

Can you think with me?

The social and cognitive conditions and the fruits of learning

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Introduction

Since Piagetian and Vygotskian times, co-operation, social interactions, language, learning and cognitive development have been considered in their interdependencies along different lines of research that are contributing to the ever more complex and rich image of what thinking is. Recent advances have drawn specific attention to the dialogical dimension of thinking and to a reconsideration of context as the social matrix of the development of thinking skills. But neither thinking nor context is a static reality: each affects the other via its authors' and participants' initiatives and interpretations. Joint actions and thought sharing (via language and semiotic mediations) are dynamical processes and these are more or less likely to be productive for knowledge creation and learning in individuals and groups. In this chapter, we would like to contribute to the description of the way in which socio-cognitive processes and their productions are transformed during dialogues and other interactions. A specific hypothesis is the red thread of our research: since learning is socially embedded, the nature of what is being learned and the capacity to transfer this learning and re-use it should be observed to be dependent on the socio-cognitive contexts of both its acquisition and its re-use. We will, in particular, pay special attention to the role of social asymmetries in knowledge appropriation. We will also illustrate our concern via a study of children solving a kind of open puzzle (Kohs cubes) individually and collectively. This task makes visible to a large extent the participants' actions and operations.

Origins of the focus on verbal interactions and collaboration in learning

'Please, listen ...!' We can easily imagine that from the dawn of humanity, mothers and fathers have hoped that their children would pay attention to what they were saying and thereby learn from them. In most formal teaching situations in the world, students are supposed to acquire knowledge via close (and often silent) attention paid to experts' displays of language and semiotic tools intended to convey knowledge. But only in the last century have psychologists managed to describe under which conditions

(developmental conditions, as Howe shows in her chapter in this volume) this reliance on language can favour the development of higher psychological functions. This has drawn attention to the important role of the learners themselves in this process: silence, attention, concentration, memorization and internalization are not the only processes at stake; learners are co-authors of their development via their own initiatives in action and discourse, accommodating to what they try to assimilate, learning to use socially provided tools and language, giving meaning to the situation, trusting or distrusting the information sources, elaborating solutions to solve the problems they meet, and relying for that on some appropriation of other people's experience and knowledge. This is not a lonely activity, but a socially embedded one, in formal and informal settings, in which the learner's identity is at stake: accepting that to relate to – or even identify with – a caretaker or teacher will confirm or modify the learner's status, conformity with the cultural norms, future perspectives, narratives, and social image. In particular, especially in social settings (such as schools) designed with the intention of fostering learning, the participants' 'competencies' as part of their identity, will become a matter of attention and social validation.

Piaget's very first studies of children were concerned with a developmental approach to the role of language (Piaget 1959). Attention was paid to the development of children's capacity to interact verbally with others in a non-egocentric way. But language, as such, was not to remain Piaget's central object of study. His model progressively started to grant primacy to reciprocal adaptation and equilibration (of action and operations, interactions and co-operation), as the processes permitting the growth of reflection and meta-reflection and thereby the development of mental structures (Piaget 1950; 1977). If Piaget then does not contribute much to the understanding of the role of language in learning, he does make important points for our concern: since birth, children learn a lot (including language) by being active in their social and physical environment; taking another person's perspective is not easy, and collaboration is a capacity that develops; what is said cannot be understood if the cognitive prerequisites are not present in the learner; and cognitive conflicts disturb ('disequilibrate', in Piagetian terms) present understanding, inducing the individual into mental reconfigurations that can be developmentally productive. Piaget also made an important point in a time of authoritarian interpersonal and social relationships in society and in education: asymmetrical relationships may disturb learning processes because authority is not a developmental source of rationality (Perret-Clermont 2008). Piaget introduced here a distinction between, on the one hand, the transmission of opinions and social conformity that takes place in asymmetrical relationships and, on the other hand, true learning that requires autonomy in checking the validity of the assertions and their backings. This constructive process of cognitive challenging is favoured by the reciprocal relations between equal peers (Piaget 1995). But these hypotheses have remained relatively unexplored in Piaget's empirical research. Vygotsky, who had published an early translation of Piaget (1923) in Russian, considered in much more depth the role of language in development. For our concern here, we would like to retain the advances Vygotsky (1962; 1978) made in alerting psychologists and educationalists to the role of semiotic mediations not only in behaviour but also in thinking itself. Pointing to a common reference is important for joint action. Signs and semiotic resources are even more important because they allow for dialogues and thus become instruments for thinking. Vygotsky contrasted everyday

learning and formal settings where academic concepts could be taught. Contrary to Piaget, Vygotsky was particularly interested in describing the asymmetrical relationships by which experts help learners in their zone of proximal development.

Wood, Bruner and Ross (1976) extended this approach with the concept of scaffolding, which adults use in order to offer novices occasions to learn and develop new competencies. These scaffoldings can also be described as joint activities, for instance, when Wertsch (1979) observes mothers and children playing with a puzzle and depicted learning. The way in which semiotic mediations are used in joint activities in 'communities of practice' (Lave 1988), creates discourse genres (including academic concepts) that are learned in order to deal with specific categories of problems and instruments. From this perspective, as we will suggest later in this chapter, scaffolding is not just a matter of an expert scaffolding a novice, but of a whole situation of activity (with its tools, semiotic resources and genres, tasks, goals and partners) scaffolding novices' learning. We are interested in this approach to learning also because it allows us to encompass not only the case of novices learning already established knowledge, but also the case of experts' advancements in knowledge creation. In both situations, through social interactions, active individuals develop a new understanding – new to them and/or new to the group or even to society. This is in line with Piaget's initial scope, which was to identify processes that can account both for learning and knowledge creation. Another consequence of this approach, when trying to understand if an individual or a group is learning, or when trying to foster learning, is that it requires considering not only a single joint activity but also a sequence of activities.

From effects to processes in the study of collaboration in learning

During the preceding decades, in line with the debates mentioned above, and in different fields (for example, psychology of learning: Carugati 1999; Gilly, Roux and Trognon 1999; Howe and Tolmie 1999; Joiner, Littleton, Faulkner and Miell 2000; Light and Littleton 1999; anthropology: Lave 1988; education: Forman and Cazden 1985; Mercer 2000; Mercer and Littleton 2007; Pontecorvo, Ajello and Zuccheromaglio 1991; Tolmie, Christie, Howe, Thurston, Topping, Donaldson, Jessiman and Livingstone 2007; vocational training: Perret and Perret-Clermont 2004; social psychology: Darnon, Butera and Mugny 2008; Perret-Clermont, Pontecorvo, Resnick, Zittoun and Burge 2004), research has paid attention to the central role of social interaction in learning. Among the questions raised are the following: Can the benefits of learning via social interaction be measured in post-tests at the individual level (Ames and Murray 1982; Doise and Mugny 1984; Gilly 1984; Perret-Clermont 1980; Roy and Howe 1990; Schwarz, Neuman and Biezuner 2000; and others)? Are the benefits predicted by the form the interaction took (Davenport and Howe 1999) or by the affective relations or gender representations between the partners (Psaltis and Duveen 2007; Sorsana 1997)? Are the learning gains related to the verbal activities in the interactions (Tasley 1995)? Under which conditions is the collectively co-constructed knowledge simply internalized (a superficial and static form of learning) by the individuals or interiorized in such a way as to become available in a new situation (Psaltis, Duveen and Perret-Clermont submitted)?

Progressively, the focus of attention has moved from the impact of social interactions on subsequent learning gains to the processes that mediate these cognitive progressions. As a result, researchers are not now looking for 'variables' or 'factors' that have a direct causal effect on the participant's thinking, but are becoming interested in the processes that mediate learning. These processes do not take place in a social vacuum but in living persons who are attributing meaning to their environment (and to its predetermined characteristics in the case of experiments in the laboratory) and, as a consequence, modifying it through thoughts or acts. In order to study these mediating processes, researchers have opened the 'social black box' and looked in detail at the socio-cognitive processes at work during the interactions. We will see that the learning situation does not appear anymore as a fixed learning context but as a dynamical encounter that modifies its characteristics and context as the conversation unfolds (Grossen 2001; Wegerif in this volume).

Socio-cognitive processes involved in learning: towards the rediscovery of verbal interactions

A repeated result is that cognitive progress is made by individuals after having interacted with others on a given task, although, of course, not in every circumstance. Beyond classical studies on imitation and social learning, socio-cultural approaches have described how knowledge is co-constructed during the interaction phase, when an adult scaffolds children and passes on to them their expertise (e.g. Rogoff 1990; Wertsch and Hickmann 1987). But it is known that confrontation with the correct solution during these interactions cannot be the only source of learning: studies on socio-cognitive conflict have reported cognitive gains even when both are novices, demonstrating thereby that the asymmetry of expertise is not necessary but that 'two heads are better than one' (Azmitia 1988; Perret-Clermont 1980; Schwarz *et al.* 2000). Non-competent partners can become competent after having been exposed to another way of solving a task, even if they did not reach the solution together during the interaction. Why?

It seems that being confronted with different answers from someone else creates a discrepancy between the learner's initial understanding and the necessity to grasp a new perspective: the learner then enters into a reflexive stance that may lead to the restructuring of his or her own thinking (Muller-Mirza and Perret-Clermont 2009). Evidence also shows that under some conditions collaboration may lead to regression (Tudge 1989, 1992). What are the specific features of the social relationship and verbal interaction that open the way for cognitive gains in the interlocutors? The fact that more competent partners verbalize their reasoning and less advanced partners accept it may lead to productive collaborative interactions (Tudge 1992). Transactive discussions (where a participant acts on the reasoning of the interlocutor through language) have repeatedly been observed to promote cognitive growth (Azmitia and Montgomery 1993; Howe and Tolmie 1998; Kruger and Tomasello 1986; Williams and Tolmie 2000). These transactive dialogues may be self-oriented (justifying one's own reasoning) or other-oriented (building on the partner's reasoning), as shown by Kruger (1992). In these studies, students involved in such a dialogue entered into a reflective attitude that was beneficial for learning. Following these findings, some

researchers then raised the pedagogical question: Can training for some form of talk contribute to more positive effects of collaboration on thinking?

Effect of language-based training for productive forms of collaboration

Fawcett and Garton (2005) have shown that children who were instructed to talk during collaboration were subsequently able to perform better on post-tests compared to those children in dyads where talk was minimal. They concluded from their study that training children in interactive skills (such as providing explanations, being sensitive to others' needs) may be a prerequisite for successful peer collaboration.

Mercer and his colleagues (Mercer 1995, 2006; Wegerif, Mercer and Dawes 1999) identified a specific educational dialogue called 'exploratory talk' in which all the members of the group were invited to contribute to the discussion, learn to make their information and reasoning clear, and to try to reach agreement before making a decision or acting. These authors have shown that teaching children this kind of explicit dialogue helps them develop social and cognitive skills that can be transferred to other situations (for instance, solving together the Raven's Progressive Matrices test). It seems that active participation in the task and in verbal exchanges, as well as being confronted with different point of view, promotes the children's re-examination of their own understanding. In this line of research, it became clear that learning, beyond being a matter of acquiring cognitive skills and following social rules (e.g. 'wait for your turn to talk'), requires what we would like to call a co-construction of shared meanings within a 'thinking space' that is respectful and emotionally secure enough to confront alternative perspectives and manage them together (Perret-Clermont 2001; Perret-Clermont and Iannaccone 2005). It is not only language and social skills that these educational programmes promote, but also the possibility of experiencing long sequences of individual and collective thinking and reflecting upon them along different cognitive, social, and argumentative dimensions. The whole design of the pedagogical sequence plays a fundamental role. Every element matters: task, goal, teacher's interventions, students' epistemic agency, interpersonal relationships, language, production of artefacts, time spent consolidating the sharing of meaning etc. Now, if children can develop in such a carefully designed supportive and challenging environment, can they demonstrate their advancement elsewhere and transfer their learning to other social settings that might be less supportive or simply different? Mercer's answer to these questions, given his research results on post-tests, is yes. Such transfers are not often reported in the literature; transfer has been observed but is dependent on the participants' understandings not only of the cognitive, but also of the social demands of the new situation and task (Beach 1999; Carraher and Schliemann 2002; Howe, Tolmie, Greer and Mackenzie 1995; Tuomi-Gröhn and Engström 2003). We will consider now if laboratory investigations of the socio-cognitive processes that mediate transfer can contribute to the understanding of 'transferability' of collaborative learning. The quality of talk depends on the interlocutors' capacity to participate in such talk. We will then expect the quality of thinking to be related to the partner's mode of thinking during the collaborative activity.

Learning and transmitting new skills in collaborative activities: some puzzling findings in successive activities

Elbers (1991) describes the learning situation as an introduction to socio-cultural ways of thinking and not as a situation of knowledge transmission. Then, what is it that is learned and how is it re-used later in other situations that might afford a different 'socio-cultural way'? Novices always develop cognitive and social competencies within a specific social situation with a specific set of tasks. Is it the case that the specificity of this social situation affects the possibility of further developing in other successive situations?

These questions require the rethinking of experimental designs in order to take into account all the phases (pre-test, intervention, post-test) as a succession of activities through which the participants construct their understanding of the micro-history that they are experiencing, both intellectually and socially, and establishing (or not) links between the different phases (Perret-Clermont and Schubauer-Leoni 1981). These activities are joint activities: in the pre-test and post-test, experimenter and child communicate, trying to succeed at establishing a common response; in the intervention phase, the activity is either individual or collective but, even when it is supposedly individual, there is still an adult who has set the task for the participant and expects to see it done in a certain way. These activities afford different opportunities for the partners to co-construct some degree of intersubjectivity and common cultural artefacts such as a common language, signs, and shared meanings (Grossen 1988, 1999; Zittoun, Gillespie, Cornish and Psaltis 2007). How do these cultural artefacts circulate from one interaction to another?

In a four-phase experiment (pre-test, training, peer-interaction, post-test), Nicolet (1995) examined the acquisition of expertise in two different training conditions (joint activity with a more advanced peer on a balance-beam task (not knowing that the peer is more advanced), or predictions confronted by feedback received from demonstrations of the balance beam operated by an adult); and then looked at how the freshly acquired knowledge was used in a new social context (interaction with a less advanced peer). In all cases, the participants did not know whether they or their partner was a novice or an expert. The adult was careful to give to the participant, via feedback, the same cognitive information as that received by the matched participant in the other experimental condition. Nicolet chose the balance-beam task because once weights are set and brakes removed, the balance gives direct 'physical' feedback. The traditional conservation or moral judgment tasks do not offer such feedback from reality. The general hypothesis was that the socio-cognitive contexts in which novices learn may have an impact on their task-related skills and social roles during the following peer session. Horizontal peer-to-peer joint activity was expected to be more productive than 'physical' demonstration embedded in an asymmetrical adult-child relationship. Nicolet found that the novices who had gained their knowledge with the adult's demonstration promoted less learning in their novice partners than their counterparts who had become experts via horizontal problem-solving activity with a peer.

Grossen replicated Nicolet's four-phase design but with Kohs cubes, a puzzle-like task (Grossen, Liengme Bessire, Iannaccone and Perret-Clermont 1993). The task was chosen because it is well documented in the literature and because it gives participants direct feedback at every step of the action. It also allows for direct observation by the

experimenter of the procedures (strategies) used by the participants without requiring them to make their thoughts and judgments explicit via an experimenter-led dialogue. Grossen *et al.* (1993) slightly modified Nicolet's two experimental conditions in order to give the adult the opportunity to transmit her knowledge explicitly (and not 'hide' behind the display of 'physical' feedback from the task): in one condition the children had to jointly construct the puzzle with an expert peer (but not known to them as an expert); in the other experimental condition, the adult taught strategies to the novices by demonstrating and verbalizing them. Precautions were taken to match the two groups of participants to the level of expertise reached after this training. The results show that participants who had learned with the adult and then interacted with novices shared their knowledge efficiently but notably regressed on the post-test. The novices who had interacted with these participants progressed the most. Conversely and quite surprisingly, many of the adult-trained children regressed in the post-test as if they had 'given away' their knowledge to the novices and remained somehow disrupted by the interaction.

This larger progression of the novices who interacted with the trained participants raised interesting questions. How could these adult-trained children have been able to scaffold their novice partners to develop more advanced thinking strategies during their collaboration without being able to apply these strategies themselves in the post-test? They seemed to be able to re-use these strategies given by the adult during the training session, but did they understand them? This finding could be taken as an indication that through demonstration and modelling, trained experts acquire relatively isolated academic concepts, but are not able to relate them to spontaneous ones. Is it due to their relatively passive position during the adult demonstration? Is it surface imitation of the adult with only internalization of words and gestures and no construction of an understanding? An important unanswered question thus remains: How is it possible that a trained expert with such 'shallow' academic concepts can successfully support the development of another peer, as the results of this experiment revealed? From a neo-Piagetian perspective, it could be that the novices were confronted with a point of view different from their own (the trained child's knowledge) with a sufficiently horizontal relationship to be able to work out their own reconstruction of what was at stake. Previous observations of Schubauer-Leoni (1986), Grossen (1988) and Nicolet (1995) also allow for the hypothesis that the adult-trained children felt insecure about their recently and passively acquired knowledge and more concerned with maintaining their status as 'experts' than co-constructing a shared understanding of the situation with their partner. Yet, from a post-Vygotskian perspective, the results of the training with the adult are uncomfortable and require further investigation. This was done in the following study led by Tartas² in which an experimenter diversely trained the novices in order to maximize the chances that they would learn to link their spontaneous knowledge and the academic concepts they are offered (Tartas *et al.* 2004).

Child-centred adult support and peer interaction: an empirical investigation

Tartas *et al.* (2004) designed the study with two aims: to explore in more depth an unresolved issue from the study of Grossen *et al.* (1993), i.e. the apparent failure of adult

training to generate progress in the post-test of adult-trained children; and to explore further, in the joint activity of Phase III, to what extent the modality of knowledge acquisition affected the social ability to share the new knowledge with partners and to benefit from interacting with them.

The design was the same as Grossen *et al.* (1993): 100 children took part, 46 of whom formed the control condition (they only participated in pre- and post-test sessions of Phases I and IV). The experiment consisted of three conditions: a control condition (Phases I and IV only) and two experimental conditions. Some novices (defined as such on the basis of the pre-test results in Phase I) were assigned to *condition 1*. Some experts and some novices, as identified in the pre-test were assigned to *condition 2*.

In *condition 1*, the novices went through Phases I (pre-test), II (adult training), III (joint activity) and IV (post-test). During Phase III they were asked to perform a joint activity with a novice (not knowing that their partner was a novice). Phase IV was a post-test similar to the pre-test of Phase I. In *condition 2*, children were not trained by the adult. They only went through Phases I (pre-test), III (joint activity) and IV (post-test). In the joint activity, the dyads always comprised a novice and an expert. The expert could either be an expert diagnosed as such on the pre-test (*condition 2*), or a child who has become an expert via adult training (*condition 1*).

In Phase II, a third of the novices were trained by an adult in a way that put them in an active position with opportunities to externalize their spontaneous thinking. The adult adjusted to the child when bringing academic concepts into the conversation and suggesting more advanced strategies. The intention was to enable the child to appropriate a specific kind of talk about Kohs cubes. Contrary to Grossen *et al.* (1993), Tartas *et al.* (2004) wanted the adult to be focused on the child who was trying to solve the task, giving help only when the child needed it, granting agency to the learner, trying to adjust the support to the specificity of the problems encountered in doing the task, and grounding the explanations in the child's activity. For example, if the child stopped because of not knowing how to proceed further, the adult intervened with some valuable thinking mediation tools in order to help define a further strategy. Consequently, it was expected that the trained participants, having had more opportunities to relate the academic concepts offered to their spontaneous knowledge, would develop a better understanding. As a consequence, in a subsequent interaction, they should be as productive or even better partners for their novice peers' progress as in Grossen *et al.* (1993), but without regressing after having interacted with them. Since their understanding was better constructed, they should not be destabilized through the interaction with their novice partners and hence not show regressions in Phase IV.

The results of the study are interesting. As expected, the children who were guided by a supportive adult, one who offered them scaffolding without depriving them of their agency, did not regress in Phase IV. The training in this study was resistant to the potentially disruptive impact of the peer interaction observed in Grossen *et al.*'s (1993) study. It also favoured the growth of the novice partner in Phase III. Another major result is that, confirming the 1993 study, the novices who interacted with a spontaneous expert also progressed. Novices in both experimental conditions progressed as well. From a cognitive point of view, we see that social interaction with a more advanced peer was as efficient as a sequence consisting of child-centred adult training followed by interaction with a novice peer. From a social point of view we observed that the

horizontal relationship between peers offered the novices opportunities for progress. The asymmetrical teaching relationship with an adult helped circulate academic concepts to the benefit of the novice partners in Phase III of both studies. But only in Tartas *et al.*'s (2004) study was it to the benefit of the trained child also. If such was the case in this study, we then wondered why, on the post-tests, the children who had benefited from adult training and peer interaction were not seen to be out-performing those who had only experienced peer interaction. Was the traditional scoring method of the Kohs cubes that we were using, sufficiently precise? We decided to turn to the Rasch model (Baucal and Bond 2004; Baucal and Jovanović 2007; Bond and Fox 2007) to reanalyse the data.

In the following part of this chapter, we will present this new analysis. We will also try to understand better what happened in Phase III and why, with Tartas *et al.*'s (2004) study, the trained children did not lose their knowledge when using it in a joint activity with a novice. We will open the 'social black boxes' of the adult-child and child-child interactions. This required transcribing the transactions of the dyads (or at least of typical dyads) in Phase IV and the training sequences in Phase III, and then relating what was observed happening across the two phases.

The socio-cognitive micro-history of two trained experts

The Rasch model was chosen in order to obtain a more refined measurement of the children's improvement on the Kohs cubes between pre-test and post-test, separating the development of new competencies from the simple improved use of existing competencies. The Rasch model enables this separation by placing participants and items in the same set, and empirically ranking both items and participants by creating a scalogram with as few errors as possible. Different levels of competence then became clear so that improvement could be described not only in quantitative terms (whether the child solves more items in the post-test), but also in qualitative terms (whether the child changes levels of competence).

Applying the Rasch analysis to the data revealed that items from the Kohs cubes form a one-dimensional scale. It also allowed the identification of three levels of competence and what counts as a major improvement. The results show that there were significant differences across dyads related to their improvement between pre-test and post-test. There were no major differences across the experimental and control conditions, except for the adult-trained children: they changed level significantly more than other groups. This was not evident in the former analysis based on classical scores.

Two cases were then selected for qualitative analysis: Isidor (adult-trained) and his novice partner, Francis; and Henry (adult-trained) and his novice partner Michael. Isidor was the child who progressed the most across the whole study, from the first level in Phase I to the third level in Phase IV. However, his novice partner, Francis, remained at level 1. In other words, this four-phase sequence offered Isidor opportunities to develop advanced understanding of Kohs cubes but, as a partner in a joint activity, he did not provide Francis with appropriate learning opportunities. (We will remember this case as exemplifying the Latin proverb '*Discendo docebis, docendo disces*' ('By learning you will teach; by teaching you will learn'), even if Isidor, of course, was not explicitly asked to teach Francis anything.)

Henry and Michael were selected because the novice child, Michael, made very significant progress between pre-test and post-test, from level 1 to level 3. He surpassed Henry, the adult-trained partner, who also made progress from level 1, but without fully reaching level 3. Again, the four-phase sequence sustained the child's progress, but was not as productive for him as the two-phase experiences for his novice partner. (We will remember this dyad as an illustration of another saying about teaching: 'The good teacher is the one whose student surpasses him', even if we ask the reader to recall that the relationship had not been established as a teaching one.)

Case 1. Isidor and Francis: 'Discendo docebis, docendo disces'

Isidor was given the standard instruction that when he finds it too difficult to complete the construction on his own he can rely on the adult's help. Subsequently, he spontaneously began to speak aloud, explaining to the adult what he was doing. Isidor seemed to want to make his strategies apparent and encouraged the adult to correct him before he acted. The discourse used by Isidor was both individual and social. As the following excerpt will illustrate, his discourse (and its academic concepts) seems to function as a mediation tool, directing Isidor's own action as well as explaining it to the expert adult for a check.

Isidor: excerpt from the beginning of Phase II (adult training)

ADULT 1: Now let's begin with this figure. (*On commence avec cette figure. Vas-y*)

ISIDOR 2: There is a blue cube here (*Il y a un cube bleu ici*)

ADULT 3: Yes (*Oui*)

ISIDOR 4: It is completely blue, hence I put a blue one (*C'est complètement bleu, donc je mets un cube bleu*)

ADULT 5: Yes (*Oui*)

ISIDOR 6: Here there is blue and yellow, so I put a blue and yellow one (*Ici il y a du bleu et du jaune, donc je mets un cube bleu et jaune*)

ADULT 7: Ok, have you then seen that the yellow is toward the outside and the blue toward the inside? (*D'accord, as-tu alors vu que le jaune est vers l'extérieur et le bleu vers l'intérieur?*)

ISIDOR 8: Yes ... heum ... here it's alike, the blue is inside and the yellow ... (places the cube without finishing his sentence) (*Oui ... heuu ... ici c'est pareil, le bleu est à l'intérieur et le jaune ...*)

ADULT 9: Ok (*Ok*)

ISIDOR 10: (now finishing the sentence) the yellow is toward the outside (*le jaune est vers l'extérieur*)

ADULT 11: I agree, so now don't forget to check a final time. (*D'accord, maintenant n'oublie pas de vérifier une dernière fois.*)

ISIDOR 12: It's fine! (*C'est bon!*)

The fact that Isidor spoke aloud before (or during) the construction of the figures (for instance saying: 'I did this thing here') seems to have induced the adult into teaching him the specific names of the geometrical forms, describing them by pointing at the

model. The adult prompted him: 'Ok, would you like to begin with this triangle here?', 'This diagonal there?' At the beginning of the training, Isidor used the word 'things' to designate the forms; but progressively, he started to use the conceptual terms. This example shows that the difference between the adult's discourse and the child's was an opportunity for development. Because of the training, Isidor gained the ability to correct himself step by step without any adult intervention. He learned to locate the position of the cubes on the model and to adjust his own construction; to locate specific geometrical forms on the model and to use them as markers; and to recognize and name triangles, diagonals, etc.

During the first part of the interaction with Francis (Phase III), Isidor took charge of the building and constructed the three first items alone. But then, as shown in the excerpt below, Francis reminded him of the adult's instruction: 'Aren't we supposed to work together?'

Isidor and Francis: excerpt from their interaction in Phase III

ISIDOR 1: Here, there is some white and some red ... eh look on which side the white is, eh look the red is here on the top, it is like that; in the bottom like that (places the cube in the right direction); look it is a triangle. (*Ici, il y a du blanc et du rouge ... cub regarde de quel côté est le blanc, eh regarde le rouge est ici en haut, c'est comme ça; regarde c'est un triangle.*)

FRANCIS 2: Where? Here? (*Où? Ici?*)

ISIDOR 3: Then there is some red. (*Ensuite il y a du rouge.*)

FRANCIS 4: Here (places a cube next to Isidor's construction) (*Ici*)

ISIDOR 5: Look if it's correct, if we get a line (points on the model and on his construction) (*Regarde si c'est correct, si on forme bien une ligne*) (...)

FRANCIS 10: Aren't we supposed to work together? (*On ne doit pas travailler ensemble?*) (...)

After Francis's reminder, the dyad conformed to this social demand by entering into a very systematic division of labour: they alternated, with each child in turn placing a cube or two. Only on limited occasions did they negotiate a move. Isidor kept to the same rules and routines that he had developed with the adult, but talked aloud less often (he might have kept using inner speech, talking to himself in the way he had been trained). He sometimes controlled his partner's construction by saying: 'It's wrong'. Only during the last item did Francis show signs of starting to learn something, but for such a short amount of time that he would not re-use it later during Phase III or during the post-test, demonstrating no learning. Isidor progressed: Phase III seems to have been an opportunity for him to better interiorize the knowledge gained from the adult.

Case 2. Henry and Michael: 'A good teacher is the one whose student surpasses him'

At the beginning of the training in Phase II, Henry managed to solve the first items using four cubes. But when the items involved nine and 16 cubes, he had serious

difficulties dividing the model into cubes and orienting them. The adult's interventions started there, when Henry showed hesitations or stopped himself, as in the example below.

The adult's first intervention in Henry's training (Phase II)

ADULT 22: Where have you decided to begin? (*Où as-tu décidé de commencer?*)

HENRY 23: There (he is pointing at the top of the model) (*Là*)

ADULT 24: Ok (*D'accord*)

ADULT 25: And afterwards then, what are you going to do? (the adult asks this question because the child had stopped his construction) (*Et ensuite, alors que vas-tu faire?*)

HENRY 26: I am not sure ... (*Je ne suis pas sûr ...*)

ADULT 27: You are not sure, so what I can tell you is that we can imagine this cube here (the child agrees); you can check by putting it just next to the model in order to check the direction of the diagonal. We are in this direction, the yellow is outside and the blue is inside, and we know by the model that it is next to a blue cube. In addition, you can use the grid of the model, it corresponds exactly to the cubes. So, now try to place this one. (*Tu n'es pas sûr, alors ce que je peux te dire c'est qu'on peut imaginer ce cube là, tu peux vérifier en le mettant juste à côté du modèle pour vérifier dans quel sens est la diagonale. On est dans cette direction, le jaune est à l'extérieur et le bleu à l'intérieur, et on sait qu'avec le modèle il est à côté d'un cube bleu. En plus tu peux utiliser la grille du modèle, ça correspond exactement aux cubes. Donc maintenant essaie de placer celui-là.*)

Henry performs the placement.

ADULT 28: How do you check? (*Comment tu vérifies?*)

HENRY 29: I look at the blue here. It's finished. (*Je regarde le bleu ici. C'est fini.*)

ADULT 30: Very well. (*Très bien.*) (...)

In this excerpt, the adult explains to Henry how to place his cubes, for instance using the grid on the model in order to check the orientation of the cubes. With the next items, Henry continues to spontaneously ask for help when he does not know how to proceed. Henry progressively uses the same vocabulary and strategies as the adult, for instance, saying prior to his action: 'Now I start this line, and the colour of the first cube is red and white'; and 'I have to check on the model the direction of the diagonal.'

During the first part of Henry and Michael's interaction, Henry directed the construction by explaining procedures to his partner ('we have to begin with the corner'; 'we must do the line'; 'next we must do the other line like that'). Henry imitated the adult in asking questions and giving explanations. During the first item, Michael was rather passive: only on two occasions did he try to signal an error or place cubes but these cubes were immediately taken away by Henry. At the beginning of the second item, Henry declared that he had been doing everything and that now it should be Michael's turn. But he kept acting on his own. Michael managed nevertheless to construct some parts. The interaction continued and progressively Michael started to take more responsibility. Finally, it was Michael who reminded Henry of the procedures that he had suggested following and with which he was not complying.

Even if Henry had given his partner vocabulary and strategies to solve the task, he was not always able to use them properly. In the brief excerpt below (beginning with the third item), we can see Henry using the same words as the adult. In fact, it is probably only on the surface that these words look like the adult's: they do not seem to have the same meaning.

Interaction phase between Henry and Michael

- (...) MICHAEL 3: Wait, wait, we will do ... (*Attends, attends, nous allons faire ...*)
 HENRY 4: this side (*ce côté-là*)
 MICHAEL 5: We begin with this line at the top (*On commence avec cette ligne là-haut*)
 HENRY 6: No, this line, this line! Ooh, you are doing the top?! (*Non cette ligne, cette ligne! Ah tu fais le haut?!*)
 MICHAEL 7: No, I am doing this side (*Non, je fais ce côté*)
 HENRY 8: A white one! (*Un blanc!*)
 MICHAEL 9: Wait! (*Attends!*)
 HENRY 10: I prefer you to complete the triangle, this triangle (he gives Michael two cubes for this triangle) (*Je préfère que tu complètes le triangle, ce triangle*)
 MICHAEL 11: Which triangle? (*Quel triangle?*)
 HENRY 12: This one! (*Celui-là!*)
 MICHAEL 13: I have already done all the top (*J'ai déjà fait tout le haut*)
 HENRY 14: The top? (*Le haut?*)
 MICHAEL 15: Yes! (*Oui!*)
 HENRY 16: Yes (checks Michael's construction) (*Oui*) (...)

It seems that there is a gap between what Henry was saying and what he was able to do. All through the interaction, Henry can be observed mentioning everything that the adult had told him in Phase II. On the post-test, Henry was not quite able to use it, but Michael did this with success.

General discussion

It is very interesting to compare the micro-history of Isidor and Henry and that of Francis and Michael in their four-phase learning sequence and to connect it with the kind of learning (surface or deep) that they accomplish. Equally novice on the pre-test, they have been invited to participate in pre-determined experimental conditions being trained by an adult before meeting a novice for a joint activity. The general results of the study presented earlier had shown that this experimental condition was the most productive one, but that the second was also a rich occasion for learning. In looking into details of their cases, it becomes obvious that an experimental condition is not a fixed context but a dynamic encounter in which the participants interpret differently their roles and focus differently on the social, linguistic or cognitive aspects of the task. Hence they engage in learning activities of different natures allowing for simple internalization of the semiotic means offered (as in the case of Henry) or for more profound learning with interiorization and thinking at a higher level (Isidor and Michael).

In the cases analysed here, this more productive learning was not directly dependent on the (a)symmetry of the relationship. Isidor benefited from an asymmetrical relationship with a caring adult in order to ask questions and enrich his thinking. It is interesting to note that in the next phase, when Isidor was in a new social situation in which he had to do a similar task with a peer, he did not manage to establish a cognitively collaborative relationship: first he acted and went thinking on his own in a sort of monologue and then he shared the work in a 'bureaucratic' way with Francis. As for Michael, he benefited from a horizontal relationship: his partner Henry was confused but verbalized useful academic concepts that he had learned previously from the adult. Indeed, Henry does not seem to have really interiorized at a deep level the adult's contributions in spite of her scaffolding help: he did not succeed in using them efficiently in Phases II and IV. Because of this, Henry left an open thinking space for Michael, who, seeing that his partner was sometimes wrong, progressively started to discuss his actions and to share the responsibility for the construction.

Isidor is seen acquiring a discourse that he will be able to re-use in a different social situation but he gives Francis no social opportunity to share the discourse. Henry is ready to imitate the adult (and hence her discourse) and as a consequence, Michael has a chance to practise it too. But perhaps this imitative role deprives Henry of a more autonomous attitude, which would have allowed him to think on his own and really listen to his partner.

These children diversely interpreted the social role in which the experimenter placed them. Isidor was doing things his own way, autonomous but not very social. He had a limited understanding of what the experimenter meant by 'working together'. By contrast, Henry seemed to understand that he was to learn to behave as the adult did and then reproduce this in front of his peer, placing him in the role of an observer – but he placed himself in the position of an unqualified observer, not of the qualified observer and helper that the adult was. Both Francis and Michael joined in the activity and tried to find their place in it. Michael was luckier than Francis with his partner. In fact, to share in the activity, Francis had to rely on the authority of the adult's instruction that 'frames' (Perret-Clermont 2001) the interaction: 'Aren't we supposed to work together?' But the argument of authority is not sufficient to invite his peer to join in a cognitive co-construction.

The relationship to the peer was also diversely understood. Isidor did not display any particular attention to his partner's point of view. He limited himself to expressing his own point of view. In fact, it is interesting to note that the experimenter in Grossen *et al.*'s (1993) research had acted in the same way when demonstrating the 'official' discourse and strategies that she intended to teach. As a consequence, her participants did not show much interiorized learning. Isidor's partner did not progress either. Henry behaved differently: he looked at Michael's productions and commented on them. Michael is then participating in a real dialogue and not facing a monologue. From this interactive experience, he starts gaining resources that he is given a chance to try out immediately during the activity. Finally, he will master them and re-use them successfully in Phase IV.

Conclusion

The instructions given by the adult were the same but the 'thinking spaces' that the children developed in Phase III were quite different, most probably because the attention of the adult was focused on the cognitive task and not on the social relationship that the children established, nor on the social skills and capacities of decentration that Howe (in this volume) has shown important. The adult was focused on the transmission of semiotic mediations to the child and not on the social management of each person's place, space and point of view.

Further research could study the scaffolding procedures of the adult along several dimensions. First, by exploring how the child-centred help offered by the adult contributes not only to making resources available that sustain the child's thinking, but also to shaping the social relationship in a way that does not always sustain the child's autonomy. Second, by analysing in more detail, as in Schwarz, Perret-Clermont, Trognon and Marro (2008), how peers, when they enter into a real dialogue, scaffold each other along the way. You do not need to be an expert to sustain the other's thinking. Third, by enlarging the concept of 'learning' in order to more clearly differentiate 'shallow' learning of academic concepts from the development of higher thinking resistant to social pressure.

Learning and thinking will then appear more clearly as the collaborative result of autonomous minds confronting viewpoints and cultural artefacts (tools, semiotic mediations, tasks, division of roles, etc.) and trying to manage differences, feedback and conflicts to pursue their activities. Moving from one activity to another, from one social space to another, individuals and groups have to reorganize their understanding, their language, and the organization of their social interactions. Transfer of learning is not only a cognitive matter. If experimenters or teachers expect transfer, they will have to learn to design not only scaffolding actions but whole sequences of joint activities (between experts and novices, between novices, with and without an awareness of the other's expertise) in which the learners will experience epistemic agency in discovering and appropriating different semiotic resources. These sequences of joint activities will need to be emotionally secure enough to grant the learners a thinking space in which to confront others' assertions so as not just to imitate what is said but also to critically reconstruct or deconstruct cultural assertions and develop new ones. In the next phase, the fruits of these joint actions and discursive collaborations will have to become objects of reflection. Something is learned only when it is socially recognized as 'learned'. Only then, it becomes a shared piece of knowledge in accordance with social and epistemic criteria that also need to be learned and developed.

Notes

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- 2 Study conducted by Valérie Tartas with the collaboration of Raffaella Rosciano and Aleksandar Baucal. (For more detailed results see Tartas, Perret-Clermont, Marro and Grossen 2004; Tartas and Perret-Clermont 2008.)

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