



## “Let’s work together”: What do infants understand about collaborative goals?

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### ABSTRACT

Collaboration is fundamental to our daily lives, yet little is known about how humans come to understand these activities. The present research was conducted to fill this void by using a novel visual habituation paradigm to investigate infants’ understanding of the collaborative-goal structure of collaborative action. The findings of the three experiments reported here suggest that 14-month-old infants understand that the actions of collaborative partners are complementary and critical to the attainment of a common collaborative goal. Importantly, 14-month-olds do not interpret the actions of two individuals in terms of a collaborative goal when their actions are not causally related. The implications of our findings for theories of collaboration and folk psychology are discussed.

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### 1. Introduction

Collaborative activities in which two (or more) individuals coordinate their actions towards the attainment of a common goal are essential to the grand achievements of the human species as well as to everyday social functioning. This distinctive form of human social behavior emerges early in life (e.g., Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Brownell & Carriger, 1990, 1991; Bruner, 1983; Eckerman & Didow, 1989; Ross & Lollis, 1987; Warneken & Tomasello, 2007), contributes critically to development (e.g., Azmitia, 1988; Radziszewska & Rogoff, 1988; Sommerville & Hammond, 2007), and has been argued to be the primary engine through which culture is created, maintained, and transmitted from one generation of the human species to the next (e.g., Rogoff, 1990; Tomasello, 1999; Tomasello, Kruger, & Ratner, 1993). Despite

the growing body of evidence documenting children’s engagement in collaboration, very little is known about what infants understand about these activities. The present research attempts to fill this void by investigating 14-month-old infants’ understanding of collaborative action.

Drawing from Bratman’s (1992) definition of shared cooperative activity, collaboration requires that the actions of collaborative partners are: (1) complementary and critical to goal attainment and (2) driven by a shared intention to attain a common goal (see also Brownell & Carriger, 1990, 1991; Warneken, Chen, & Tomasello, 2006). To illustrate, consider the actions that are necessary for the members of a volleyball team to score points and ultimately, win the game. To do this, one team member might volley the ball into the air to set-up the play for a teammate who will then smash the ball onto the other side of the net. In this case, the individual actions of the teammates are different, however both are critical to the attainment of the same goal, and thus are structured by the collaborative goal of winning the game. Critically, only the actions of individuals who play an active role in goal attainment are

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collaborative. Although fans may express support for a team and desire the same outcome as the players, their actions are not instrumental for goal attainment and thus, they are not engaged in the collaboration.

The propensity to engage in collaborative interactions emerges during infancy. Infants coordinate their own actions with those of a social partner in familiar cooperative routines, such as peek-a-boo, before their first birthday (e.g., Bates et al., 1979; Bruner, 1983; Duncan & Farley, 1990; Hubley & Trevarthen, 1979; Ross & Lollis, 1987). Between 13- and 30-months, infants become more skilled partners in novel cooperative activities in which they and their partners engage in complementary actions (Bakeman & Adamson, 1984; Brenner & Mueller, 1982; Brownell & Carriger, 1990, 1991; Brownell, Ramani, & Zerwas, 2006; Eckerman, Davis, & Didow, 1989; Eckerman & Didow, 1989; Warneken & Tomasello, 2007; Warneken et al., 2006). These findings raise the question of whether infants understand the collaborative goal structure underlying these activities; do infants represent collaborative activities as depending on complementary actions in service of a collaborative goal? Ross and Lollis (1987) investigated infants' understanding of collaboration by examining their responses to disruptions in familiar collaborative games. When an experimenter stopped taking her turn in a game of stack-and-topple with 9-, 12-, 15-, and 18-month-old infants, infants responded by expressing frustration, alternating their gaze from the adult's face to the toys, and/or offering the toys to the adult. Infants' responses suggest that they were aware of their partner's role in the collaboration. However, it is also possible that infants protested the suspension of an engaging familiar game without understanding the complementary nature of each partner's role (Warneken et al., 2006).

Warneken and colleagues (e.g., Warneken & Tomasello, 2007; Warneken et al., 2006) examined this possibility by investigating infants' responses to interruptions that occurred while they were engaged in novel collaborative activities. They posited that if infants truly appreciate the critical contribution of the actions of both individuals, infants should also protest an interruption in less ritualized cooperative games. To investigate this, 14-, 18-, and 24-month-olds were introduced to a series of novel collaborative activities such as an elevator task in which one partner pushed up a transparent cylinder with a toy inside while the other retrieved the toy from the back of the apparatus. At a certain point during the activity the experimenter stopped completing her role. Infants expressed frustration at these interruptions and made attempts to reengage their partner by drawing their partner's attention towards the apparatus. Warneken and colleagues argued that infants' behaviors during interruptions offered further evidence that they viewed their partner's actions as being critical for goal attainment.

The above findings suggest that 14-month-old infants appreciate one feature of collaboration – that the actions of collaborative partners are important for goal attainment. However, these findings do not address whether 14-month-olds appreciate another fundamental feature of collaboration – that the actions of collaborative partners are directed at the attainment of a common goal. On the one

hand, infants might have understood that their partner shared the collaborative goal of completing the experimental games. On the other hand, infants could have protested because *their* goal was thwarted and they had simply formed a representation of the actions that needed to be conducted to achieve their own goal (see also Gräfenhain, Behne, Carpenter, & Tomasello, 2009; Warneken et al., 2006). In this case, infants would consider the adult as a social tool as opposed to a collaborative partner. Because these studies did not separate infants' engagement in a collaborative activity from their cognitive representations of the activity, the latter interpretation cannot be ruled out. Further, these findings do not tell us whether infants understand that *only* the actions of individuals who are directly involved in a collaboration can be structured in terms of a collaborative goal. Thus, although there is clear evidence that 14-month-olds show a strong propensity to engage in joint activities, their understanding of the collaborative-goal structure that underlies these activities remains unclear.

The present research was designed to seek clearer evidence on these issues by recruiting the visual habituation paradigm, which has proven useful in tapping infants' analysis of goal-directed action (for reviews see Gergely & Csibra, 2003; Woodward, 2005, 2009; Woodward, Sommerville, Gerson, Henderson, & Buresh, 2009). This method provides a measure of infants' action understanding independent of their own goals (and actions) and it distinguishes infants' analysis of regularities in movement from their analysis of the goal structure of an event.

Evidence from visual habituation studies indicates that 14-month-olds possess some of the cognitive sophistication necessary for understanding collaboration. Interpreting collaborative goals requires the ability to identify the actions of collaborative partners as being hierarchically structured with respect to the attainment of a common goal. The findings from several studies suggest that 12-month-olds understand that the actions of individual agents can be hierarchically structured by goals (e.g., Sommerville & Woodward, 2005; Woodward & Sommerville, 2000). Equally important for understanding collaborative exchanges is the ability to track the goals of different agents (e.g., “she does x” and “he does y”). Buresh and Woodward (2007) found that infants as young as 9-months-old track goals as specific to the person who completes the action.

Here, we ask whether 14-month-old infants can go beyond the analysis of the goals of single individuals when they see two individuals produce complementary actions in service of a collaborative goal. In Experiment 1, infants were habituated to an event in which one actor (the box-opener) opened a box and a second actor (the duck-getter) retrieved a toy duck. In the *collaboration condition*, the duck was inside the box and the actors worked together to retrieve the toy. In the *no collaboration condition*, the duck was outside the box and the actors independently retrieved each object. Of interest was whether infants interpreted the box-opener's goal as getting the duck versus the box. To address this question, we showed infants test events in which the box-opener had access to both the duck and the box and reached toward one of these objects.

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