the

exploring behavior of children, by the extent of their material manipulations, their reliance on social interactions, should have considered societies, children's peer groups, and scientific disciplines as so many *time-producing collectives*, and should have deconstructed, one by one, most Western beliefs into the asocial, atemporal nature of formalism. He should have wrenched *out* of the mind every single one of the concepts that rely so obviously on material, social, and practical mediations, and since he had the extraordinary chance of being a reasonably good biologist, he, and he alone, not taken in by the awe of Science with a capital S, should have seen how close children's controversies were to scientific controversies. Thus, struck by the extravagant ethnocentrism of most psychology, he would have founded "cognitive anthropology" and shown the gap that exists not only between practical cognitive cultures, as Ed Hutchins has recently shown in his fundamental book (Hutchins, 1995) but, going much further, he would also have started to study what times and what spaces suffering biological bodies would trace on their own terms...

And yet, and yet, as we all know, this is not what happened! Too bad for the social history of thought! The heroic effort we celebrate in this symposium under the paradoxical umbrella of Mind and Time aimed at eliminating from the mind, from the production of science, from ontogenic development, from the history of science and, finally, especially in *Biology and Knowledge*, from the history of life itself, any trace of history, of time-producing practice. Isabelle Stengers, a philosopher of time if any, has proposed, after Deleuze, to distinguish virtualities from potentialities. Potentiality is the realization "in time" of what was already there *in potentia*. Time unfolds determinations, but nothing really happens, exactly as it is possible to calculate all the positions of the pendulum from its initial position without the actual fall of the pendulum adding any new information. The same is true of development, if development is understood as the unfolding of potentialities – a problem, as is well known, that Piaget tackled twice in the growth of mollusks and of child intelligence. Virtuality is something altogether different. It depends on the *otherness*, on the fifth dimension of process, on this quality of connection with other actants that I took, earlier in this paper, as the deeper definition of time and space, that is,

the intensity of time and space. The question is thus to decide whether time is the realization of potentialities, or whether it emerges from the eliciting, the eduction of virtualities, of surprising differences.

The constancy of Piaget, during such a long career, in seizing any occasion, in all the many domains in which he worked, to turn virtualities into potentialities, this constant erasure of time and practice in all the topics he took on, is so stunning that it requires an explanation that I am not equipped to find but that, I am sure, we will uncover by the end of this symposium.

My own guess is that *theology* must have played an enormous role in this adequation of Switzerland, Western science, thought, mind, ontogenesis, formalism, and life. The timelessness thus produced had all the character of the timelessness of a *secular* protestant theology. Contrary to what is often thought, theologians are often more rationalists than epistemologists, especially because they imagine that God has something to do with the *same* time and space as the one produced by immutable mobiles, except that He is beyond. But, since theologians do not focus on the work of producing those mobiles but only on its result, much like train travelers and epistemologists do, they take isotopy and isochrony as features of the world. They commit, to use Heidegger's language, the sin of metaphysics. Thus, there is no other way for them but to consider God as an entity which is somewhat "beyond" space-time, in a transcendent "other world." If one wishes, like the young Piaget, to maintain the anhistoricity provided by this God of beyond and above, but wishes, at the same time, to distance oneself from the embarrassing baggage that goes with Christian theology, one of the solutions is to make sure that *this* world itself has all the characters of constancy, formalism, anhistoricity of the "other" world.

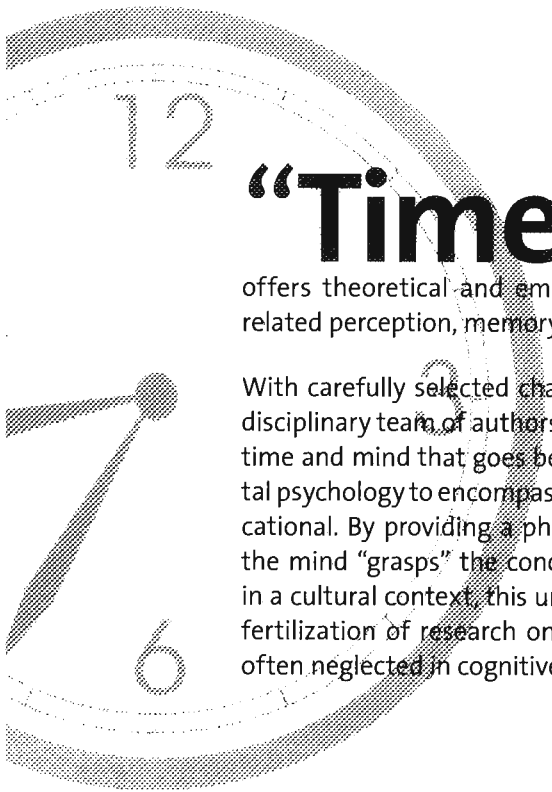
The enterprise resembles somewhat the experiment to reach absolute zero by progressively slowing down the motions of atoms. The fusing together of psychology, history, life, logic, mathematics, and pedagogy, creates a confined space in which this extraordinary trial can take place: The slowing down of history, the slow replacement of virtualities by potentialities, the transformation of process into the actualization of constants, one of the most daring scientific enterprises of this century, already rich in such

endeavours, to make sure that – how can I put this as politely as possible? – to make sure that nothing unanticipated or untowards happens; to make sure that every stage will be regulated according to schedule; that ontogeny will recapitulate phylogeny; that this world will be as well regulated as the lost other world; that balances and accounts will always be kept in spite of all the imbalances; that constancy will always be maintained in spite of the turmoil of history and world wars; that capitalization will go on for ever without losses or spending... Ah hah, maybe the contextualists are right after all, a Swiss dream if any, the paradoxical timelessness of clockmakers! The ideal for an army of passive defense. A world run smoothly like clockwork, where trains, colleges, and classrooms run on time, a world where nothing would happen. A mind and no time...? Yes, a magnificent experiment to show in relief what has been missed so far in discussions about timing, spacing, and acting.

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