Cognitive Development 40 (2016) 46–59

Contents lists available at ScienceDirect

Cognitive Development

# Children's reasoning about other's intentions: False-belief and counterfactual conditional inferences

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ARTICLE INFO

*Article history:*
Received 4 March 2016
Received in revised form 7 June 2016
Accepted 23 August 2016

*Keywords:*
Intentions
Reasons
False beliefs
Counterfactuals
Reasoning

ABSTRACT

We report four experiments on children's reasoning about intentions using a new change-of-intentions task, in which an observer witnesses an actor carrying out an action, e.g., Mary hears her brother Tom say he wants to switch on the TV to watch a cartoon DVD. Mary goes away and the reason for the action changes, Tom's grandmother tells Tom to switch on the TV to watch the news. The experiments examine reasoning about false beliefs, e.g., What will Mary believe is the reason that Tom is switching on the TV?, and counterfactual reasoning, e.g., If Tom's grandmother hadn't asked Tom to switch on the TV to watch the news, what would have been the reason he was switching it on? Experiment 1 reveals three effects, first,children aged 6 years make more mistakes than those aged 8 years, second, they make more mistakes in false belief than counterfactual reasoning, and third, they make more mistakes for a desire changed to an obligation, compared to an obligation changed to a desire. Experiment 1B shows that the effects also occur for children aged 7 years compared to 9 years. Experiment 2 shows that the effects occur for unfamiliar make-believe content, and Experiment 3 shows that they occur in stories with a simpler structure. The implications for understanding the cognitive processes underlying children's reasoning about intentions are discussed.



## 1. Introduction

A child who is invited by another child to play on a swing may need to figure out the actor's intention – the actor may wish to be friends, or may expect to gain access to the child's toy, or may be about to trick the child in a prank, or may be following the instruction of an adult. The child may also need to track changes in the actor's intentions – the invitation may have arisen initially because the actor was instructed by an adult, but the actor may now wish to be friends. An important step in understanding other people's actions is reasoning about their intentions (e.g., Grant & Mills, 2011; Juhos, Quelhas, & Byrne, 2015; Walsh & Byrne, 2007). Intentions span a vast array of diverse reasons for actions, including internal reasons such as desires and urges, goals and values, and external reasons such as obligations and rules, social conventions and orders (e.g., Davidson, 1963; Von Wright, 1983). Adults believe that their own actions are determined primarily by their intentions (e.g., Libet, Gleason, Wright, & Pearl, 1983) and they evaluate the intentionality of other people's actions by considering their desires and knowledge (e.g., Malle & Knobe, 1997). Reasoning about people's intentions requires a 'theory of mind', that is, an understanding that others' mental states, such as their beliefs, desires, and knowledge, may differ from one's own (e.g.,

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http://dx.doi.org/10.1016/j.cogdev.2016.08.007
0885-2014/

Premack & Woodruff, 1978). We aim to investigate children's reasoning about other people's intentions by examining their inferences that others may have false beliefs about an actor's intentions, and by examining their counterfactual inferences about how the actor's intentions could have been different. The four experiments we report contribute to the discussion about the relation between the development of false belief reasoning and counterfactual reasoning.

### 1.1. False beliefs and counterfactual inferences

By four to five years of age children understand that others may have false beliefs about the physical world (e.g., Wellman, Cross, & Watson, 2001). For example, in a standard false belief task children are asked to consider two puppets, Sally and Anne, who are in the kitchen; Sally places some chocolate in the cupboard, and she leaves; Anne takes the chocolate and moves it to the fridge; Sally returns. They are asked, where will Sally look for the chocolate? Children aged 3 years usually say Sally will look in the fridge, some children at the age of 4 years and most by the age of 5 years say Sally will look in the cupboard (e.g., Wimmer & Perner, 1983). Understanding that others may have false beliefs is an important milestone that marks children's ability to distinguish between the mental and physical world (e.g., Miller, 2009). It has been tested extensively for one's own and other's false beliefs, in various situations (e.g., Bloom & German, 2000; Baron-Cohen, Leslie, & Frith, 1985).

Children also develop the ability to reason about hypothetical situations and in particular to think about things that didn't happen. Counterfactual inferences, such as 'if Anne had not moved the chocolate, where would it be?' have been proposed to play an important role in the development of reasoning about other's false beliefs such as 'where does Sally think the chocolate is?' (e.g., Riggs, Peterson, Robinson, & Mitchell, 1998). Understanding false beliefs is correlated with counterfactual thinking (e.g. Peterson & Riggs, 1999; Riggs et al., 1998; see also Robinson & Beck, 2000), even when age, verbal intelligence, and other linguistic factors are controlled (e.g., Guajardo, Parker, & Turley-Ames, 2009; Müller, Miller, Michalczyk, & Karapinka, 2007; see also Perner, Sprung, & Steinkogler, 2004). The two sorts of inferences activate similar brain areas (e.g., Van Hoeck et al., 2014) and children with autism exhibit difficulties with both false belief and counterfactual reasoning (e.g., Grant, Riggs, & Boucher, 2004; Peterson & Bowler, 2000; Scott, Baron-Cohen, & Leslie, 1999). Children may develop 'mindreading' abilities by deploying reasoning strategies that depend on counterfactual thoughts (e.g., Peterson & Riggs, 1999), including the ability to add or delete events from a representation of reality (e.g., Guajardo & Turley-Ames, 2004). They understand that Sally will think the chocolate is still in the cupboard because they can think that if Anne *had not* moved the chocolate to the fridge, it *would still* be in the cupboard. Counterfactual reasoning may comprise an important ingredient in false belief reasoning by enabling representational advances such as understanding that propositions refer to, or are about, the real world (e.g., Perner, 2000), or by enabling processing advances such as modifying one's own knowledge of a situation to simulate an alternative that accommodates the perspective of another person (e.g., Carlson & Moses, 2001; Peterson & Riggs, 1999).

However, even if counterfactual reasoning is necessary for false belief reasoning, it does not appear to be sufficient. Children's development of counterfactual reasoning begins to emerge early at 2–3 years but continues to develop throughout middle childhood even to young adolescence (e.g., Beck, Robinson, Carroll, & Apperly, 2006; Guttentag & Ferrell, 2004; Rafetseder, Schwitalla, & Perner, 2013; see also Beck & Riggs, 2014; Rafetseder & Perner, 2014). Since children aged 3 years can reason about simple counterfactual situations, such as simple causal and spatial inferences (e.g., German & Nichols, 2003; Harris, 2000; Perner et al., 2004) and yet still fail false belief tasks, their difficulties may arise from a third source that affects both false belief and counterfactual reasoning, such as executive function skills (e.g., German and Nichols, 2003; Guajardo et al., 2009; Müller et al., 2007; see also Beck, Riggs, & Gorniak, 2009). Counterfactuals such as 'if Anne had not moved the chocolate, it would still be in the cupboard' require reasoners to envisage two possibilities, the counterfactual conjecture 'Anne did not move the chocolate and it is still in the cupboard' and the presupposed or known facts 'Anne moved the chocolate and it is not in the cupboard' (see Byrne, 2016 for a review). Counterfactual reasoning and false belief reasoning both require executive function skills, including working memory e.g., holding in mind two representations simultaneously (e.g., Carlson & Moses, 2001; Müller et al., 2007), inhibitory control, e.g., suppressing attention to one representation, such as setting aside what is known about reality (e.g., Leslie, 1987; Robinson & Beck, 2000), and representational flexibility e.g., considering different perspectives about the same situation (e.g. Drayton, Turley-Ames, & Guajardo, 2011; Müller et al., 2007). But false belief reasoning may require further skill at tracking the status of each possibility as corresponding to each person's belief, the counterfactual conjecture 'Anne did not move the chocolate and it is still in the cupboard' corresponds to Sally's belief, and the presupposed or known facts, 'Anne moved the chocolate and it is not in the cupboard' corresponds to the child's knowledge of the situation.

Untangling the relationship between counterfactual reasoning and false belief reasoning has been compromised by an acknowledged limitation in previous studies, that reasoning about false beliefs has required participants to consider another person's mental states, e.g., 'where does Sally think the chocolate is?' whereas reasoning counterfactually has required them to consider only physical states, e.g., 'if Anne had not moved the chocolate where would it be?', and so the counterfactual question removes any mentalistic component of belief (e.g., Peterson & Riggs, 1999). Accuracy in first-order false belief tasks is correlated with accuracy even in an unrelated counterfactual reasoning task, for counterfactuals about either physical states or mental states, i.e., emotions (e.g., Guajardo et al., 2009). However, unaccounted variance in correlations between counterfactual and false belief reasoning has been attributed to false belief tasks making reference to mental states, unlike counterfactuals in first-order tasks (Guajardo & Turley-Ames, 2004). To remedy this discrepancy, we devised a novel change-