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Preschoolers' Understanding of Intentions as Causal Action Plans

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Introduction

Understanding the intentions of others is at the core of our everyday social-cognitive and communicative skills. It is implied in the way we categorize other people's actions as *intentional* or not, in our attributions of plans and long-term goals to people, in moral judgments we make about the actions of others and also in our understanding of communicative acts. According to several theorists, the adult concept of intention and intentional action is not a simple one. It refers to internal mental states (desires, goals, plans), to external behavior or action, to an action's outcomes and the objective state of reality, and finally to the ways in which those elements are causally linked with one another (Searle, 1983). In other words, for us, intention is never just an intention to make something happen but rather an intention to make it happen in a specific way – a causal action plan. The widely cited work by Malle & Knobe (1997) demonstrates that an adult's folk concept of intentional action has five core components: (1) a desire for an outcome, (2) the belief that a certain action brings about the desired outcome, (3) an intention to perform this action in order to achieve the desired outcome (4) skills to perform the intended action, and (5) awareness that the outcome *is* the result of the intended and performed action. The absence of any of these elements can result in excluding the action in question from the intentional action category, and hence can change its moral value. Both accounts pinpoint a rather elusive aspect of our commonsense

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intention attributions: the person who is attributed an intention to act is by the same token attributed a mental representation of how this very intention is supposed to lead causally to its intended outcome. The causal links between intention and action and between action and intention are part of the content which we attribute to the agent to whom we attribute an intention to act. It is not yet clear, however, how this relatively complex folk theory emerges in the course of development.

The ability to attribute contentful mental states to others as well as to ourselves is often referred to as using theory of mind. Research into how children acquire a theory of mind famously dominated the field of social cognitive development in the last 30 years or so and resulted in an impressive body of empirical knowledge about older toddlers' and preschoolers' understanding of beliefs, desires, perceptions and pretences (for a review see Doherty, 2008; Wellman, 2010). This body of research indicated that 2.5-year-olds can understand actions in terms of the agent's desires (Wellman & Woolley, 1990) and that by the age of four, children can appreciate that another person's actions are determined by his or her beliefs which may differ from the child's own (Wellman, Cross, & Watson, 2001). This picture changed dramatically over the last five years as more and more researchers reported results strongly suggesting that some preliminary notion of belief can be found even in infants in their second year of life (Onishi & Baillargeon, 2005; Surian, Caldi, & Sperber, 2007; Southgate, Senju, & Csibra, 2007).

But even without the ability to represent the content of other people's mental states, even younger infants can already benefit from some important skills relevant for the development of intention understanding. Nine- and possibly even six-month-olds differentiate between intentional and unintentional failures to share toys with them (Behne, Carpenter, Call, & Tomasello, 2005; Marsh, Stavropoulos, Nienhuis, & Legerstee, 2010) – a skill also documented in our closest primate relative, the chimpanzee (Call & Tomasello, 2008). Infants as young as five or six months of age have long been thought to encode the goals of observed goal-directed actions (Luo & Baillargeon, 2005; Woodward, 1998). They react with higher dishabituation (longer looking) to events which involve a change of the target-object of the grasp, or approach, than to events which involve a change of motion-path (when the target-object stays the same but is moved to a new location). This phenomenon, sometimes dubbed "the Woodward effect", has recently been reported in infants as young as three months of age (Luo, 2010; Somerville, Woodward, & Needham, 2005). Six-month-olds are also able to some extent to evaluate the efficiency of the action by means of which a goal is achieved, and they expect the agent to pursue the most direct (most efficient) path towards the target (Csibra, 2008) – again, a skill recently documented in nonhuman primates (Rochat, Serra, Fadiga, & Gallese, 2008). Importantly, infants' performance on some of the tasks assessing key early developmental milestones on their way to intention understanding correlates with their later performance on theory-of-mind tasks when they are preschool-aged (Wellman & Brandone, 2009).

Despite these impressive infant achievements, more sophisticated aspects of intention understanding take much more time to develop. Distinguishing between intention and desire may be considered a particularly difficult conceptual problem because the contents of desire and intention overlap considerably – people very seldom intend to achieve something they do not want. However, philosophical analyses of these two concepts show many significant differences in how the two notions function in our everyday attributions. Here are some of them:

(a) It is possible to have two conflicting desires but not intentions (Bartman, 1984);
(b) It is possible to want (but not to intend) to achieve something while being fully aware that achieving it is unlikely;
(c) It is possible to intend to act against one's own desires (Feinfield, Lee, Flavell, Green, & Flavell, 1999);
(d) It is possible to want to achieve something and never take up any goal-directed action, whereas intention implies goal-directed action;
(e) Desire represents a goal, which can be achieved in many ways. Intention represents not only a goal but also the way to achieve it. This is why a desired and intended outcome achieved in an unintended way may satisfy the desire but not the intention (Searle, 1983; Davidson, 1980);
(f) Desire will be satisfied regardless of how the desired outcome was brought about. However, intention can only be satisfied if the outcome was brought about as a result of having this particular intention (Searle, 1983; Oslon, Astington, & Zelazo, 1999).

The last two points may become clearer if we think of intentions as mental representations detailing a specific causal action plan leading from the intention itself through overt behavior to its intended outcomes, as suggested by philosopher John Searle (1979, 1983, 1984). According to Searle, for an intention to be satisfied, it is not enough that all three elements (intention, action, outcome) happen. Each of them has a specific causal role to play in the causal chain: the action has to happen as a consequence of having a particular intention and the outcome has to happen as a consequence of this particular action[1]. How can Searle know that our notion of intention actually requires this? His method of choice is a thought experiment known as *deviant causal chains*. The name refers to the fact that the scenarios undergoing philosophical examination involve causal chains which deviate from those intended by the agent. Imagine someone who is shaking a tree in order to retrieve a ball which got stuck among the branches. Despite all his efforts the ball stays in the tree. After a while the wind starts blowing and moving the branches and soon the ball falls straight into our protagonist's arms. Although the protagonist in this little scenario performed

[1] As a matter of fact not *any* causal link will do. The causal relationships between the three intended elements in the chain have to happen as *intended* (see Davidson 1980). However this caveat is beyond the scope of the current study.

the intended action and the sequence of events ended with the apparently desired outcome (the ball was retrieved), still it is obvious that the real cause that brought the desired outcome is far from the intended one. It goes without saying that when shaking the tree, our protagonist was assuming that the ball would be retrieved as a result of this action and the blowing wind was never a part of his plan.

Our adult concept of intention and intentional action is refined and sophisticated enough to capture deviations from intended action plans. Intentions not only represent the goal but also spell out the precise way of achieving it – a causal plan of action, and attributing them implies attributing some level of awareness of the plan. One can then ask at which point in their development children acquire the ability to fill in the details of such action plans attempted by others. For instance, would they assume that someone who wants to retrieve a ball stuck in a tree top and shakes the tree, has some sort of mental representation (e.g., wants, assumes or expects) of the causal connection between shaking the tree and getting the ball back? If they do, it would certainly demonstrate an ability to reason about the intrinsic aspect of others' intentions that does not have to be taken into account when thinking solely about people's desires.

Only a handful of studies have attempted to assess the intention-desire distinction in preschoolers and they are not free from certain limitations. According to Philips, Baron-Cohen, & Ritter (1998) and Schult (2002), four- and five-year-olds (but not three-year-olds) who achieved their desired outcome in an unintended way were able to talk correctly about their unfulfilled intention. For example, in a game which consisted in hitting colored fields to gain prizes, after declaring that they wanted to hit green and missing, they admitted afterwards that green had been their intended color, even if the one they actually hit won them the desired prize. Younger preschoolers tended to claim that the prize-worthy color they actually hit was the one they had *intended* to hit from the very beginning. However, in these studies participants were asked to report their *own* intentions, and the task did not really tap into children's reasoning about the causal structure of events. To what extent the results might have been influenced by the procedure (the children were required to say out loud the color they intended to hit, and the correct response to the test question afterwards consisted in saying the same color out loud once more) is another issue (see also Astington, 2001).

In another study by Schult (2002) children were tested on a task which in principle required distinguishing between desires (for outcomes) and intentions (about ways to achieve the outcomes), but the scenarios used might not have differentiated clearly enough between the protagonist's intention and the external behavior described in the scenario for any firm conclusions to be drawn about young preschoolers' performance. More recent studies indicate that the ability to both identify and appropriately explain a whole range of intentional acts emerges around the age of seven or even later, and preschool children focus mainly on pro-

tagonists' desires and actions. Five- and six-year-olds (Mull & Evans, 2010) are able to take into account both the protagonist's goal and skills, but not the protagonist's awareness of the action when attributing intentionality to his/her action. Moreover, it is not until the age of five that children can accurately attribute intention on the basis of knowledge (Joseph & Target-Flusberg, 1999). Overall, the available evidence does not give solid grounds for a general conclusion about four-year-olds' ability to differentiate others' intentions from desires or to reason about the fine-grained elements of attributed intentions, such as a causal link between action and outcome.

Whereas the Mull & Evans (2010) study was aimed at investigating children's understanding of the role of outcome awareness in the attribution of intention, we focused on their representation of the causal link between action and outcome. Our study was planned to avoid some of the problems discussed earlier. Preschool children were asked to interpret stories involving deviant causal chains, like the scenario about a ball stuck in a tree. While the protagonist's goal was always achieved, and hence his/her desire for that goal was satisfied, it was never achieved by means of his/her actions but rather as a result of some unintended events. We asked the children directly: what was the intended and what was the actual cause leading to the achievement of the goal? Correct answers to these questions required reasoning about causal relationships which were never explicitly provided in the scenario.

Method

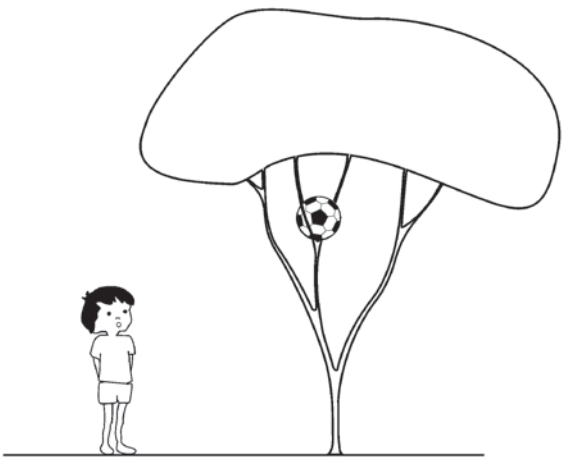
Participants

Forty-eight children (22 girls and 26 boys) recruited from preschools in Warsaw participated in the study. There were 16 four-year-olds (age range: 3;9 to 4;10, mean age 4;4), 16 five-year-olds (age range: 5;0 to 5;11 months, mean age 5;7), 16 six-year-olds (age range: 6;0 to 6;10, mean age 6;2).

Materials

Three stories involving deviant causal chains were constructed. Each story was about a child who had a goal (for instance, to retrieve a ball trapped among the tree branches) and came up with a plan how to achieve that goal. Each protagonist declared their intention out loud, without revealing the action plan ("I know what I'll do to make the ball fall") and next he/she performed the intended action (He approached the tree and shook it firmly), but the action did not lead to the expected outcome. Then, the desired goal was achieved by coincidence (the wind blew and moved the branches, and then the ball fell). Each scenario was illustrated with a picture showing the initial setup (see Figure 1 for an example). One extra story and picture was designed for the warm-up phase. This story referred to an event in which the protagonist's goal was fulfilled in the intended way.

Figure 1. The exemplary picture (accompanying Story 1)



Procedure

All the children were tested individually during a single session lasting about ten minutes in a quiet, separate room at the child's preschool. Written consent was obtained from parents or guardians.

At the beginning the children were familiarized with the manner of verbally describing the action and causal links. They were first asked open-end questions abut the meaning of words such as plan, to think of doing something, to want to do something. Then the experimenter told a story about Sophie who had come up with a plan how to achieve her goal of grabbing a mug that was out of her reach, and then she achieved her goal in the intended way (she pulled the tray the mug was standing on). To make the children comfortable about answering the experimental questions, the experimenter asked them only about Sophie's behavior, which was described explicitly in the vignette, and praised the children for answering correctly. The experimenter summed up the vignette using expressions which would later be used to phrase the test questions.

In the test phase each child listened to three vignettes. At the end of each vignette the experimenter summarized the gist of it ("So you remember: when Johnny shook the tree the ball didn't fall but when the wind blew the ball finally fell down") and asked a 2-choice test question ("What did Johnny plan? Did Johnny want the ball to fall down because he shook the tree? Or did he want the ball to fall down because the wind blew?") followed by a 2-choice control question about the actual cause ("Do you remember why the ball fell down? Because Johnny shook the tree

Table 1. Means and standard deviations of correct answers, and the number of children in each age group giving zero, one, two or three correct answers to the test questions.

	N	Mean	SD	Number of correct answers to test questions			
				0	1	2	3
4-year-olds	16	0.62	0.88	9 (56.25%)	5 (31.25%)	1 (6.25%)	1 (6.25%)
5-year-olds	16	1.06	1.39	9 (56.25%)	2 (12.5%)	0	5 (31.25%)
6-year-olds	16	2.62	0.88	1 (6.25%)	1 (6.25%)	1 (6.25%)	13 (81.25%)

or because the wind blew?"). The order in which the children answered the test and the control questions was counterbalanced in each age group and across all the stories, so for each story half the participants answered the test question first, and the other half answered it after the control question. The two options to choose from (e.g., shaking the tree vs. the wind) were always presented in the order in which they appeared in the vignette.

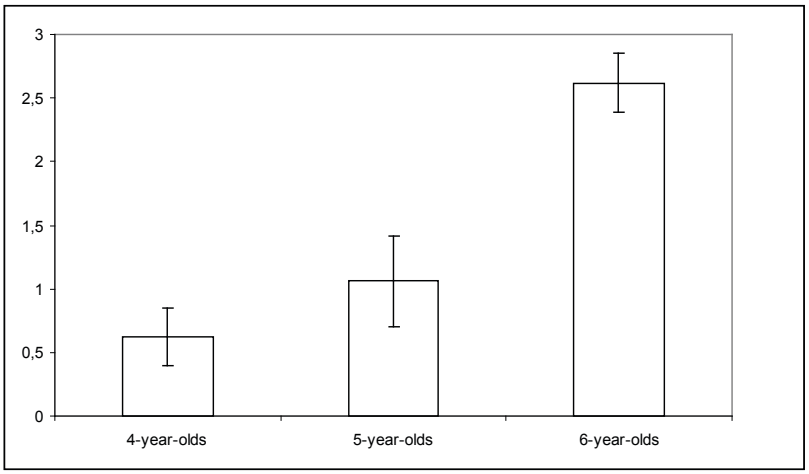
Results and discussion

Overall, the children gave correct answers to almost all the control questions. Only one four-year-old child made a mistake on one control question. However, the distribution of the answers to the test questions is much more diverse across the age groups. While the six-year-olds answered 87% of the test questions correctly, the five-year-olds did so only 35% of the time and the four-year-olds only 20% of the time.

For further analysis, the children were given one point for each correct choice of the intended cause. So each child could score from 0 to 3 points. Table 1 lists the means and standard deviations for this measure.

A one-way analysis of variance (ANOVA) with age group as a factor revealed a significant age effect ($F(2,45) = 15.1$, $p < 0.001$; see Figure 2). A contrast analysis (planned comparisons) revealed that this effect was driven by differences between the six-year-olds' performance and that of each of the remaining age groups ($F(1,45) = 27.4$, $p < 0.001$ for six-year-olds vs. four-year-olds, and $F(1,45) = 16.8$, $p < 0.001$ for six- vs. five-year-olds). There were no significant differences between the four- and five-year-olds' scores ($F(1,45) = 1.3$, $p = 0.26$). Additional t-tests were run to compare each age group's mean against the chance level (set at the 1.5 score). The six-year-olds performed significantly above this chance level ($t(15) = 5.1$, $p < 0.001$), while the four-year-olds' mean score was significantly below the chance level ($t(15) = 3.9$, $p < 0.01$). The five-year-olds' mean score did not significantly differ from the chance level ($t(15) = 1.2$, $p = 0.22$).

Figure 2. Mean frequences of correct answers (with standard error bars) across age groups



As illustrated in Table 1, between-group differences in responses to the test questions can also be observed in the patterns of answers from individual children. Thirteen out of 16 (81.25%, binomial $p < 0.0001$) six-year-olds answered all three test questions correctly, pointing to the cause intended by the protagonist. On the other hand, only one four-year-old succeeded in all three test questions, and 9 out of 16 (81.25%) did not answer any of them correctly (binomial $p < 0.0001$). The results show that six-year-olds, but not four-year-olds, differentiate between the intended and the actual cause of the desired outcome. The five-year-olds' results are mixed – 5 of them succeeded in all three test questions, while 9 succeeded in none. Interestingly, the majority of the participants answered consistently over all three test trials. Only two five-year-olds and two six-year-olds gave one or two correct answers out of three. The proportion of four-year-olds answering inconsistently across trials was somewhat higher, but still below the level expected from random distribution (binomial $p < 0.005$). This could suggest that two separate strategies dominated in our participants' performance, and that the developmental shift between them takes place between the ages of five and six.

Conclusion

The developmental trends found in our study seem to confirm the philosophical analyses according to which the content of intentions that we attribute on an everyday basis is rich enough to include not only the goal and the action, but also the intrinsic causal links binding the two together. By the age of six, children

understand that the intended cause of the outcome desired by the agent can be different from the actual cause which brought the outcome about.

The mixed results of five-year-olds and clear misattributions of four-year-olds may be surprising, since the age of four is indicated as a turning point in the development of theory of mind (Perner, 1993; Wellman, 1990; Doherty, 2008). The children's poor test results in these age groups in our study could imply that reasoning about intrinsic elements of the content of others' intentions (that is, the *intended* causal link between the *intended* action and the *intended* outcome) is quite a difficult task. Moreover, another element of that representation – the goal of another person's action, can be represented by children much earlier in development and may be a dominant factor in their developing understanding of intentions.

It is important to note that the four-year-old children's responses were not random but rather were clearly determined by a reliance on actual events resulting in the intended outcome. This pattern is reminiscent of those reported in studies relying on the verbal false belief task: children from younger age groups base their verbal answers on their own representation of a situation while older preschoolers can take into consideration information about how that situation is represented in another person's mind (Wellman, Cross, & Watson 2001). Our intention understanding task (like the verbal false belief task) required children to process two inconsistent representations of the same situation: one referring to reality and the other referring to a causal connection represented only in the mind of the protagonist. Completing this task correctly might have depended considerably on good executive functioning, as has been well documented for false beliefs tasks (see Doherty, 2008). In summary: although some elements of understanding intention are available already to four-year-old or even younger children, the basic theory containing all its key components (as listed by Malle & Knobe, 1997 and Searle, 1984) is constructed gradually until the age of six or seven (and perhaps still developed over the next few years).

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Appendix
Key elements of the stories used in the experiment

	Protagonist	Goal	Planned causal chain	Real causal chain
Warm-up	Sophie	To grab the mug from the far side of the table	To get the mug by pulling the tray on which it is standing	(same as planned)
Story 1	John	To retrieve the ball stuck in the tree	To make the ball fall by shaking the tree	The wind moved the branches and made the ball fall
Story 2	Barbara	To remove a mud stain from the sheet	To remove the stain by washing the sheet	The rain washed the mud out
Story 3	Adam	To make the balloon burst	To pierce the balloon with scissors	The balloon bumped into a bouquet of roses and was pierced by a thorn