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The development of co-representation effects in a joint task: Do children represent a co-actor?

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ABSTRACT

When two adults jointly perform a task, they often show interference effects whereby the other's task interferes with their own performance (Sebanz, Knoblich, & Prinz, 2003). The current study investigated whether these co-representation effects can be observed in young children. This phenomenon can be used as a criterion for adult-like joint action in children, which has been under debate in existing literature due to the difficulty in identifying what mechanisms underlie the behaviours observed (Brownell, 2011). In Experiment 1, two children performed an adapted Bear Dragon task (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996), where children were required to point to a picture when instructed to do so by one puppet and to inhibit pointing when instructed to by the other. In the Same Task condition, both children in a pair were asked to respond to the same puppet, whereas in the Different Task condition, they were asked to respond to different puppets. Children made more errors in the Different Task condition than the Same Task, suggesting that they were experiencing interference from their partner's task rule. In Experiment 2 children in Different and Same task conditions began with the same task as in Experiment 1 and then switched which puppet to respond to. Switch costs were lower in the Different task condition, consistent with children having already represented the alternative task rule on behalf of their partner during the pre-switch phase. Experiment 3 replicated the effect of Task in a novel computer-based paradigm with children between 4 and 5 years, but not younger. These data provide the first direct evidence that children as young as 4 years co-represent a partner's task during a joint activity, and that younger children may not be capable of co-representation.

1. Introduction

When working together during a joint activity, adults are proficient at predicting their partner's actions in order to perform complementary actions. This capacity for co-ordinated joint action is thought to be important for a wide range of activities including dance, sport and music, but also more everyday activities like lifting an object with a partner or having a conversation (Allport, 1924). These behaviours are argued to be achieved through a number of mechanisms, including joint attention, action observation, task sharing, action co-ordination and understanding of agency (Sebanz, Bekkering, & Knoblich, 2006). In turn, mechanisms may be mediated by either lower level processes such as 'mirroring' or simulation (Sebanz & Knoblich, 2009) or higher level mechanisms involving intention understanding and symbolic communication (Atmaca, Sebanz, & Knoblich 2011; Humphreys & Bedford, 2011). Either way, joint action requires some form

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of 'representation' of the basis of a partner's actions, whether this be representing intentions or simply motor schema. The current studies investigated whether 2–5 year-old children automatically generate such representations during joint activity.

There is a plentiful body of research on children's ability to perform joint actions, most of which involves demonstrating children's apparent reciprocation on games involving turn-taking. For example, children at around 18 months are able to participate in games such as throwing a ball back and forth between themselves and a partner (Hay, 1979). In research using more concrete goals (e.g. making a ball bounce on a trampoline) rather than abstract goals (e.g. maintaining interaction with a partner, as in ball throwing), children were less able to coordinate their actions with a partner at 18 months, but even so, they could succeed at above-chance at around 24 months (Warneken, Chen, & Tomasello, 2006). Such evidence has led to claims that joint action occurs fairly early on in development (Carpenter, 2009).

However, there are also grounds for thinking there may be important differences between the abilities of children and adults to engage in joint action. Whereas at least some aspects of adults' joint action processing are spontaneous or even automatic, there is evidence that young children's engagement in joint actions typically requires scaffolding by a caregiver (Brownell, 2011). Thus, joint actions are typically learned in the context of a parent–child dyad before they can be applied to other situations, at around 24 months. This argument is supported by Bakeman and Adamson (1984), who showed that at 18 months participants' play consisted of 25% joint activity with their mothers, whereas only 7% was with a peer.

In some cases it may also be difficult to determine whether young children's actions with others actually share a joint goal. Actions in conjunction with a partner may seem collaborative but may in fact be the product of the child trying to reach their individual goal. For example, Hamann, Warneken, and Tomasello (2012) showed that two year-old children would participate in a joint task up until they had achieved their own goal of retrieving a toy, but only three year-olds would continue to participate until both themselves and their partner had retrieved a toy each. This age difference suggests the younger child may be using the partner as a way of achieving their own personal goal, rather than understanding a joint goal. In summary, while there is a rich evidence base of phenomena that imply the existence of joint action abilities in young children there is less evidence for the mechanisms by which joint actions are achieved (Brownell, 2011). Approaches that aim to discover something about these mechanisms would provide a stronger basis for comparison between children and adults' abilities than the behavioural phenomena alone.

One important phenomenon in adult joint action is the co-representation of tasks for each participant of joint activity. Adults represent the complementary task that a partner of joint activity performs, in addition to their own task and in a relatively automatic manner, which can lead to tell-tale interference effects in some circumstances. Sebanz et al., 2003 investigated this with adults by employing a modified version of the classic Simon task paradigm (Simon & Wolf, 1963). In the classic Simon task, participants are required to respond to a button on one or the other side of the keyboard in response to a simple conditional rule (e.g. left button for a green ring on a pointing finger, right button for a red ring). However, half of the pointing fingers pointed to the side of the screen corresponding with the correct button (i.e. if the 'green' response button is on the left of the keyboard, the finger with the green ring points to the left side of the screen) and half on the opposite side. Thus, participants experience congruency effects whereby responses are slower when stimulus and response are spatially incompatible. Interestingly, in a 'Go-Nogo' version of the task, where participants are only required to respond to one of the stimulus types with one button (i.e. respond to 'green' rings but ignore 'red'), this incompatibility effect disappears (Sebanz et al., 2003). Participants are able to respond equally quickly on all trials because their conditional response no longer varied on a spatial dimension, meaning that irrelevant spatial information from the position of the stimulus could not interfere (e.g. if the participant has to respond to green stimuli only, they can ignore red stimuli). Sebanz et al. investigated this further by asking participants to participate in either the original two-choice Simon task, a Go-Nogo version of the task or a joint 'Social Simon' version, where two participants worked simultaneously, each performing a Go-Nogo task on a single colour. In terms of an individual participant's task, the joint version was identical to the Go-Nogo version except that another participant was present and acting on the alternative task rule. Sebanz et al. found that participants showed similar compatibility effects to when they had to make both responses themselves, despite the fact that representing their partner's task in these circumstances was unnecessary and detrimental. In other words, participants made slower responses on spatially incompatible trials, suggesting that they represented their partner's task in a similar way to that in which participants represented their own actions when required to respond to both buttons themselves, even though it is detrimental to their own performance.

The interference effects observed by Sebanz et al. serve as a sign that a participant is co-representing a partner's task. Co-representation is good evidence that adults are able to perform actions that are joint in nature rather than being due to individual actions that appear joint due to the circumstances in which they are observed. Although the mechanisms underlying co-representation are still under debate in current literature, this finding in adults can be used to set a specific criterion for joint action in children. If children also show interference effects on their performance when acting alongside a partner, this would constitute evidence that, like adults, they are generating some form of representation of their partner's action, as a motor schema or as an intentional action. Meeting this criterion will provide a basis for further investigation into the level of processing involved in co-representation and therefore joint action in young children. Additionally, the age at which co-representation effects can be found can provide information about the processes themselves.