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How apes get into and out of joint actions: Shared intentionality as an interactional achievement

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How apes get into and out of joint actions: Shared intentionality as an interactional achievement

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Abstract

Compared to other animals, humans appear to have a special motivation to share experiences and mental states with others (Clark, 2006; Grice, 1975), which enables them to enter a condition of ‘we’ or shared intentionality (Tomasello & Carpenter, 2005). Shared intentionality has been suggested to be an evolutionary response to unique problems faced in complex joint action coordination (Levinson, 2006; Tomasello, Carpenter, Call, Behne, & Moll, 2005) and to be unique to humans (Tomasello, 2014). The theoretical and empirical bases for this claim, however, present several issues and inconsistencies. Here, we suggest that shared intentionality can be approached as an interactional achievement, and that by studying how our closest relatives, the great apes, coordinate joint action with conspecifics, we might demonstrate some correlate abilities of shared intentionality, such as the appreciation of joint commitment. We provide seven examples from bonobo joint activities to illustrate our framework.

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1. Introduction

Most social animal species cooperate in response to a range of problems and often in complex ways (Clutton-Brock, 2009; Trivers, 1971), but human cooperation is usually singled out as unique, for a variety of reasons. Prominent among these are accounts based on the human motivations and abilities for interacting cooperatively (Levinson, 2006), which have led to the possibility of complex joint action and the emergence of cumulative culture, social institutions, norms and conventionalised languages (Tomasello, 2009). When humans perform joint actions they do so by collaborating towards a shared goal, which requires coordination of individual actions (H. H. Clark, 1996), attentional foci, visual perspectives and intentional states (Moll & Tomasello, 2007). Human joint action has thus been characterized as establishing a state of ‘we’ intentionality, also called collective intentionality (Searle, 1990) or shared intentionality (Tomasello & Carpenter, 2007). Although intuitively appealing, the concept is controversial. While many agree that there is something special about how humans interact, and that their joint actions are enabled by shared intentionality, it has been difficult to agree on the cognitive abilities and mental states constituting it. One contentious issue is whether shared intentionality is a qualitatively distinct cognitive ability, and based on a special motivation to share experiences and mental states with others, and is thus unique to adult humans, or whether it emerges gradually (ontogenetically and phylogenetically) from simpler forms of social awareness.

In this paper, we describe an alternative approach to the comparative assessment of shared intentionality that is less reliant on assumptions about cognitive states and abilities. We propose a framework for describing the collaborative process necessary to achieve coordinated joint action that can be applied to any species. Our core thesis is that shared intentionality can be operationalised as a publicly observable *interactional achievement*, i.e., as the outcome of a joint process of alignment of behaviours via signal exchange (Mondada, 2011; Schegloff, 1986) during joint action, irrespective of cognitive states presumed to be involved in cooperative activities. This framework will allow systematic assessment of the presence or absence of specific behavioural correlates of shared intentionality, such as attempts to establish participation frameworks when initiating a joint action, reengaging partners who interrupt the joint action, or showing signs of leave-taking when disengaging from the joint action. Our approach is based on an understanding, derived from interdisciplinary studies of human social interactions, of how humans get into, conduct, and get out of joint actions in an orderly way, thereby collaboratively constructing the state of “togetherness” characteristic of shared intentionality. This creates a broader, less theory-laden set of criteria for assessing shared intentionality than previously considered.

We first review the mainstream view, which portrays shared intentionality as a high-level individual cognitive ability, and the critiques of this view that have emerged. We then describe our framework, inspired by both ethology and human interaction research. We illustrate it with examples of how bonobos, the closest primate relative of modern humans, coordinate naturally occurring joint actions. The examples suggest that bonobos are sensitive to some degree to the imperatives involved in opening, maintaining, and closing joint actions. We finish by assessing the implications of our framework in offering new perspectives on the evolutionary origins of shared intentionality and its links to uniquely human traits, such as language.

2. Shared intentionality

2.1 Defining shared intentionality: Ability vs. process-based approaches

Definitions of shared intentionality focus on the ability and motivation (Levinson, 2006; Rosas & Bermúdez, 2018) to participate in joint commitments or to share goals or intentions. For Searle (1990), collective intentions are not simply the sum of individual intentions of doing things jointly with someone else, nor the sum of individual capacities for planning and coordinating actions with others. Coinciding individual intentions, in other words, are not sufficient to create shared intentions (Bratman, 1993; Tomasello, 2014; Tuomela, 2005). For instance, to play a game of tennis together, it is not sufficient that two players intend to play a game of tennis, but both also have to *agree* to play the game together. Purportedly, shared intentionality thus relies on complex cognitive abilities, such as recursive mind-reading and perspective-taking, allowing partners to understand that their roles are complementary and part of a joint commitment (Tomasello & Carpenter, 2007; Tomasello & Moll, 2010). However, these definitions tend to place the bar for what counts as shared intentionality rather high (Tollefsen & Dale, 2012), thus excluding cases of joint action in agents with different cognitive abilities than adult humans, e.g., children, animals or artificial agents (Kern & Moll, 2017; Rosas & Bermúdez, 2018; Sebanz & Knoblich, 2016; Townsend et al., 2017). Moreover, shared intentionality, in this view, is conceptualized as a modular evolutionary saltation rather than as a set of gradually evolved cognitive capacities, which is problematic. A potentially promising solution to this problem has been proposed by Tollefsen and Dale (2012), who suggest focusing on the *processes* by which joint action is initiated and maintained. While high-level joint commitments can entail the initiation of joint actions (e.g., two players agree to play tennis together), their maintenance may often rely on lower-level alignment processes (e.g., hitting the ball back and forth) that involve perception or motor behaviour and, presumably, little cognition.

A focus on the *processes* of joint actions has the additional advantage of opening research on the phylogenetic history of shared intentionality. This is well illustrated by a recent study on object moving in *Paratrechina longicornis* ants. When humans perform the joint action of moving a piano into a house, they typically coordinate their individual actions with communication, to coordinate movements, assign roles and agree on leadership, that is, they enter a state of shared intention. When the ants were tested with a very similar problem (carrying large food items to the nest) they also coordinated their actions and avoided inefficient tug-of-wars, but their joint action was not driven by communication, role taking, or agreed leadership but from an over-proportional influence of newly arriving ants that were best informed about the nest-bound direction (Gelblum et al., 2015). Hence, although ants can coordinate their actions to collaboratively carry large loads, the processes through which joint action are achieved (and the degree to which participants understand these processes) are different from humans. We thus suggest that studying the alignment processes involved in the coordination of joint action has explanatory potential for reconstructing the evolution of shared intentionality.

2.2. Shared intentionality in great apes?

Although apes cooperate regularly, e.g., hunting (C. Boesch, 2002, 2005) or patrolling borders (Watts & Mitani, 2001), it is unclear whether they experience something akin to shared intentionality (C. Boesch & Boesch, 1989; Hamann, Warneken, Greenberg, & Tomasello, 2011; Mitani & Watts, 2001). Individuals may simply be acting in parallel with others in pursuit of a personal goal, without experiencing a state of shared intention. According to one influential account, shared intentionality involves three essential component abilities, i.e., (1) understanding of intentions, (2) cooperative communication, and (3) mutual helping (Tomasello & Carpenter, 2007; Tomasello et al., 2005; Tomasello & Moll, 2010). Although it is very difficult to provide systematic evidence from free-ranging animals, these abilities have been demonstrated to some degree in apes, mostly in laboratory experiments. First, apes appear to understand others as intentional agents insofar as they (a) prefer partners that have collaborated well with them in the past (Melis, Hare, & Tomasello, 2006a), (b) are capable of attributing motives to others (Call & Tomasello, 2008) and (c) appear to read false beliefs in others (Krupenye, Kano, Hirata, Call, & Tomasello, 2016). Second, in terms of cooperative communication, they can tailor signals to their audience’s attentional state (Hostetter, Russell, Freeman, & Hopkins, 2007; Leavens, Hostetter, Wesley, & Hopkins, 2004), to their recipients’ understanding (Cartmill & Byrne, 2007), knowledge (Catherine Crockford, Wittig, Mundry, & Zuberbühler, 2012; Roberts, Vick, Roberts, & Menzel, 2014, Bohn et al. 2015) and familiarity (Genty et al., 2015a). They are capable of using referential signals (e.g., Genty & Zuberbühler, 2014; Hobaiter et al., 2014; Leavens & Hopkins, 1998; Leavens, Hopkins, et al., 2004; Lyn et al., 2014; Pika & Mitani, 2006; Savage-Rumbaugh, McDonald, Sevcik, Hopkins, & Rubert, 1986; Slocombe & Zuberbühler, 2005) and of engaging in gestural turn-taking (Fröhlich, Kuchenbuch, et al., 2016a; Rossano, 2013). Third, chimpanzees understand role reversal

(Povinelli, Nelson, & Boysen, 1992) and collaborate via complementary roles (Fletcher, Warneken, & Tomasello, 2012). They reliably help conspecifics to access food (Melis & Tomasello, 2013; Melis et al., 2011; Warneken, Hare, Melis, Hanus, & Tomasello, 2007; Yamamoto, Humle, & Tanaka, 2009), even without being specifically solicited (Greenberg, Hamann, Warneken, & Tomasello, 2010). Bonobos even extend this behaviour to strangers (Tan, Ariely, & Hare, 2017).

Curiously, however, despite the apparent presence of the three key component abilities for shared intentionality (Tomasello & Carpenter, 2007), joint actions in great apes do not appear to be governed by it. When tested in collaborative tasks, chimpanzees do not reverse roles (Fletcher et al., 2012; Tomasello & Carpenter, 2005) nor do they help partners receive rewards after they have received their own (Greenberg et al., 2010; Hamann, Warneken, & Tomasello, 2012). Furthermore, chimpanzees do not reengage reluctant (human) partners in cooperative games, suggesting that they do not understand joint commitment (Warneken, Chen, & Tomasello, 2006). They also show no sign of leave-taking when disengaging from a joint action, and they do not protest when a partner interrupts a joint action (Melis, Hare, & Tomasello, 2006b; Warneken et al., 2006). Taken together, these findings suggest that great ape social interactions are driven by individual and competitive motives, rather than human-like cooperation (Hare & Tomasello, 2004; Muller & Mitani, 2005). Their interactions seem mostly egoistic, which is well illustrated when dominant individuals coerce others into cooperating or use them as social tools (Völter, Rossano, & Call, 2015). Also important, in captivity great apes seem to show little to no motivation for collaborating with conspecifics (Bullinger, Melis, & Tomasello, 2011; Melis & Tomasello, 2013) and do not seem to understand that their actions are essential for successful joint action (Carpenter & Call, 2013).

So, what could possibly account for the discrepancy between the presence of component abilities of shared intentionality and the absence of the behavioural patterns indicative of shared intentionality in apes? One possibility is that captive apes are cognitively different from wild apes (e.g. Boesch 2008), a general issue that cannot be addressed here.

Another possibility is that the experimental designs used to test shared intentionality are inadequate, perhaps due to their high complexity and low ecological validity. For example, in other studies apes did cooperate in triadic activities with human partners (Hirata, Morimura, & Fuwa, 2010; MacLean & Hare, 2013; Pika & Zuberbühler, 2008), suggesting that performance differences may be due to the nature of the task. Also, in laboratory experiments apes are typically required to interact with human experimenters, with whom they do not share a natural communication system, nor a relevant history of reciprocity, which could explain the performance differences between apes and human children (e.g., Warneken et al., 2006). Furthermore, language-trained apes do have the potential to interact with humans in collaborative activities, to understand their communicative conventions and to communicate cooperatively with them (e.g., Gardner & Gardner, 1969; Miles, 1990; Savage-Rumbaugh et al., 1986). Finally, the current evidence largely consists of studies with chimpanzees, but there may be species differences. For instance, chimpanzees live in social organisations that are more competitive than bonobos (De Waal, 1989; Hare & Tomasello, 2004; Hare, Melis, Woods, Hastings, & Wrangham, 2007), and bonobos are more prosocial, more tolerant, and show more positive responses towards strangers (Tan et al., 2017; Tan & Hare, 2017). In sum, the current evidence for shared intentionality in great apes is controversial, with a species bias towards chimpanzees and an experimental design bias where important confounds have not been removed (Leavens, Bard, & Hopkins, 2017).

2.3. Shared intentionality as a collaborative process

As mentioned, definitions of shared intentionality tend to focus on a high-level cognitive ability that can be present or absent in individuals. In contrast, Tollefsen and Dale (2012) focus on the processes by which joint activities are initiated and coordinated, like behavioural and motor synchronization, is empirically better suited for systematic studies of natural social interactions. In humans, a large body of research suggests that alignment towards joint action takes place through collaborative signal exchanges that unfold via turn-taking (H. H. Clark, 1996; Pickering & Garrod, 2004). These exchanges are visible and audible to external observers and thus have the potential to become public correlates of shared intentionality (or, for that matter, any kind of purportedly purely cognitive phenomena; Mondada, 2011).

In fact, the concept of shared intentionality actually builds on seminal contributions to the understanding of social interaction. For example, Goffman (1963) distinguished ‘unfocused’ interactions (people are co-present but do not engage in a joint activity, e.g., while waiting at a bus stop) from ‘focused’ interactions, where ratified participants sustain a shared focus of attention (see also Gilbert, 1990). In focused interactions, participants are jointly committed to an activity and thus mutually accountable towards their partners for its pursuance and completion (A. Clark, 2008; Goffman, 1963, 1967). This accountability is particularly visible when the interaction is initiated, suspended or ended. For example, partners orient their bodies, talk and gaze to progressively achieve the state of focused interaction (Mondada, 2009). They justify the necessity to suspend the interaction (Chevalley & Bangerter, 2010), try to reengage reluctant partners who may abruptly stop participating (Warneken et al., 2006) and collaborate to end the activity appropriately and take leave of each other (Albert & Kessler, 1976; Schegloff & Sacks, 1973). Appropriate construction of the beginning or ending of a joint action often serves to relate it to an overarching and sustainable relation between the participants; thus, shared intentionality can endure beyond a single interaction to enable the pursuit and completion of long-term projects.

We thus believe it is useful to revisit the concept of shared intentionality with a systematic redefinition as the outcome of a collaborative process of alignment via signal exchange. This is likely to open up new ways for the comparative assessment of its full or partial presence in different species. We thus advocate a close analysis of natural behaviour using state-of-the art theoretical concepts and micro-analytical methods from human interaction studies to directly compare the processes by which humans and great apes achieve coordinated joint actions, a paradigm shift that is likely to benefit animal behaviour research (Fedurek, Slocombe, Hartel, & Zuberbühler, 2015; Fröhlich et al. 2016a; Fröhlich, Müller, Zeiträg, Wittig, & Pika, 2017; Logue & Stivers, 2012; Rossano, 2013).

In the next section, we describe a framework for the systematic assessment of how joint action is initiated, maintained and terminated in humans, as well as its possible application to great apes.

3. Joint action coordination in humans and its application to great apes

Joint action involves two or more individuals collaborating to achieve a shared goal. This poses coordination problems that need to be solved for the action to emerge and get completed successfully. Initiators of the joint action need to make their intentions intelligible to their partners. Participants need to understand what they are going to do together, when and how they are going to do it, and who is going to be involved (or not involved). Because joint actions involve spending time, effort and attention, they entail opportunity costs. In committing themselves to a joint action, then, participants renounce the opportunity to pursue other activities. Recruiting participants for joint action thus also poses potential threats to partners' face (Brown & Levinson, 1987; Goffman, 1967), which participants need to continuously manage.

As a result of these coordination demands, joint actions typically play out in three main phases. First, there is the opening phase where a participation framework is established. Participation frameworks are typically established by looking at potential partners as a way of selecting participants, by engaging in mutual gaze and gaze exchanges (Goodwin & Goodwin 2004; Goodwin 2007, Rossano, 2013) to construct a shared focus of attention (Goffman, 1981; Kendon, 1976, 2004). They also feature greeting sequences (De Stefani & Mondada, 2018; Youssouf, Grimshaw, & Bird, 1976), and negotiation of the terms of commitment to the content, location and timing of the action (H. H. Clark, 1996). Then, there is the main body, or the joint action proper, where the "official business" of the interaction is accomplished. Progress in accomplishing the main body needs to be coordinated, e.g., by signalling transitions from one part of a task to the next (Bangerter & Clark, 2003) or re-affirming ongoing joint commitments. Because joint actions are sometimes interrupted by some external event, participants collaborate to suspend and reinstate them in an orderly way. Participants may ask permission to suspend the interaction, apologize for keeping their partners waiting, justify the necessity to suspend before reinstating the activity and check availability when attempting to re-engage (Bangerter, Chevalley, & Derouwaux, 2010; Chevalley & Bangerter, 2010). Finally, there is the closing phase where participants coordinate their readiness to end the joint action. They need to arrive at the mutual conviction that they are ready to end the interaction. In humans, participants communicate this readiness through sequences like *okay* - *okay*, ensuring that hitherto unraised topics can be addressed if necessary. Then, they progress through steps, including reminiscing about the encounter, suggesting continuity of the relationship, exchanging well-wishing expressions like *good-bye* and finally, taking leave of each other, for example by walking away (Albert & Kessler, 1976; Bangerter, H. Clark, & Katz, 2004; Broth & Mondada, 2013; H. Clark & French, 1981; Schegloff & Sacks, 1973). This phase can be divided into two sub-phases: the *pre-exit* in which participants establish mutual awareness of the readiness of participants to end the encounter, and the *exit* where the encounter is terminated and participants take leave of each other (Heesen et al., 2017; Schegloff & Sacks, 1973). Among other things, the closing phase allows participants to symbolically maintain interpersonal relationships beyond the encounter. These phases suggest that beginnings and endings of encounters are not discrete points in time, but processes (Albert & Kessler, 1976). While they may vary cross-culturally in terms of the exact signals used to perform them, in themselves they seem to be consistent across many human cultures (Duranti, 1997; Levinson, 2006) and bear witness to the importance of constructing the psychological state of “togetherness” inherent to human joint action (Carpenter & Call, 2013). At the same time, their consistency suggests a possible ethological foundation and continuity with earlier *Homo* species (Levinson, 2006; Levinson & Holler, 2014) or great apes. Indeed, apes also engage in coordinated actions with conspecifics, such as joint travel, cooperative hunting~~,~~ social grooming or social play. As discussed above, the degree to which these actions are joint in terms of whether or not partners aim to achieve shared goals together, or whether partners have shared intentions, remains unknown. Although apes’ intentions cannot be directly measured, the communicative signals and behaviours deployed to coordinate these interactions are observable. If ape joint actions also feature observable exchanges of signals that resemble those humans use to construct opening, main body and closing phases and to deal with interruptions, then this would constitute suggestive evidence for their possession of some form of shared goals. In other words, we argue that even without necessarily creating mental representations of goals, individuals engaging in joint activities can create shared goals as a result of interactional achievements. These shared goals could be behaviourally and communicatively manifested when both partners (implicitly or explicitly) agree to engage in a joint activity together, commit to complete this activity together (even if interrupted), and seem both satisfied to end the interaction when disengaging from it. Commitment to this shared goal could also be behaviourally and communicatively evidenced in cases of interruption of the joint activity by an external stimuli, by the use of communicative signals to advertise the necessity to suspend the activity, the reengagement of the initial social partner after interruption, the continuity of the activity at the point where it was left off at the time of suspension, or the manifestation of frustration, protest or sanction when a partner breaks the commitment without respecting the norms to disengage from it. Thus, by applying methods of investigation developed in the analysis of human joint action, it is possible to operationalize the concepts of shared goals and joint commitment (both correlates of shared intentionality) by assessing whether apes' joint actions feature identifiable opening, main body, and closing phases, what signals are involved to coordinate the different phases and to manage cases of interruptions, whether the coordination depends on the type of activity, the species, and/or whether it is affected by the relationship between partners (friendship and rank).

Potential opening phases in ape joint action can be conceptually divided into two sub-phases. First, there is the *pre-entry* in which one participant selects a partner, orients its body towards it, approaches it, attracts its attention, and checks its availability with the aim of attaining a state of joint attention and ascertaining they are ready and willing to participate in a yet unspecified joint action. This phase may vary in duration, depending on the initial spatial proximity between individuals. Pre-entry may be unnecessary if potential interaction partners are already in proximity to each other. Then there is the *entry* (see Figs. 1 and 2), where participants establish a joint commitment to engage in a *specific type* of joint action (with potentially species-typical initiation signals) and determine the details of its content, timing and location. For example, combinations of gesture sequences are used to signal the intention of engaging in joint travel between mother and infant chimpanzees (Fröhlich, Wittig, & Pika, 2016b), and specific gestures or body signals are used to initiate social play, social grooming (K. E. Graham, Hobaiter, Ounsley, Furuichi, & Byrne, 2018; Hobaiter & Byrne, 2014) or sex (Genty, Neumann, & Zuberbühler, 2015b) with conspecifics. In ape interactions, the *main body* or the activity properly speaking (e.g., play, grooming) can be composed of sub-phases, depending on how the activity unfolds. For example, participants may coordinate a *type-change* e.g., from grooming to play or from contact play to chase play. They may engage in *role-reversal* e.g., from being the groomer to being groomed or from chasing to being chased. If an *interruption* occurs, for example through the intervention of a third individual, participants need to coordinate on the suspension and the possible reinstatement of the activity with their original partner. Finally, apes may express intentions to end a joint action before actually doing so (*pre-exit*), for instance through behaviour or communicative signals that reduce the activity intensity or tempo. In the exit, participants may take leave of each other via communicative signals or specific behaviours beyond simply walking away. Like the pre-entry, the exit may be dropped if partners remain in proximity to each other.

4. Joint action coordination in great apes

4.1 Candidate activities for the study of joint action in great apes

Social play and social grooming represent two promising candidate activities for the study of joint action coordination in apes. They are both frequent, require on-the-fly coordination between partners for prolonged periods of time and involve reciprocity and communication to distinguish them from related, non-friendly contexts (Demuru, Ferrari, & Palagi, 2015; Fedurek et al., 2015; Fröhlich, Wittig, & Pika, 2016c; Genty et al., 2009; Hobaiter & Byrne, 2011; Elisabetta Palagi, 2006). Social play covers many functions (K. L. Graham & Burghardt, 2010;

Göncü, & Gaskins, 2007), including learning social positions and rules (Poirier & Smith, 1974; Tartabini & Dienske, 1979), reducing aggression and establishing social bonds (Drea, Hawk, & Glickman, 1996; Pellis & Pellis, 1996). Although all partner combinations are possible, apes seem to prefer to engage in play with individuals matching in age class (Cordoni & Palagi, 2011).

Social grooming, beyond its hygienic function, serves to reduce tension (C. Crockford et al., 2013), promote tolerance (Port, Clough, & Kappeler, 2009), restore relationships after aggression (Aureli, Cords, & Van Schaik, 2002; Barrett, Gaynor, & Henzi, 2002), facilitate coalitions, and establish and maintain social bonds (Dunbar, 1991, 2010; Fedurek & Dunbar, 2009; Schino, di Sorrentino, & Tiddi, 2007; Seyfarth & Cheney, 1984). Male chimpanzees close in rank groom each other more than those distant in rank (Arnold & Whiten, 2003) and lower ranking males spend more time grooming higher ranking males (Kaburu & Newton-Fisher, 2016; Schino & Aureli, 2009). Male bonobos with strong social bonds groom each other more often, but the duration and reciprocity of consecutive grooming bouts is not influenced by rank difference (Surbeck & Hohmann, 2015).

Another promising candidate activity for the study of joint action coordination in great apes is sex. In particular, bonobos are known for their socio-sexual behaviour (de Waal, 1987; Kano, 1992; Kuroda, 1984), and exhibit frequent sexual interactions, in almost every partner combination. Beyond reproduction, bonobos' sexual behaviour functions to mediate their social interactions and relationships, including tension reduction (Hohmann et al., 2009), especially in the context of food competition, where it is offered to gain access to resources (de Waal, 1987; Kano, 1992; Kuroda, 1984; Parish, 1994). Sex is also used for strengthening female social bonds (Badrian &Badrian, 1984; Furuichi, 1989; Hohmann & Fruth, 2000; Kano, 1992), for consolation (Clay & de Waal, 2013), and reconciliation (Clay & de Waal, 2014: de Waal, 1990; Hohmann & Fruth, 2000). However, bonobos' sexual interactions are rarely isolated from other social interactions, mainly play, grooming, and feeding, and for this reason it appears difficult to detach this specific activity from its role in the coordination of the larger activity itself (e.g., sex is often used right at the end of a social activity to ensure a smooth ending to the interaction).

Communicating about intentions and subsequent behaviours is essential to initiate, maintain, and terminate joint actions in animals, especially for activities involving close physical proximity, such as play and grooming, that are risky and could potentially give way to aggression. Consequently, many species exhibit specific signals and behaviours to advertise friendly intentions (Bekoff & Allen, 1998; Fedurek et al., 2015; Elisabetta Palagi, Cordoni, & Borgognini Tarli, 2004) and to coordinate this type of joint action. Great apes look at their partner and engage in mutual gaze as a way of establishing participation frameworks (Liebal et al., 2004; Rossano & Liebal, 2014; Rossano, 2013). They use specific gestural communication to initiate play bouts (Genty et al., 2009), to reengage reluctant partners (Hobaiter & Byrne, 2014), change tempo (Hobaiter & Byrne, 2014) and to terminate play bouts (Fröhlich et al., 2017; Genty et al., 2009; Heesen et al., 2017; Hobaiter & Byrne, 2014). Play bouts are also maintained with the use of play faces and laughter (Enomoto, 1990; E. Palagi, 2008).

Great apes initiate social grooming with specific postural, gestural or vocal signals (Fedurek & Dunbar, 2009; Goodall, 1986; Hobaiter & Byrne, 2014) and direct the groomer’s attention to a desired body location with specific signals (K. E. Graham et al., 2018; Hobaiter & Byrne, 2014; Pika & Mitani, 2006). Grooming is often reciprocated by taking turns in coordinated ways (Machanda, Gilby, & Wrangham, 2014). Risks of aggression are prevented (for instance when grooming vulnerable body parts like the face or genital area) and bouts maintained by lip-smacking (Fedurek et al., 2015).

To date, play and grooming interactions have been investigated in a rather fragmented manner focusing mainly on the initiation, maintenance or more rarely on the termination of the activities. Researchers, however, have rarely focused on the sequential organization of the activities and how the communicative signals potentially represent means to solve the coordination problems inherent with initiating, maintaining and closing joint action (Hayaki, 1985; Heesen et al., 2017; King, 2009).

In what follows we will present a fine-grained analysis of seven examples of joint action coordination in bonobo dyads engaged in grooming and play.

4.2 Examples of joint action coordination in bonobos

Images were taken from video clips of interactions collected as part of a larger project on joint action coordination in bonobos and chimpanzees. We recorded focal samples from 9 individuals at the San Diego Zoo, USA between January and March 2017 (270 hours of recording) and from 16 individuals at La Vallée des Singes, France between April and September 2017 (330 hours of recording). Grooming and play interactions were recorded on a digital camera equipped with a directional microphone in order to capture all visual and audible signals deployed. In the following excerpts, we briefly describe the relationship between the two protagonists in terms of kinship, social bonds and dominance rank. To assess the strength of social bonds and the dominance relationships we used measures of Dyadic Sociality Index (Neumann, in preparation) and Elo-rating (Neumann & Kulik, 2014) respectively. More precisely, for the Dyadic Sociality Index, to determine the strength of social bonds between partners, we analysed, for each dyad, the duration and direction (i.e., who initiated the interaction) of grooming and play interactions, the number and direction of approaches, and the time they spent in close proximity to one another (i.e., arm-length distance). For the elo-rating, the dominance rank of each individual was calculated based on the outcome of conflicts (i.e., winner, loser or tie). The values varied between 0.04 (weakest bond) and 5.48 (strongest bond) for La Vallée des Singes, and between 0.21 (weakest bond) and 3.87 (strongest bond) for the San Diego zoo. For the following descriptive illustrations, we used the median (0.61 for La Vallée des Singes, and 0.68 for the San Diego zoo) as a cut-off value to categorize the strength of social bonds, i.e., the pairs with a value above the median were considered as strongly bonded, and those with values below the median as weakly bonded. The elo-rating scores varied between 417 (lowest ranking) and 1663 (highest ranking) for La Vallée des Singes, and between 761 (lowest ranking) and 1258 (highest ranking) for the San Diego zoo. The evaluation of relative difference in rank between partners was based on their individual elo-rating scores.

The following examples illustrate how the joint actions are initiated (Examples 1 and 2), how they are interrupted and resumed (Examples 3,4 and 5) and how they are ended (Examples 6 and 7). These examples were selected based on their image quality, their ability to best illustrate each of the different subphases of joint action, the fact that they included clear and visible signals, and because they featured various combinations of partners' relationship types. We highlight similarities and differences in the behavioural structure of the initiation, maintenance, resumption and closing of bonobo joint actions and those of humans. The communicative signals indicated in italics are part of the species' described repertoire of gestures (Genty, Clay, Hobaiter, & Zuberbühler, 2014; Genty et al., 2015b; K. E. Graham, Furuichi, & Byrne, 2017), facial expressions (de Waal, 1988), vocalisations and body postures (Bermejo & Omedes, 1999; de Waal, 1988; Genty et al., 2014).

4.2.1. Example (1): Opening of grooming interaction between two adult males

Example (1) (Fig. 1) is extracted from Clip S1 and illustrates the opening of a grooming interaction between two adult males, Kelele and Diwani, housed at La Vallée des Singes, France. They are both low-ranking, with Diwani being higher in rank (elo-rating= 953) than Kelele (elo-rating= 417). They are unrelated and share a strong bond (DSI=1.31). Right before the beginning of the interaction, Kelele and Diwani are sitting in the grass about 4 metres apart, their backs turned to one another.

4.2.1.1. Pre-entry

Kelele stands up and approaches Diwani from his right side (Fig.1, I-1.). They gaze at each other, for 1.0 s, establishing mutual gaze and a potential participation framework (Fig. 1, I-2).

4.2.1.2. Entry

Diwani and Kelele gaze at each other twice, (for 0.50 and 1.10 s) before Diwani reaches out (*Reach)* with his right foot (Fig. 1, I-3), waits for a response, persists and repeats *Reach* gesture and extends it further, waits for a response, and repeats *Reach* gesture again. Kelele sits down in front of Diwani and presents (*Present*) his body for grooming (Fig. 1, I-4). Diwani approaches and sits close to Kelele. Kelele approaches his face to peer into Diwani's eyes (Fig. 1, I-5), Diwani starts grooming Kelele's head (Fig. 1, I-6).

We suggest that the communicative signals used by Kelele and Diwani in the opening phase (*Reach*, *Present*), associated with the exchange of gazes between participants are used to establish the type of activity they are going to be engaging in (i.e., grooming), their individual roles (groomer/ groomee) and a potential participation framework. They solve several coordination problems, for example clarifying Kelele's intentions and verifying both partners' availability and willingness to engage in a grooming bout.

--- Figure 1 about here ---

4.2.2. Example (2): Opening of play interaction between an adult male and an infant male

This example is extracted from Clip S2 and illustrates the opening of a play interaction between an adult male, David, and his infant male son, Moko, housed at La Vallée des Singes, France. Their mothers are the two highest ranking females in the group, indirectly conferring them a high status in the group. David is the highest-ranking male in the group (elo-rating=1428), Moko is also high ranking (elo-rating= 1099). Their bond is quite strong (DSI= 1.22).

4.2.2.1. Entry

Moko is sitting on a tree trunk, holding a rope (Fig 2, I-1). David approaches him. They gaze at each other for 5.8 s, establishing mutual gaze and a potential participation framework (Fig. 2, I-2.). Moko stomps his left foot on the rope (*Stomp*) (Fig. 2, I-3.). David climbs on the tree trunk and Moko stands up to move aside (Fig.2, I-4) while they gaze at each other again for 0.62 s, then again for 1.76 s. Moko performs a somersault (*Somersault*) on the tree trunk (Fig. 2, I-5) and David approaches Moko to initiate contact play (Fig. 2, I-6) by mock-biting him.

We suggest that the gestural signals used by Moko in the opening phase (*Stomp*, *Somersault*), associated with the exchange of gazes between participants are used to establish the type of activity they are going to be engaging in and a potential participation framework.

--- Figure 2 about here ---

4.2.3. Example (3): Interruption and resumption of grooming (in main body) between an adult female and an adult male

This example is extracted from Clip S3 and illustrates the re-engagement of a partner following an interruption of a grooming interaction between an adult female, Lisa, and an adult male, Vic, housed in the San Diego zoo, USA. Vic is Lisa's son and they share a relatively strong bond (DSI= 0.96). Lisa is the second highest ranking female (elo-rating= 1197) in the group and Vic is of medium rank (elo-rating= 985).

4.2.3.1. Interruption

Lisa and Vic have been engaged in grooming for almost 3 minutes. At this point, Lisa is grooming Vic's right shoulder (Fig. 3, I-1). Their attention is distracted by an external event (noise in the upper part of the enclosure). They look in the direction of the interruption source and interrupt their grooming bout (Fig. 3, I-2). They both stand up and walk in the direction of the noise (Fig. 4, I-3). Vic climbs up a tree to get closer to it (Fig. 3, I-4). They both gaze up in the direction of the noise (Fig. 3, I-4). Lisa walks back to the location where they were grooming before, Vic remains in the tree. Vic later gazes at Lisa, climbs down the tree (Fig. 3, I-5) and walks back towards Lisa, Lisa watches him approaching (Fig. 4, I-6). They gaze at each other (Fig. 3, I-7). After an interruption of 1 min 10 s in total, Lisa reengages him in the grooming interaction. She claps her hand (*Clap*) at Vic's approach (Fig. 3, I-7) and reaches out to him with her right hand (*Reach*) (Fig. 3, I-8). Vic sits down in body contact with Lisa. Lisa starts grooming him again on the left shoulder at the same location they were sitting before the interruption (Fig. 3, I-9).

The resumption of the activity with the same partner and at the same location, after being interrupted by an external event, having relocated and being physically separated, and the reengagement via communicative signals, suggests the possibility that Lisa and Vic are both committed to grooming each other at a specific location until both are ready to terminate the activity. We also suggest that the communicative signals used to reengage the partner, i.e., the gestures *Clap* and *Reach*, associated with direct gaze, represent potential reengagement signals.

--- Figure 3 about here ---

4.2.4. Example (4): Interruption and resumption of grooming (in main body) between an adult female and an adult male

This example is extracted from Clip S4 and illustrates the reengagement of a partner following an interruption in the main body of a grooming interaction between a high-ranking (elo-rating = 1255) adult female, Ulindi, and an unrelated low-ranking (elo-rating=417) adult male, Kelele, housed at La Vallée des Singes, France. They have a relatively strong bond (DSI= 0.95).

4.2.4.1. Interruption

Kelele and Ulindi have been grooming for about 38 minutes. During this interaction several *role-reversals* (from groomer to groomee) and minor interruptions occurred. Ulindi is grooming Kelele's left leg at this point (Fig. 4, I-1). She takes a break, interrupting the grooming bout. After 5.0 s, their attention is directed towards David, the highest-ranking male of the group, approaching (Fig. 4, I-2). When David arrives in close proximity to them, he looks at Kelele (Fig. 4, I-3). Kelele moves aside with a pout face (*Pout*) (Fig. 4, I-3). David sits between them and starts grooming Ulindi's right foot (Fig. 4, I-4). Ulindi immediately bends over, stretches out her arms to grab Kelele's shoulder and arm (*Grab*) and pulls Kelele to her (*Pull*) to reengage him in the previously interrupted grooming interaction (Fig. 4, I-5) Ulindi resumes grooming on Kelele's right arm (Fig. 4, I-6). David sits up and stops grooming Ulindi.

Even when interrupted by a high-ranking individual, Ulindi resumes the interrupted grooming interaction with Kelele, her original partner. This suggests the possibility that the two partners are committed to grooming each other until both are ready to terminate the activity.

--- Figure 4 about here ---

4.2.5. Example (5): Interruption and resumption of grooming (in main body) between an adult female and an adult male

This example is extracted from Clip S5 and illustrates the reengagement of partners following an interruption in the main body of a grooming interaction between an adult female, Ulindi, and an unrelated adult male, Diwani, housed at La Vallée des Singes, France. They have a weak bond (DSI= 0.6). Ulindi is high-ranking (elo-rating= 1255) and Diwani is of medium rank (elo-rating= 953).

4.2.5.1. Interruption

Ulindi and Diwani have been engaged in a grooming interaction for about 6 minutes, with no role reversals but one previous interruption (at 1min into grooming and 20s long) caused by a third party and followed by reengagement. At this point, Diwani is grooming Ulindi’s neck (Fig. 5, I-1). A noise in the holding area attracts Diwani’s attention (Fig. 5, I-2). He looks up, stands up and walks in the direction of the noise. Ulindi stands up and follows him (Fig. 5, I-3). They both walk towards the holding area and peer inside to find the source of distraction. After a few seconds, Diwani turns around and walks away (Fig. 5, I-4). Ulindi stays a little longer and peers inside the holding area again (Fig. 5, I-5). Diwani and Ulindi are about 4 metres apart, they gaze at each other for 1.5 s (Fig. 5, I-6). Diwani starts walking back towards the location where they were grooming before the interruption. Ulindi starts walking in the same direction. After 1 minute of interruption in total, Diwani sits down at the same location in their enclosure they were grooming before the interruption. Ulindi approaches him. When mutual gaze has been re-established, Diwani reengages the interrupted grooming interaction by presenting for grooming (*Present*) (Fig. 5, I-7). Ulindi comes in close proximity and presents her backside for grooming (*Present*), all the while they gaze at each other (for 3.15 s) (Fig. 5, I-8). Diwani starts grooming her backside (Fig. 5, I-9). The grooming interaction is reinstated.

The resumption of the activity, with the same partner and at the same location, after being interrupted by an external event, having relocated and being physically separated, and the reengagement of partner via communicative signals, suggests the possibility that Ulindi and Diwani are committed to grooming each other, at a specific location, until both are ready to terminate the activity. We further suggest that the gaze exchanges and *Present* body postures deployed during the reinstatement of the activity, potentially represent reengagement signals.

--- Figure 5 about here ---

4.2.6. Example (6): Closing of a play interaction between an adult male and an infant male

This example is extracted from Clip S2 (see 4.2. for description of social partners in terms of identity, kinship, social bonds and dominance relationship).

4.2.6.1. Exit

David and Moko have been playing for about a minute (40.0 s in contact play then changed play type (*Type change*) from contact to chase play) and engaged in a chase play for 15.0 s when David stops running and sits down (Fig. 6, I-1). Moko slaps David’s back (*Slap*) (Fig. 6, I-1) with a play face (*Playface*), David replies with a play face (*Playface*) (Fig. 6, I-1). David puts his hand on Moko’s back (*Hand on*) (Fig. 6, I-2). Moko climbs up the tree trunk, David gazes at Moko (Fig. 6, I-3). Moko lays down on top of the tree trunk. The play interaction is closed. We suggest that the gestural signal (*Hand on)* and the gaze deployed during the closing phase might potentially represent leave-taking signals.

--- Figure 6 about here ---

4.2.7. Example (7): Closing of a grooming interaction between two adult females

This example is extracted from Clip S6 and illustrates the closing phase of a grooming interaction between two adult females, Daniela and Ulindi, housed at La Vallée des Singes, France. Daniela and Ulindi are both high-ranking. Daniela is higher ranking (elo-rating= 1482) than Ulindi (elo-rating= 1255). They have a relatively strong bond (DSI= 0.72).

4.2.7.1. Exit

Daniela and Ulindi have been grooming for almost 30 minutes (Fig. 7, I-1) with two *role-reversals* (from groomer to groomee) and one interruption. At this time, Daniela is grooming Ulindi's left arm (Fig. 7, I-1). Daniela stops grooming Ulindi (Fig. 7, I-2), grabs Ulindi's left arm with her left hand (*Grab*) (Fig. 7, I-3) stands up, grabs Ulindi's left arm with her right hand (*Grab*) and starts walking away (Fig. 7, I-4). Ulindi looks at Kallie walking away (Fig. 7, I-4). While walking away Daniela gazes back twice at Ulindi who is gazing back at her (Fig. 7, I-5, I-6). Ulindi looks at Daniela walking away. The grooming interaction is closed.

We suggest that the gestural signals (*Grab*) might represent leave-taking signals and mutual gazes with gazing back at a partner while walking away during a closing phase might be used to ensure that the mutual conviction to terminate the activity has been reached.

--- Figure 7 about here ---

5. Discussion

The question of whether cooperative actions of nonhuman species like great apes involve shared intentionality is still open and results are controversial. While empirical research suggesting that they do not (Warneken et al. 2006) is limited by confounds (Leavens et al., 2017), there are conceptual problems with defining shared intentionality as a high-level cognitive ability (Kern & Moll, 2017; Rosas & Bermúdez, 2018; Sebanz & Knoblich, 2016; Townsend et al., 2017). Agents who do not possess such abilities are nonetheless able to engage in complex forms of cooperation. Alignment processes at 'lower' levels like perceptual or motor behaviour may potentially serve to coordinate joint actions (Tollefsen & Dale, 2012). In this paper, we proposed that such processes are empirically accessible in the form of behavioural outputs and exchanges of signals, sometimes in turn-taking sequences, to enable coordinated action. Shared intentionality, in other words, may be the outcome of empirically accessible coordination work by participants, an ‘interactional achievement’ (Mondada, 2011; Schegloff, 1986). Rather than focussing on the putative cognitive states that may or may not underlie cooperative action (and potentially confer upon those instances the status of bona fide joint action as found in adult humans), comparing the steps by which participants in joint actions get into, maintain and get out of them in an orderly manner may constitute a framework to systematically assess the presence of shared intentionality across species.

Building on research from the study of human interaction, we described a set of generic coordination problems that would-be participants must solve to achieve coordinated action and illustrated their application to examples of joint actions in bonobos. Bonobos’ joint activities evidence some features of macro-level phases of opening, main body and closing. Some of the described behaviours could potentially correspond to correlates of a sense of commitment: reengaging partners after interruptions, reversing roles and taking leave of partners. They use signals like gestures, vocalizations, body postures and gaze exchanges to coordinate the different phases of joint action and navigate between them. From the examples described, mutual gaze exchanges seem to be consistently used during openings to check partners’ availability and ratify participants, thus potentially establishing a participation framework, gestures (such as *Reach* in grooming and *Stomp* in play) and body posture (such as *Present* in grooming) are used to initiate the activity, to potentially ratify participants and establish the type of activity to be engaged in (i.e., grooming or play in these cases). During the main body, signals are used to maintain the activity and potentially the joint commitment to engage in the current activity together, such as *Playfaces* and *Slap* in play. Following interruptions, signals are used to reengage the initial partner and reinstate the activity. These signals resemble initiation signals, such as *Reach*, *Grab* or *Clap* in grooming. Finally, some signals are deployed during closings, such as *Hand on* in play, *Grab* in grooming, mutual gazes and gazing back at their partner (in grooming and play) while disengaging from the activity. No vocal signals were described in the excerpts, but for instance laughter is commonly used during play bouts to maintain the play activity (Heesen et al., 2017) and lip-smacking to maintain grooming bouts (Fedurek et al., 2015). Although we are reporting observations on just a handful of examples extracted from a large data set, engagement in these types of activities and therefore joint actions is rather common in great apes. Here, the goal has been to illustrate the alignment processes that facilitate the achievement of joint action. This framework expands the observable correlates of shared intentionality, by redefining it as a transient, collective state of being, achieved in interaction. This framework can facilitate systematic comparison between human and great apes (or other primate species) (Jaeggi, Burkart, & Van Schaik, 2010), revealing insights into their capacities to co-construct a state of shared intentionality through the orderly process of joint action coordination. Such insights may help reconstruct the evolution of human-like shared intentionality and cognition-for-interaction underpinning human joint action.

With this research framework we propose to address the following research questions: How do the phases relate to the overall activity? Do the signals deployed convey specific information regarding the status of the activity (e.g., are mutual gaze exchanges during closings used as leave-taking signals to ensure that the mutual conviction to terminate the activity has been reached)? How is the presence and duration of phases and the type of signals used to navigate across the phases affected by the type of activity, the species' social organization and the relationship (friendship, rank) between partners? Can we find possible evidence that apes understand shared goals? For example by showing potential behavioural correlates of an awareness of joint commitment such as, in the case of interruption of the joint activity by an external stimulus, the use of communicative signals to advertise the necessity to suspend the activity, the reengagement of the initial social partners after interruption, the continuity of the activity at the point where it was left off at the time of suspension, or the manifestation of frustration, protest or sanction when a partner breaks the commitment without respecting the norms to disengage from it?

This approach also allows us to highlight similarities and difference across species in the ability to create shared intentionality and shed some light on the evolution of this supposedly human ‘unique’ ability. We further speculate that if language has evolved as a means to solve coordination problems (De Ruiter & Levinson, 2008; Levinson, 2006; Tomasello, 2008) by communicating cooperatively about goals and intentions, we might learn more about its origins by looking at the way our closest relatives coordinate joint activities. Our approach would thus allow us to explore one aspect of the evolution of language that is the development of cooperative communication as a means to coordinate joint action to achieve shared intentionality. Accordingly, while Tomasello (2014) traces back the emergence of shared intentionality to *Homo heidelbergensis* (400,000 ya), this framework and initial observations might suggest otherwise. Indeed, if we find similarity in the way bonobos and chimpanzees coordinate joint action, and if we find evidence for the presence of components of shared intentionality, such as the understanding of joint commitment to a shared goal, we could trace back at least some of the building blocks of shared intentionality and language to our common ancestor (Levinson & Holler, 2014), and refute the claim that shared intentionality emerged only with the genus *Homo*.

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References

Albert, S., & Kessler, S. (1976). Processes for ending social encounters: The conceptual archaeology of a temporal place. *Journal for the Theory of Social Behaviour*, *6*(2), 147–170. https://doi.org/10.1111/j.1468-5914.1976.tb00363.x

Arnold, K., & Whiten, A. (2003). Grooming interactions among the chimpanzees of the Budongo Forest, Uganda: tests of five explanatory models. *Behaviour*, *140*(4), 519–552.

Aureli, F., Cords, M., & Van Schaik, C. P. (2002). Conflict resolution following aggression in gregarious animals: a predictive framework. *Animal Behaviour*, *64*(3), 325–343.

Badrian, A. & Badrian, N. (1984). Social Organization of *Pan paniscus* in the Lomako Forest, Zaire. In R.L. Susman (Eds) *The Pygmy Chimpanzee: Evolutionary Biology and Behavior* (pp. 325-346). New York: Plenum Press.

Bangerter, A., Chevalley, E., & Derouwaux, S. (2010). Managing third-party interruptions in conversations: Effects of duration and conversational role. *Journal of Language and Social Psychology*, *29*(2), 235–244.

Bangerter, A., & Clark, H. H. (2003). Navigating joint projects with dialogue. *Cognitive Science*, *27*(2), 195–225.

Bangerter, A., H. Clark, H. H., & Katz, A. R. (2004). Navigating joint projects in telephone conversations. *Discourse Processes*, *37*(1), 1–23. https://doi.org/10.1207/s15326950dp3701_1

Barrett, L., Gaynor, D., & Henzi, S. P. (2002). A dynamic interaction between aggression and grooming reciprocity among female chacma baboons. *Animal Behaviour*, *63*(6), 1047–1053.

Bekoff, M., & Allen, C. (1998). Intentional communication and social play: how and why animals negotiate and agree to play. *Animal Play: Evolutionary, Comparative, and Ecological Perspectives*, 97–114.

Bermejo, M., & Omedes, A. (1999). Preliminary vocal repertoire and vocal communication of wild bonobos (*Pan paniscus*) at Lilungu (Democratic Republic of Congo). *Folia Primatologica*, *70*(6), 328–357.

Boesch, C., & Boesch, H. (1989). Hunting behavior of wild chimpanzees in the Taï National Park. *American Journal of Physical Anthropology*, *78*(4), 547–573. https://doi.org/10.1002/ajpa.1330780410

Boesch, C. (2002). Cooperative hunting roles among Tai chimpanzees. *Human Nature*, *13*(1), 27–46.

Boesch, C. (2005). Joint cooperative hunting among wild chimpanzees: Taking natural observations seriously. *Behavioral and Brain Sciences*, *28*(5), 692–693. https://doi.org/10.1017/S0140525X05230121

Boesch, C. (2008). Taking development and ecology seriously when comparing cognition: reply to Tomasello and Call (2008). *Journal of Comparative Psychology*, *122*(4), 453–455.

Bratman, M. E. (1993). Shared intention. *Ethics*, *104*(1), 97–113.

Broth, M., & Mondada, L. (2013). Walking away: The embodied achievement of activity closings in mobile interaction. *Journal of Pragmatics*, *47*(1), 41–58. https://doi.org/10.1016/j.pragma.2012.11.016

Brown, P., & Levinson, S. C. (1987). *Politeness: Some universals in language usage.* (Vol. 4). Cambridge university press.

Bullinger, A. F., Melis, A. P., & Tomasello, M. (2011). Chimpanzees, *Pan troglodytes*, prefer individual over collaborative strategies towards goals. *Animal Behaviour*, *82*(5), 1135–1141.

Call, J., & Tomasello, M. (2008). Does the chimpanzee have a theory of mind? 30 years later. *Trends in Cognitive Sciences*, *12*(5), 187–192. https://doi.org/10.1016/j.tics.2008.02.010

Carpenter, M., & Call, J. (2013). How joint is the joint attention of apes and human infants.

Agency and Joint Attention, 49–61.

Cartmill, E. A., & Byrne, R. W. (2007). Orangutans modify their gestural signaling according to their audience's comprehension. *Current Biology*, *17*(15), 1345–1348. https://doi.org/10.1016/j.cub.2007.06.069

Chevalley, E., & Bangerter, A. (2010). Suspending and reinstating joint activities with dialogue. *Discourse Processes*, *47*(4), 263–291.

Clark, A. (2008). *Supersizing the Mind: Embodiment, Action, and Cognitive Extension*. Oxford University Press, USA.

Clark, H. H. (1996). *Using language*. Cambridge university press.

Clark, H. H. (2006). Social actions, social commitments. *Roots of Human Sociality: Culture, Cognition and Interaction*, 126–150.

Clay, Z. & de Waal, F. B. (2014). Sex and strife: post-conflict sexual contacts in bonobos. *Behaviour*; *152* (313-334).

Clay, Z. & de Waal, F. B. (2013). Bonobos respond to distress in others: consolation across the age spectrum. *PloS One* 8, e55206; doi:10.1371/journal.pone.0055206

Clutton-Brock, T. (2009). Cooperation between non-kin in animal societies. *Nature*, *462*(7269), 51–57. https://doi.org/10.1038/nature08366

Cordoni, G., & Palagi, E. (2011). Ontogenetic trajectories of chimpanzee social play: similarities with humans. *PLoS One*, *6*(11), e27344.

Crockford, C., Wittig, R. M., Langergraber, K., Ziegler, T. E., Zuberbühler, K., & Deschner, T. (2013). Urinary oxytocin and social bonding in related and unrelated wild chimpanzees. *Proceedings of the Royal Society B: Biological Sciences*, *280*(1755), 20122765–20122765. https://doi.org/10.1098/rspb.2012.2765

Crockford, C., Wittig, R. M., Mundry, R., & Zuberbühler, K. (2012). Wild chimpanzees inform ignorant group members of danger. *Current Biology*, *22*(2), 142–146. https://doi.org/10.1016/j.cub.2011.11.053

De Ruiter, J. P., & Levinson, S. C. (2008). A biological infrastructure for communication underlies the cultural evolution of languages. *Behavioral and Brain Sciences*, *31*(5), 518–518.

De Stefani, E., & Mondada, L. (2018). Encounters in public space: How acquainted versus unacquainted persons establish social and spatial arrangements. *Research on Language and Social Interaction*, *51*(3), 248–270.

de Waal, F. B. (1987). Tension regulation and nonreproductive functions on sex in captive bonobos (*Pan paniscus*). *National Geographic Research*, 3, 318–335.

de Waal, F. B. (1988). The communicative repertoire of captive bonobos (*Pan paniscus*), compared to that of chimpanzees. *Behaviour*, 183–251.

de Waal, F. B. (1989). Food sharing and reciprocal obligations among chimpanzees. *Journal of Human Evolution*, *18*(5), 433–459.

de Waal, F. B. (1990) *Peacemaking among primates.* Harvard University Press.

Demuru, E., Ferrari, P. F., & Palagi, E. (2015). Emotionality and intentionality in bonobo playful communication. *Animal Cognition*, *18*(1), 333–344.

Drea, C. M., Hawk, J. E., & Glickman, S. E. (1996). Aggression decreases as play emerges in infant spotted hyaenas: preparation for joining the clan. *Animal Behaviour*, *51*(6), 1323–1336.

Dunbar, R. I. (1991). Functional significance of social grooming in primates. *Folia Primatologica*, *57*(3), 121–131.

Dunbar, R. I. (2010). The social role of touch in humans and primates: behavioural function and neurobiological mechanisms. *Neuroscience & Biobehavioral Reviews*, *34*(2), 260–268.

Duranti, A. (1997). Universal and culture-specific properties of greetings. *Journal of Linguistic Anthropology*, *7*(1), 63–97.

Enomoto, T. (1990). Social play and sexual behavior of the bonobo (*Pan paniscus*) with special reference to flexibility. *Primates*, *31*(4), 469–480.

Fedurek, P., & Dunbar, R. I. (2009). What does mutual grooming tell us about why chimpanzees groom? *Ethology*, *115*(6), 566–575.

Fedurek, P., Slocombe, K. E., Hartel, J. A., & Zuberbühler, K. (2015). Chimpanzee lip-smacking facilitates cooperative behaviour. *Scientific Reports*, *5*, 13460.

Fletcher, G. E., Warneken, F., & Tomasello, M. (2012). Differences in cognitive processes underlying the collaborative activities of children and chimpanzees. *Cognitive Development*, *27*(2), 136–153.

Fröhlich, M., Kuchenbuch, P., Müller, G., Fruth, B., Furuichi, T., Wittig, R. M., & Pika, S. (2016a). Unpeeling the layers of language: Bonobos and chimpanzees engage in cooperative turn-taking sequences. *Scientific Reports*, *6*, 25887. https://doi.org/10.1038/srep25887

Fröhlich, M., Müller, G., Zeiträg, C., Wittig, R. M., & Pika, S. (2017). Gestural development of chimpanzees in the wild: the impact of interactional experience. *Animal Behaviour*, *134*, 271–282. https://doi.org/10.1016/j.anbehav.2016.12.018

Fröhlich, M., Wittig, R. M., & Pika, S. (2016b). Play-solicitation gestures in chimpanzees in the wild: flexible adjustment to social circumstances and individual matrices. *Open Science*, *3*(8), 160278.

Fröhlich, M., Wittig, R. M., & Pika, S. (2016c). Should I stay or should I go? Initiation of joint travel in mother–infant dyads of two chimpanzee communities in the wild. *Animal Cognition*, *19*(3), 483–500. https://doi.org/10.1007/s10071-015-0948-z

Furuichi, T. (1989). Social interactions and the life history of female *Pan paniscus* in Wamba, Zaire. *International Journal of Primatology*, *10*, 173–197.

Gardner, R. A., & Gardner, B. T. (1969). Teaching sign language to a chimpanzee. *Science*, *165*(3894), 664–672.

Gelblum, A., Pinkoviezky, I., Fonio, E., Ghosh, A., Gov, N. & Feinerman, O. (2015). Ant group optimally amplify the effect of transiently informed individuals. Nature communications, *6*, e7729

Genty, E., Breuer, T., Hobaiter, C., & Byrne, R. W. (2009). Gestural communication of the gorilla (*Gorilla gorilla*): repertoire, intentionality and possible origins. *Animal Cognition*, *12*(3), 527–546. https://doi.org/10.1007/s10071-009-0213-4

Genty, E., Clay, Z., Hobaiter, C., & Zuberbühler, K. (2014). Multi-modal use of a socially directed call in bonobos. *PLoS One*, *9*(1), e84738. https://doi.org/10.1371/journal.pone.0084738

Genty, E., Neumann, C., & Zuberbühler, K. (2015a). Bonobos modify communication signals according to recipient familiarity. *Scientific Reports*, *5*, 16442. https://doi.org/10.1038/srep16442

Genty, E., Neumann, C., & Zuberbühler, K. (2015b). Complex patterns of signalling to convey different social goals of sex in bonobos, *Pan paniscus*. *Scientific Reports*, *5*, 16135. https://doi.org/10.1038/srep16135

Genty, E., & Zuberbühler, K. (2014). Spatial reference in a bonobo gesture. *Current Biology*, *24*(14), 1601–1605. https://doi.org/10.1016/j.cub.2014.05.065

Gilbert, M. (1990). Walking together: A paradigmatic social phenomenon. *Midwest Studies In Philosophy*, *15*(1), 1–14. https://doi.org/10.1111/j.1475-4975.1990.tb00202.x

Goffman, E. (1963). *Behavior in public places* (New York: Free Press).

Goffman, E. (1967). On face-work. *Interaction Ritual: Essays on Face-to-Face Behavior*, 5–46.

Goffman, E. (1981). *Forms of talk*. University of Pennsylvania Press.

Gomez, J.-C. (2010). The ontogeny of triadic cooperative interactions with humans in an infant gorilla. *Interaction Studies*, *11*(3), 353–379.

Göncü, A., Gaskins, S., & Gaskins, S. (2007). *Play and Development: Evolutionary, Sociocultural, and Functional Perspectives* (London: Lawrence Erlbaum).

Goodall, J. (1986). *The chimpanzees of Gombe: patterns of behavior*. Cambridge, MA: Belknap Press of Harvard University Press.

Goodwin, C., & Goodwin, M. H. (2004). Participation. *A companion to linguistic anthropology*, *222-244*.

Goodwin, C. (2007). Participation, stance and affect in the organization of activities. *Discourse & Society*, *18*(1), 53-73.

Graham, K. E., Furuichi, T., & Byrne, R. W. (2017). The gestural repertoire of the wild bonobo (*Pan paniscus*): a mutually understood communication system. *Animal Cognition*, *20*(2), 171–177.

Graham, K. E., Hobaiter, C., Ounsley, J., Furuichi, T., & Byrne, R. W. (2018). Bonobo and chimpanzee gestures overlap extensively in meaning. *PLOS Biology*, *16*(2), e2004825. https://doi.org/10.1371/journal.pbio.2004825

Graham, K. L., & Burghardt, G. M. (2010). Current perspectives on the biological study of play: signs of progress. *The Quarterly Review of Biology*, *85*(4), 393–418.

Greenberg, J. R., Hamann, K., Warneken, F., & Tomasello, M. (2010). Chimpanzee helping in collaborative and noncollaborative contexts. *Animal Behaviour*, *80*(5), 873–880.

Grice, H. P. (1975). Logic and Conversation. In *Syntax and Semantics* (Vol. 3). London: Academic Press.

H. Clark, H. H., & French, J. W. (1981). Telephone goodbyes. *Language in Society*, *10*(1), 1–19. https://doi.org/10.1017/S0047404500008393

Hamann, K., Warneken, F., Greenberg, J. R., & Tomasello, M. (2011). Collaboration encourages equal sharing in children but not in chimpanzees. *Nature, 476*(7360), 328–331.

Hamann, K., Warneken, F., & Tomasello, M. (2012). Children’s developing commitments to joint goals. *Child Development*, *83*(1), 137–145.

Hare, B., Melis, A. P., Woods, V., Hastings, S., & Wrangham, R. (2007). Tolerance allows bonobos to outperform chimpanzees on a cooperative task. *Current Biology*, *17*(7), 619–623. https://doi.org/10.1016/j.cub.2007.02.040

Hare, B., & Tomasello, M. (2004). Chimpanzees are more skilful in competitive than in cooperative cognitive tasks. *Animal Behaviour*, *68*(3), 571–581. https://doi.org/10.1016/j.anbehav.2003.11.011

Hayaki, H. (1985). Social play of juvenile and adolescent chimpanzees in the Mahale Mountains National Park, Tanzania. *Primates*, *26*(4), 343–360. https://doi.org/10.1007/BF02382452

Heesen, R., Genty, E., Rossano, F., Zuberbühler, K., & Bangerter, A. (2017). Social play as joint action: A framework to study the evolution of shared intentionality as an interactional achievement. *Learning & Behavior*, *45*(4), 390–405. https://doi.org/10.3758/s13420-017-0287-9

Hirata, S., Morimura, N., & Fuwa, K. (2010). Intentional communication and comprehension of the partner's role in experimental cooperative tasks. *The Mind of the Chimpanzee: Ecological and Experimental Perspectives*, 251.

Hobaiter, C., & Byrne, R. W. (2011). The gestural repertoire of the wild chimpanzee. *Animal Cognition*, *14*(5), 745–767. https://doi.org/10.1007/s10071-011-0409-2

Hobaiter, C., & Byrne, R. W. (2014). The meanings of chimpanzee gestures. *Current Biology*, *14*(24), 1596–1600. https://doi.org/10.1016/j.cub.2014.05.066

Hobaiter, C., Leavens, D. A., & Byrne, R. W. (2014). Deictic gesturing in wild chimpanzees (*Pan troglodytes*)? Some possible cases. *Journal of Comparative Psychology*, *128*(1), 82.

Hohmann, G. & Fruth, B. (2000). Use and function of genital contacts among female bonobos. *Animal Behaviour*, *60*, (107–120).

Hohmann, G., Mundry, R. & Deschner, T. (2009). The relationship between socio-sexual behavior and salivary cortisol in bonobos: tests of the tension regulation hypothesis. *American Journal of Primatology*, 71, 223–232.

Hostetter, A. B., Russell, J. L., Freeman, H., & Hopkins, W. D. (2007). Now you see me, now you don't: evidence that chimpanzees understand the role of the eyes in attention. *Animal Cognition*, *10*(1), 55.

Jaeggi, A. V., Burkart, J. M., & Van Schaik, C. P. (2010). On the psychology of cooperation in humans and other primates: combining the natural history and experimental evidence of prosociality. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1553), 2723–2735.

Kaburu, S. S., & Newton-Fisher, N. E. (2016). Bystanders, parcelling, and an absence of trust in the grooming interactions of wild male chimpanzees. *Scientific Reports*, *6*, 20634.

Kano, T. (1992).*The last ape: Pygmy chimpanzee behavior and ecology*. Stanford University Press.

Kendon, A. (1976). The F-formation system: The spatial organization of social encounters. *Man-Environment Systems*, *6*, 291–296.

Kendon, A. (2004). *Gesture: Visible action as utterance*. Cambridge University Press.

Kern, A., & Moll, H. (2017). On the transformative character of collective intentionality and the uniqueness of the human. *Philosophical Psychology*, *30*(3), 319–337. https://doi.org/10.1080/09515089.2017.1295648

King, B. J. (2009). *The dynamic dance: Nonvocal communication in African great apes*. Harvard University Press.

Krupenye, C., Kano, F., Hirata, S., Call, J., & Tomasello, M. (2016). Great apes anticipate that other individuals will act according to false beliefs. *Science*, *354*(6308), 110–114.

Kuroda S. (1984). Interaction over Food among pygmy chimpanzees. In R.L. Susman (Eds) *The Pygmy Chimpanzee* (pp. 301-324). Springer, Boston, MA.

Leavens, D. A., Bard, K. A., & Hopkins, W. D. (2017). The mismeasure of ape social cognition. *Animal Cognition*. https://doi.org/10.1007/s10071-017-1119-1

Leavens, D. A., & Hopkins, W. D. (1998). Intentional communication by chimpanzees: a cross-sectional study of the use of referential gestures. *Developmental Psychology*, *34*(5), 813.

Leavens, D. A., Hopkins, W. D., & Thomas, R. K. (2004). Referential communication by chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology*, *118*(1), 48–57. https://doi.org/10.1037/0735-7036.118.1.48

Leavens, D. A., Hostetter, A. B., Wesley, M. J., & Hopkins, W. D. (2004). Tactical use of unimodal and bimodal communication by chimpanzees, *Pan troglodytes. Animal Behaviour*, *67*(3), 467–476. https://doi.org/10.1016/j.anbehav.2003.04.007

Levinson, S. C. (2006). On the human “interaction engine.” In S. C. Levinson & N. J. Enfield (Eds.), *Roots of human sociality: Culture, cognition and interaction* (pp. 39–69). Oxford: Berg.

Levinson, S. C., & Holler, J. (2014). The origin of human multi-modal communication. *Phil. Trans. R. Soc. B*, *369*.

Liebal, K., Call, J., Tomasello, M., & Pika, S. (2004). To move or not to move: how apes adjust to the attentional state of others. *Interaction Studies*, *5*(2), 199-219.

Logue, D. M., & Stivers, T. (2012). Squawk in interaction: a primer of conversation analysis for students of animal communication. *Behaviour*, *149*(13–14), 1283–1298.

Lyn, H., Russell, J. L., Leavens, D. A., Bard, K. A., Boysen, S. T., Schaeffer, J. A., & Hopkins, W. D. (2014). Apes communicate about absent and displaced objects: methodology matters. *Animal Cognition*, *17*(1), 85–94. https://doi.org/10.1007/s10071-013-0640-0

Machanda, Z. P., Gilby, I. C., & Wrangham, R. W. (2014). Mutual grooming among adult male chimpanzees: the immediate investment hypothesis. *Animal Behaviour*, *87*, 165–174.

MacLean, E., & Hare, B. (2013). Spontaneous triadic engagement in bonobos (*Pan paniscus*) and chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology*, *127*(3), 245–255. https://doi.org/10.1037/a0030935

Melis, A. P., Hare, B., & Tomasello, M. (2006a). Chimpanzees recruit the best collaborators. *Science*, *311*(5765), 1297–1300.

Melis, A. P., Hare, B., & Tomasello, M. (2006b). Engineering cooperation in chimpanzees: tolerance constraints on cooperation. *Animal Behaviour*, *72*(2), 275–286. https://doi.org/10.1016/j.anbehav.2005.09.018

Melis, A. P., & Tomasello, M. (2013). Chimpanzees’(*Pan troglodytes*) strategic helping in a collaborative task. *Biology Letters*, *9*(2), 20130009.

Melis, A. P., Warneken, F., Jensen, K., Schneider, A.-C., Call, J., & Tomasello, M. (2011). Chimpanzees help conspecifics obtain food and non-food items. *Proceedings of the Royal Society B: Biological Sciences*, *278*(1710), 1405–1413. https://doi.org/10.1098/rspb.2010.1735

Miles, H. L. (1990). The cognitive foundations for reference in a signing orangutan. In S. T. Parker & K. R. Gibson (Eds.), *"Language" and intelligence in monkeys and apes: Comparative developmental perspectives* (pp. 511–539). New York, NY, US: Cambridge University Press.

Mitani, J. C., & Watts, D. P. (2001). Why do chimpanzees hunt and share meat? *Animal Behaviour*, *61*(5), 915–924. https://doi.org/10.1006/anbe.2000.1681

Moll, H., & Tomasello, M. (2007). Cooperation and human cognition: the Vygotskian intelligence hypothesis. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *362*(1480), 639–648.

Mondada, L. (2009). Emergent focused interactions in public places: A systematic analysis of the multimodal achievement of a common interactional space. *Journal of Pragmatics*, *41*(10), 1977–1997. https://doi.org/10.1016/j.pragma.2008.09.019

Mondada, L. (2011). Understanding as an embodied, situated and sequential achievement in interaction. *Journal of Pragmatics*, *43*(2), 542–552.

Muller, M. N., & Mitani, J. C. (2005). Conflict and cooperation in wild chimpanzees. *Advances in the Study of Behavior*, *35*, 275–331.

Neumann, C., & Kulik, L. (2014). EloRating-a brief tutorial. *R Package Version*, *43*, 1–26.

Palagi, E. (2008). Sharing the motivation to play: the use of signals in adult bonobos. *Animal Behaviour*, *75*(3), 887–896.

Palagi, E. (2006). Social play in bonobos (*Pan paniscus*) and chimpanzees (*Pan troglodytes*): Implications for natural social systems and interindividual relationships. *American Journal of Physical Anthropology*, *129*(3), 418–426. https://doi.org/10.1002/ajpa.20289

Palagi, E., Cordoni, G., & Borgognini Tarli, S. M. (2004). Immediate and delayed benefits of play behaviour: new evidence from chimpanzees (*Pan troglodytes*). *Ethology*, *110*(12), 949–962.

Parish, A. R. (1994). Sex and food control in the 'uncommon chimpanzee': how bonobo females overcome a phylogenetic legacy of male dominance. Ethology. and Sociobiology, *15* (157–179).

Pellis, S. M., & Pellis, V. C. (1996). On knowing it's only play: the role of play signals in play fighting. *Aggression and Violent Behavior, 1*(3), 249–268.

Pickering, M. J., & Garrod, S. (2004). Toward a mechanistic psychology of dialogue. *Behavioral and Brain Sciences*, *27*(2), 169–190.

Pika, S., & Mitani, J. (2006). Referential gestural communication in wild chimpanzees (*Pan troglodytes*). *Current Biology*, *16*(6), R191–R192. https://doi.org/10.1016/j.cub.2006.02.037

Pika, S., & Zuberbühler, K. (2008). Social games between bonobos and humans: evidence for shared intentionality? *American Journal of Primatology*, *70*(3), 207–210. https://doi.org/10.1002/ajp.20469

Poirier, F. E., & Smith, E. O. (1974). Socializing functions of primate play. *American Zoologist*, *14*(1), 275–287.

Port, M., Clough, D., & Kappeler, P. M. (2009). Market effects offset the reciprocation of grooming in free-ranging redfronted lemurs, Eulemur fulvus rufus. *Animal Behaviour*, *77*(1), 29–36.

Povinelli, D. J., Nelson, K. E., & Boysen, S. T. (1992). Comprehension of role reversal in chimpanzees: evidence of empathy? *Animal Behaviour*, *43*(4), 633–640. https://doi.org/10.1016/S0003-3472(05)81022-X

Roberts, A. I., Vick, S.-J., Roberts, S. G. B., & Menzel, C. R. (2014). Chimpanzees modify intentional gestures to coordinate a search for hidden food. *Nature Communications, 5*, 3088.

Rosas, A., & Bermúdez, J. P. (2018). Viewing others as equals: The non-cognitive roots of shared intentionality. *Review of Philosophy and Psychology*, *9*(3), 485–502.

Rossano, F. (2013). Sequence organization and timing of bonobo mother-infant interactions. *Interaction Studies*, *14*(2), 160–189. https://doi.org/10.1075/is.14.2.02ros

Rossano, F. (2013). Gaze in Conversation. *The handbook of conversation analysis*, 308-329.

Rossano, F., & Liebal, K. (2014). Requests' and 'offers' in orangutans and human infants. *Requesting in social interaction*, 333-362.

Savage-Rumbaugh, S., McDonald, K., Sevcik, R. A., Hopkins, W. D., & Rubert, E. (1986). Spontaneous symbol acquisition and communicative use by pygmy chimpanzees (*Pan paniscus*). *Journal of Experimental Psychology: General*, *115*(3), 211.

Searle, J.R. (1990). Collective intentions and actions. In P. Cohen, J. Morgan, & M. Pollack (Eds.), *Intentions in communication* (pp. 401–415). Cambridge, MA:MIT Press.

Schegloff, E. A. (1986). The routine as achievement. *Human Studies*, *9*(2–3), 111–151.

Schegloff, E. A., & Sacks, H. (1973). Opening up closings. *Semiotica*, *8*(4), 289–327. https://doi.org/10.1515/semi.1973.8.4.289

Schino, G., & Aureli, F. (2009). Reciprocal altruism in primates: partner choice, cognition, and emotions. *Advances in the Study of Behavior*, *39*, 45–69.

Schino, G., di Sorrentino, E. P., & Tiddi, B. (2007). Grooming and coalitions in Japanese macaques (*Macaca fuscata*): partner choice and the time frame reciprocation. *Journal of Comparative Psychology*, *121*(2), 181.

Sebanz, M.J., & Knoblich, G. (2016). The Sense of Commitment: A Minimal Approach. Frontiers in psychology, 6, 1968. doi:10.3389/fpsyg.2015.01968

Seyfarth, R. M., & Cheney, D. L. (1984). Grooming, alliances and reciprocal altruism in vervet monkeys. *Nature*, *308*(5959), 541.

Slocombe, K. E., & Zuberbühler, K. (2005). Functionally referential communication in a chimpanzee. *Current Biology*, *15*(19), 1779–1784. https://doi.org/10.1016/j.cub.2005.08.068

Surbeck, M., & Hohmann, G. (2015). Social preferences influence the short-term exchange of social grooming among male bonobos. *Animal Cognition*, *18*(2), 573–579.

Tan, J., Ariely, D., & Hare, B. (2017). Bonobos respond prosocially toward members of other groups. *Scientific Reports*, *7*(1), 14733.

Tan, J., & Hare, B. (2017). Prosociality among non-kin in bonobos and chimpanzees compared. *Bonobos: Unique in Mind, Bain, and Behavior (Eds Hare, B. & Yamamoto, S.),* 140–154.

Tartabini, A., & Dienske, H. (1979). Social play and rank order in rhesus monkeys (*Macaca mulatta*). *Behavioural Processes*, *4*(4), 375–383.

Tollefsen, D., & Dale, R. (2012). Naturalizing joint action: A process-based approach. *Philosophical Psychology*, *25*(3), 385–407.

Tomasello, M. (2008). *Origins of human communication*. MIT press

Tomasello, M. (2009). *Why we cooperate*. MIT press

Tomasello, M. (2014). *A natural history of human thinking*. Harvard University Press.

Tomasello, M., & Carpenter, M. (2005). The emergence of social cognition in three young chimpanzees: III. Understanding intentional action. *Monographs of the Society for Research in Child Development*.

Tomasello, M., & Carpenter, M. (2007). Shared intentionality. *Developmental Science*, *10*(1), 121–125.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences*, *28*(5), 675.

Tomasello, M., & Moll, H. (2010). *The gap is social: Human shared intentionality and culture*. Springer.

Townsend, S. W., Koski, S. E., Byrne, R. W., Slocombe, K. E., Bickel, B., Boeckle, M., …

Manser, M. B. (2017). Exorcising Grice's ghost: an empirical approach to studying intentional communication in animals. *Biological Reviews*, *92*(3), 1427–1433. https://doi.org/10.1111/brv.12289

Trivers, R. L. (1971). The evolution of reciprocal altruism. *The Quarterly Review of Biology*, *46*(1), 35–57.

Tuomela, R. (2005). We-intentions revisited. *Philosophical Studies*, *125*(3), 327–369.

Völter, C. J., Rossano, F., & Call, J. (2015). From exploitation to cooperation: social tool use in orang-utan mother–offspring dyads. *Animal Behaviour, 100*, 126–134.

Warneken, F., Chen, F., & Tomasello, M. (2006). Cooperative activities in young children and chimpanzees. *Child Development*, *77*(3), 640–663. https://doi.org/10.1111/j.1467-8624.2006.00895.x

Warneken, F., Hare, B., Melis, A. P., Hanus, D., & Tomasello, M. (2007). Spontaneous altruism by chimpanzees and young children. *PLoS Biology*, *5*(7), e184.

Watts, D. P. (1998). Coalitionary mate guarding by male chimpanzees at Ngogo, Kibale National Park, Uganda. *Behavioral Ecology and Sociobiology*, *44*(1), 43–55.

Watts, D. P., & Mitani, J. C. (2001). Boundary patrols and intergroup encounters in wild chimpanzees. *Behaviour, 138*(3), 299–327. https://doi.org/10.1163/15685390152032488

Yamamoto, S., Humle, T., & Tanaka, M. (2009). Chimpanzees help each other upon request. *PLoS One*, *4*(10), e7416.

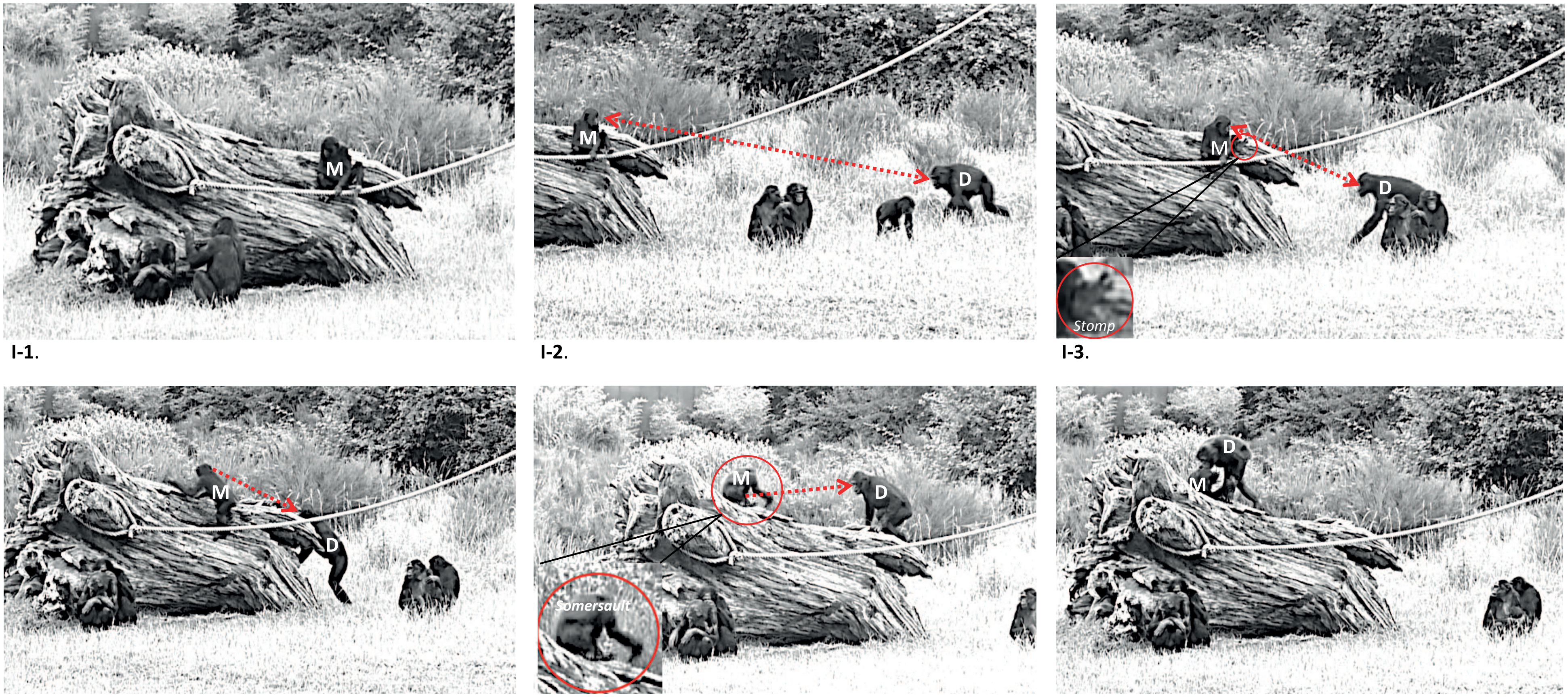
Youssouf, I. A., Grimshaw, A. D., & Bird, C. S. (1976). greetings in the desert. *American Ethnologist*, *3*(4), 797–824.

Figure 1. **Opening of grooming interaction** between two adult males, Kelele (K) and Diwani (D) at La Vallée des Singes, France. Red arrows indicate gaze direction, red circles indicate communicative signals (gestures, facial expressions, body postures)

I-1. I-2. I-3.

I-4. I-5. I-6.

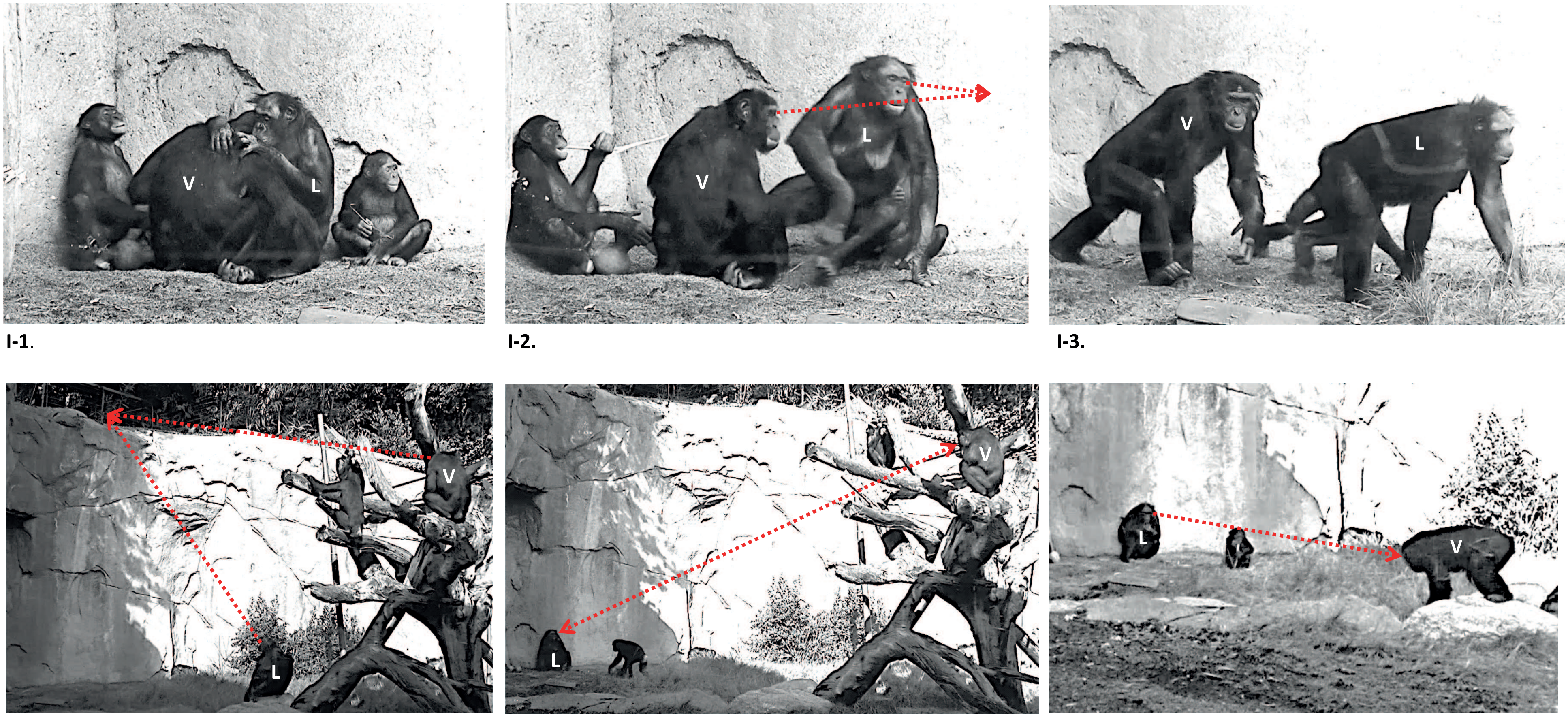
Figure 2. Opening of play interaction between an adult male David (D) and an infant male Moko (M) at La Vallée des Singes, France. Red arrows indicate gaze direction, red circles indicate communicative signals (gestures, facial expressions, body postures).



I-1. I-2. I-3.

I-4. I-5. I-6.

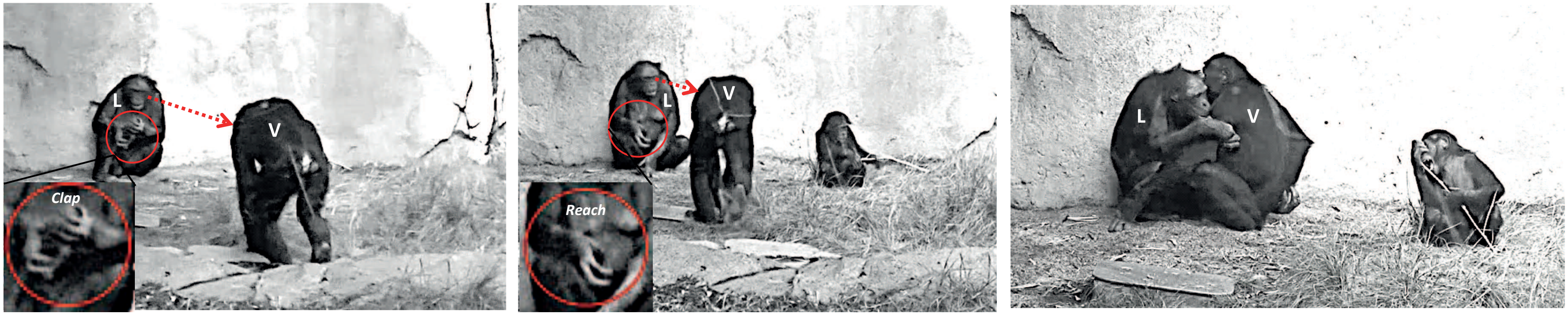
Figure 3. **Interruption and resumption of grooming (in main body)** between an adult female Lisa (L) and her adult son Vic (V) at the San Diego zoo, USA. Red arrows indicate gaze direction, red circles indicate communicative signals (gestures, facial expressions, body postures).



I-1. **I-2.** **I-3.**

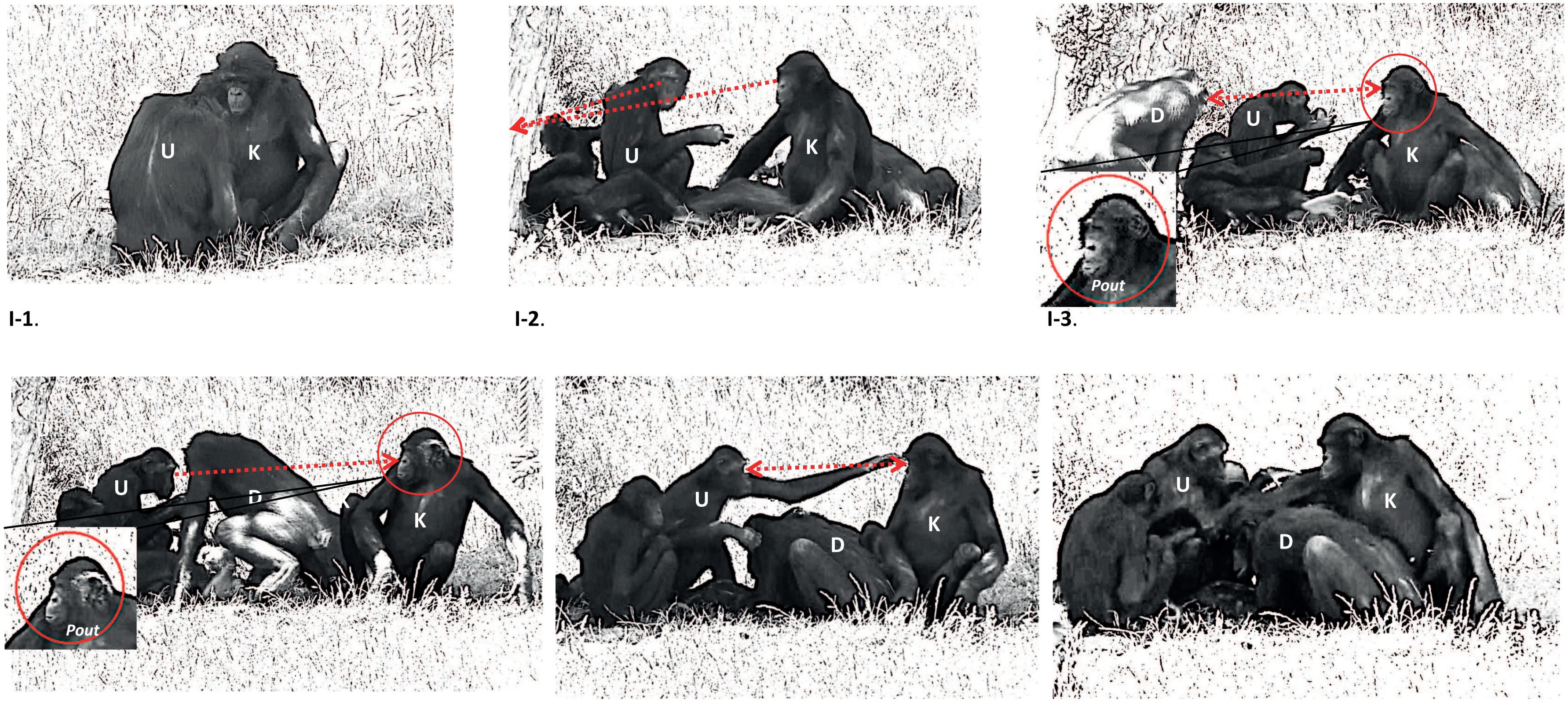
I-4. **I-5.** **I-6.**

Figure 3. continued



I-7. **I-8.** **I-9.**

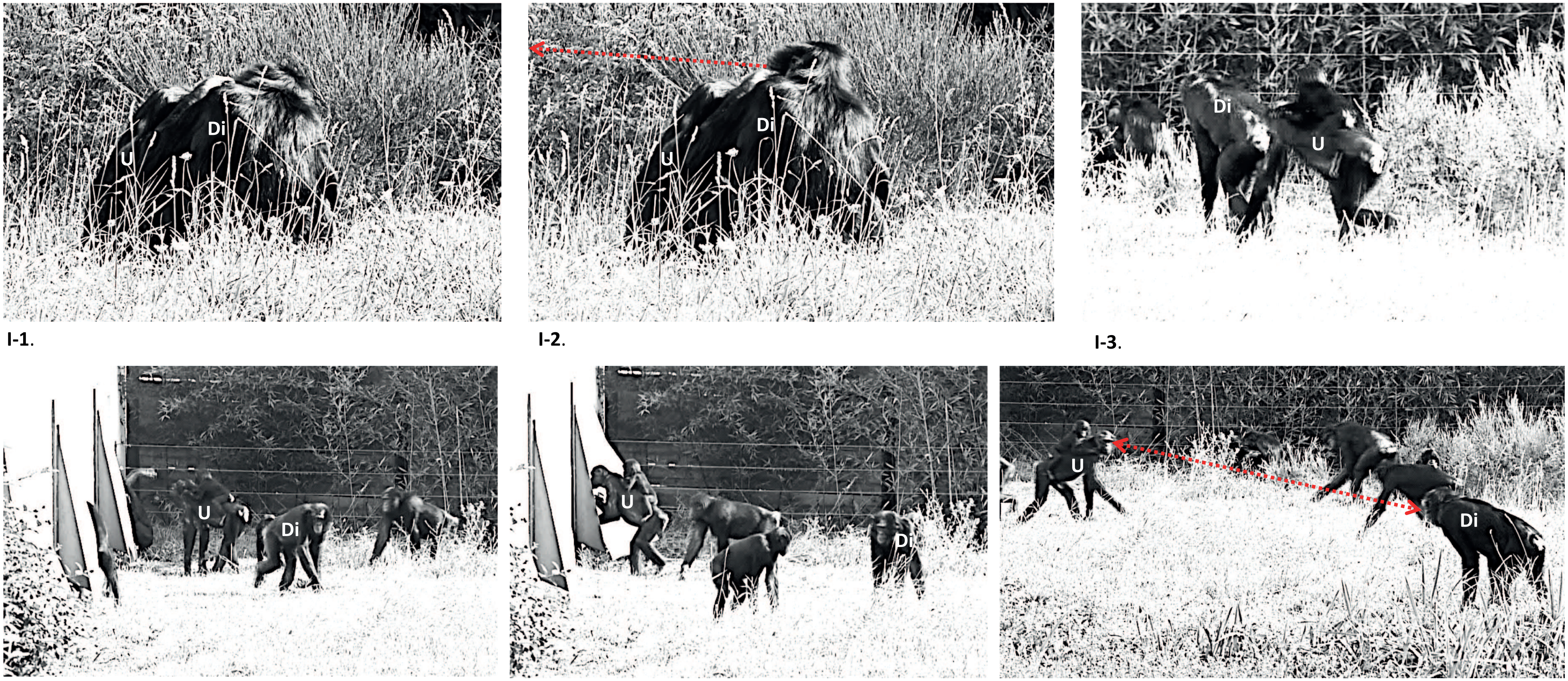
Figure 4. **Interruption and resumption of grooming (in main body)** between an adult female Ulindi (U) and an adult male Kelele (K) at La Vallée des Singes, France. Red arrows indicate gaze direction, red circles indicate communicative signals (gestures, facial expressions, body postures). D = David.



I-1. **I-2.** **I-3.**

I-4. **I-5.** **I-6.**

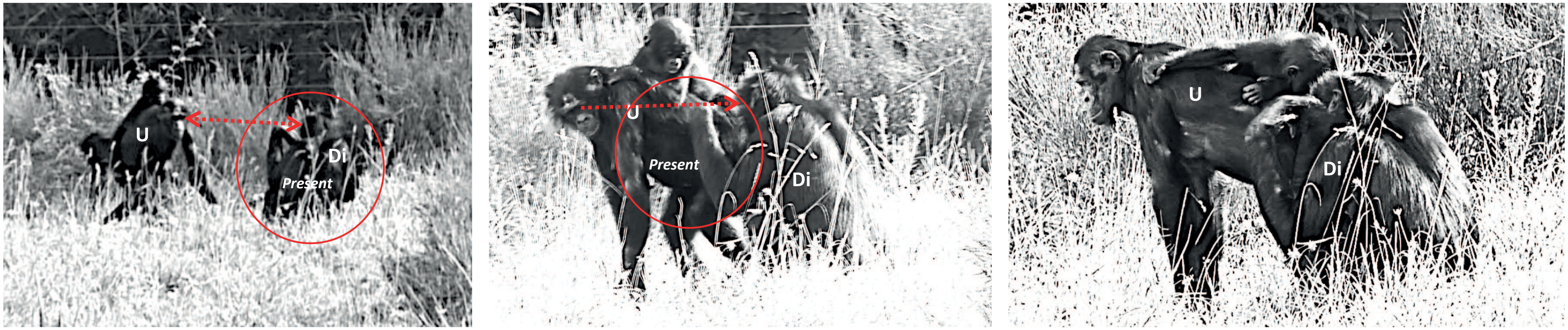
Figure 5. Interruption and resumption of grooming (in main body) between an adult female Ulindi (U) and an adult male Diwani (Di) at La Vallée des Singes, France. Red arrows indicate gaze direction, red circles indicate communicative signals (gestures, facial expressions, body postures).



I-1. **I-2.** **I-3.**

I-4. **I-5.** **I-6.**

Figure 5. Continued



I-7. **I-8.** **I-9.**

Figure 6. **Closing of play interaction** between an adult male David (D) and an infant male Moko (M) at La Vallée des Singes, France.
Red arrows indicate gaze direction, red circles indicate communicative signals (gestures, facial expressions, body postures).

I-1. **I-2**. **I-3**.

Figure 7. **Closing of grooming interaction** between two adult females Daniela (Da) and Ulindi (U) at La Vallée des Singes, France. Red arrows indicate gaze direction, red circles indicate communicative signals (gestures, facial expressions, body postures).