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PAPER

Executive function and the development of belief–desire psychology

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Abstract

In two studies children's performance on tasks requiring the ascription of beliefs and desires was investigated in relation to their executive function. Study 1 (n = 80) showed that 3- and 4-year-olds were more proficient at ascribing subjective, mutually incompatible desires and desire-dependent emotions to two persons than they were at ascribing analogous subjective false beliefs. Replicating previous findings, executive function was correlated with false-belief ascription. However, executive function was also correlated with performance on tasks requiring subjective desire understanding. Study 2 (n = 54) replicated these results, and showed that the correlations hold even if age, vocabulary and working memory are controlled for. The results are discussed with regard to the role of executive function and conceptual change in theory of mind development.

Introduction

Our folk psychology is basically a belief–desire psychology. We ascribe to each other on the one hand attitudes relating to how the world *is* (beliefs) and on the other hand attitudes indicating how the world subjectively *should be* (desires). Rational action is explained on the basis of these kinds of attitudes, as in 'He carried an umbrella because he *thought* it might rain, and he *wanted* to stay dry' (e.g. Davidson, 1963; von Wright, 1971).

The development of belief–desire psychology

Theory of mind research, dealing with the ontogeny of our folk psychology, has long been concerned with how children develop an understanding of these two forms of propositional attitudes.

One view, the so-called 'asymmetry view', claims that there is an asymmetry in the way children come to understand the two kinds of attitudes: they have a rich concept of desires as truly subjective attitudes long before they have an equally rich concept of beliefs. Thus 2- and 3-year-olds – long before they pass the false-belief and other related tasks and thus master adult-like belief–desire psychology – are often said to be 'desire theorists' (Wellman, 1990). Various lines of research speak in favour of this assumption: for example, 2- to 3-year-olds can predict and explain people's actions based on their desires before they can do so regarding beliefs (e.g. Wellman & Woolley, 1990). Children at this age are also capable of ascribing desire-dependent emotions (happiness, sadness) long before they are capable of ascribing belief-dependent emotions (e.g. surprise) (e.g. Hadwin & Perner, 1991; Wellman & Bartsch, 1988). Linguistically, German 3-year-olds can use 'that' complementation clauses to describe unfulfilled desires ('She wants that the cat be in the bed' when the cat is on the mat) before they can describe a person's mistaken belief in analogous ways ('She thinks that the cat is in the bed' while the cat is on the mat; Perner, Sprung, Zauner & Haider, 2003). Most dramatically, even children from 18 months appreciate that someone may have preferences diverging from their own, for example that an adult – in contrast to themselves – prefers broccoli over crackers (Repacholi & Gopnik, 1997).

The alternative 'symmetry view' grants that young children reveal considerable proficiency in ascribing desire-like attitudes (just as they ascribe knowledge-like attitudes), but denies that children younger than 4 years have a concept of desires as truly subjective and perspectival states (just as they don't yet have a notion of truly subjective beliefs). They only have a sophisticated notion of objective desirability (e.g. Moore *et al.*, 1995; Perner, 2004; Perner, Zauner & Sprung, 2005).

With such a notion, 2- to 3-year-olds can mark different events as objectively good/bad in different situations for different people (e.g. broccoli is objectively good for the other, but objectively bad for the child); and

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describe people as aiming at what is good (for them), as happy when the good happens.

What young children cannot yet do with such a notion of objective desirability is ascribe different evaluations of one and the same event to different people. Such incompatible evaluations (A desires p, whereas B desires non-p) present a type of perspective problem, and children do not master perspective problems – regarding both cognitive and conative attitudes – before age 4 (Perner *et al.*, 2002, 2003, 2005; for more detail on Perner's formal account of perspective problems, see Appendix 1).

Initial evidence for the symmetry view came from two studies showing that 3-year-old children had difficulty (as much difficulty as in false-belief tasks) in tasks requiring an understanding of mutually incompatible desires and desire-dependent emotions.

In one study, 3-year-olds played a competitive game against a puppet, and in the context of this game children were poor at ascribing to the puppet and to themselves mutually incompatible desires (Moore *et al.*, 1995). In another study, children were told stories about two characters who had mutually incompatible desires, whereupon an event occurred that satisfied only one of the desires. Children found it as difficult to then ascribe different desire-dependent emotions to the two characters as they found the false-belief task (Lichtermann, 1991, cited in Perner *et al.*, 2005).

However, in a more comprehensive and systematic recent study of children's belief and desire ascription that combined the different measures used in these studies (asking about desires and desire-dependent emotions, and using cases in which the child herself was or was not involved) these initial findings could not be replicated: with improved tasks based on these previous studies, young 3-year-olds (almost at floor in the false-belief task) were quite proficient at ascribing different desires to different characters both when the two desires pertained to two third persons and when they themselves were one of the desirers. The findings regarding children's ascription of differing desire-dependent emotions were somewhat more mixed, but at least in some simpler tasks 3-year-olds showed some competence (Rakoczy *et al.*, 2007).

In sum, from as early as 18 months children are capable of ascribing simple preferences and desires to people, and even different desires to different people. From around 3 years (at latest), the most recent evidence suggests, children are capable even of attributing incompatible desires to different people. Children thus seem to come to understand subjective conative perspectives earlier than they come to understand subjective cognitive attitudes.

Belief–desire psychology and executive function

But why is this so? One prominent possibility is that the crucial difference here lies in the different logical and normative structures of the two kinds of attitudes. Beliefs have mind-to-world direction of fit and thus aim at truth. If the content of a belief does not match the world the mistake is on the part of the believer (if she comes to realize her belief was false, she rationally ought to abandon it). Being true is thus the normative default for beliefs, and ascribing false beliefs therefore requires deviating from and suppressing this default of truth.

Desires, in contrast, have world-to-mind direction of fit. It is not the case that they ought to be fulfilled (at the moment they are held) in the sense in which beliefs ought to be true (if a desirer comes to realize that her desire does not match the world, there is no rational pressure to give up the desire, but rather to try to change the world…). Satisfaction of desires is not a default in the way that truth is the default for beliefs. Therefore ascribing desires, even incompatible ones, in contrast to ascribing beliefs, does not require the suppression of any normative default[1].

As a consequence of these logical structures, ascribing subjective (i.e. potentially false) beliefs might be specifically difficult because of the requirements of executive function: ascribing beliefs, but not conative attitudes, involves *inhibition* – namely the inhibition of the default ascription of true beliefs (e.g. Leslie, 1994; Moore *et al.* 1995; Moses *et al.*, 2005; Russell, 1996; Sabbagh, Shiverick & Moses, 2006a).

Empirical support for such a possibility comes from numerous correlational studies of theory of mind and executive function. First of all, it is a very robust finding that competence in false-belief (FB) tasks is correlated with competence in executive function (EF) tasks (even when chronological and mental age are controlled for; and even across cultures, see Sabbagh *et al.*, 2006b). These correlations are clearest for so-called 'conflict-inhibition' (CI) tasks that involve elements of both inhibition and working memory, such as simplified 'Simon says' tasks in which the child has to comply with the commands of a nice bear, but neglect the commands of a mean dragon (e.g. Carlson and Moses, 2001; Carlson *et al.*, 2002; Hughes, 1998; for an overview, see Moses *et al.*, 2005).

Second, several studies have found that EF is quite specifically related to false-belief ascription, but not to other structurally similar tasks. For example, conflict-inhibition EF tasks correlate with FB tasks, and with tasks requiring an understanding of false signs (that also aim at truth), but not with structurally analogous 'false-photo' tasks (Sabbagh *et al.*, 2006a). The crucial difference in terms of logical structure between the FB and the false-sign tasks on the one hand, and the false-photo test on the other, is that beliefs and signs aim at truth and thus have the normative default of being true, whereas photos do not do so in the same way (photos of a tree in winter aren't false in summer).

Third, EF has been found to correlate with belief ascription specifically, as compared with other aspects of

[1] As long as the desires are relatively neutral and aren't morally questionable, for example. In the case of such 'wicked desires' there might well be similar demands of default inhibition (see Yuill *et al.*, 1996).

folk psychology: FB tasks, but not closely matched tasks involving ascribing simple desires or pretend attitudes, have been found to correlate with EF tasks (Moses, Carlson, Stieglitz & Claxton, 2003; cited in Moses *et al.*, 2005).

Based on these lines of evidence, it has recently been claimed that 'executive functioning is required to reason only about representations that are intended to reflect a true state of affairs' (Sabbagh *et al.*, 2006a, p. 1034). If that were the case, then indeed EF, as involved in the inhibition of the default of truth in belief ascription, would be a promising candidate for explaining the asymmetry in young children's development of belief–desire psychology.

The existing lines of evidence, however, are not easy to interpret. In particular, it has been shown that EF is specifically related to FB ascription and not to the ascription of conative attitudes. But crucially the tasks used to tap the latter ascriptions differed from FB tasks in at least two respects: first, in the kind of attitudes used (conative versus cognitive; only the latter aiming at truth); and second, in whether the logical structure of the tasks presented a truly subjective perspective problem (FB tasks do, tasks testing simple desire understanding don't). In other words, there was a confound between kind of attitude and logical structure. What is thus needed to disentangle these two features is a test of the correlation between EF and tasks that both tap understanding desires (not aiming at truth) and present a perspective problem; that is, tasks that require ascribing incompatible desires.

The present study

Such desire-reasoning tasks were therefore administered to 3- to 4-year-olds, along with FB and CI tasks. By examining the correlations of such desire-reasoning tasks with EF and FB tasks, one prominent explanation for the asymmetry in desire versus belief understanding could be tested: namely that beliefs, owing to their logical structure (their mind-to-world direction of fit, their aiming at truth), involve specific EF requirements.

At the same time, this correlational design allowed us to explore the foundations for the well-established specific FB–EF correlations. In particular, we could disentangle whether this correlation results from the truth-directedness of belief lacking in simple desires, photos etc. (as claimed, for example, by Sabbagh *et al.*, 2006a), or whether it results from the fact that FB tasks present perspective problems, and coordinating different perspectives in such problems – regardless of whether they are cognitive or conative ones – requires EF, in particular inhibitory control.

In the former case (EF is involved only in ascribing truth-aiming representations), EF should correlate specifically with FB tasks and not with incompatible-desire ascription tasks. In the latter case (EF is involved in all kinds of perspective problems), however, because both FB and incompatible-desire tasks present perspective problems, both should correlate with EF.

In addition, this design made it possible to follow up on existing work on children's understanding of belief and desire, with the aim of replicating and extending previous findings. In particular, recent work has found relatively unambiguous evidence regarding the ascription of incompatible desires (which was easier than FB tasks), but mixed findings regarding the ascription of different desire-dependent emotions (Rakoczy *et al.*, 2007). However, only young 3-year-olds were tested in that study, and they might have been overwhelmed by the performance factors of such tasks. A wider age range was thus tested in the present study to clarify these previous mixed findings.

Furthermore, previous preliminary work failed to find differences in children's understanding of incompatible desires depending on whether the child was one of the desirers or not (Rakoczy *et al.*, 2007, Study 2). The present study incorporated a more systematic comparison between desire ascription tasks in which the child herself was or was not one of the desirers, and tested for the relation of first-person involvement and EF (inhibition). That EF should play a role specifically in ascribing desires to someone else when they conflict with the child's own desires would be predicted by accounts claiming that EF plays a role in theory of mind because it is necessary for overcoming egocentric biases (e.g. Moore *et al.*, 1995; Prencipe & Zelazo, 2005). In contrast, if EF is crucial to all kinds of perspective problems then it should be involved in ascribing incompatible desires when the child herself both is and is not one of the desirers.

Study 1 used standard FB tasks, tasks of understanding incompatible desires and a CI EF task. In the incompatible-desires tasks (taken from Rakoczy *et al.*, 2007), the child and another character had mutually incompatible desires. Two kinds of questions were asked: first, what each character desired (Q1), and second, after one desire had been fulfilled and the other frustrated, what desire-dependent emotions each character had (Q2). Following Sabbagh *et al.* (2006a), the CI task used was the Bear–Dragon task (after Reed *et al.*, 1984), as this task has been found to be the best differential predictor of FB performance specifically. Study 2 followed up with a similar design, but with additional desire-understanding tasks in which the child herself was not one of the desirers, and controlled for verbal intelligence and working memory.

Study 1

Method

Participants

Eighty participants were included in the final sample (37–61 months; mean age 43 months; 43 girls). Children in both studies were recruited in urban daycare centres, came from mixed socio-economic backgrounds and were all native German speakers. Sixteen additional children were tested but had to be excluded from analysis owing to experimental error (n = 1), because they failed to complete more than one task (n = 7), were uncooperative (n = 7) or turned out to be bilingual (n = 1).

Design

Each child was tested by a single experimenter (E) in a single session (25–35 minutes) in which she received three types of tasks: false-belief (FB), conflicting-desires, and executive function (EF) tasks. There were three FB questions: (1) change of location, after Wimmer & Perner (1983); (2) and (3) unexpected content ('Smarties') in the first and third person, each after Perner *et al.* (1987). Each child received two conflicting-desires tasks in which she herself and another character (a puppet) had conflicting desires: in one the child won (i.e. her desire was satisfied), and in the other the child lost (i.e. the puppet's desire was satisfied). In each task, two kinds of questions about the players' desires (Q1) and their desire-dependent emotions (Q2) were asked. The EF task used was the 'Bear–Dragon' task, after Kochanska *et al.* (1996).

The order of the tasks was partly fixed: children always received a block consisting of the FB tasks and the Bear–Dragon task (in this order). Across children, it was counterbalanced whether the conflicting-desires tasks (given in a block) came before or after the FB and EF tasks (the reason for this counterbalancing was that there were planned comparisons between FB and conflicting-desires tasks; therefore, the relative order of these two types for tasks had to be counterbalanced to avoid a confound between task and order). Within the conflicting-desires tasks, it was counterbalanced across children whether the child won on the first or second task (so that children's performance could be meaningfully analysed as a function of whether they lost or won).

Materials and procedure

False-belief tasks. A traditional change-of-location FB task (Wimmer & Perner, 1983) was administered by acting out a story with plastic figures. A boy put a piece of cake into a cupboard. In his absence, the dog moved the cake to another location. The following three control questions were then asked. (1) Where did the boy put the cake in the beginning? (2) Where is it now? (3) Who put it there? If any one of the control questions was answered incorrectly, children got feedback and the question was repeated (up to two times). Then the boy returns and children are told that he wants his cake now and asked the test question 'Where will he look for his cake first?' (after Siegal & Beattie, 1991).

A standard unexpected-content FB task with a candy box containing a pen was used (Perner, Leekam & Wimmer, 1987) with both first-person ('Initially, before you looked into the box, what did you think was in the box?') and third-person ('What will your friend … (name of friend) think is in the box?') test questions. Before the test questions were asked, children received the control question 'Now, what is in here?' (and were given negative feedback and a second chance when they answered incorrectly).

Conflicting-desires tasks. The conflicting-desires tasks from a study by Rakoczy *et al.* (2007), modelled after Moore *et al.* (1995), were used. The child and another character played a game during the course of which they had differing and mutually incompatible desires, only one of which could be and was satisfied. The child was asked about each character's desires (Q1), and (after one desire had been satisfied, the other frustrated) about the character's desire-dependent emotions (Q2).

The basic setup of the game was as follows. The child and another character (a puppet called 'Rudi') shared a booklet. There were two stickers, only one of which could go into the booklet at a given time. The stickers were pinned to a 'chance machine' that determined which sticker would be put into the book. The 'chance machine' consisted of a Styrofoam board (approximately 50 × 30 cm) and an inverted Y-shaped transparent tube attached to the board. A marble dropped into the tube disappeared behind the board and re-appeared in one of the two tube ends on either side of the board, from where it dropped to a tray in a seemingly random fashion (in fact, the experimenter could surreptitiously control the location to which the marble would go). The rule was that the sticker above the tray to which the marble went would be put into the booklet.

Before the actual test trials, the child was familiarized with the apparatus in a series of warm-up trials in which she played alone (see Appendix 2). In the test trials, the child and Rudi shared a small booklet into which one (and only one) sticker could be put per page. Rudi was enacted by the experimenter, who moved him and spoke for him. At the beginning of each trial, two stickers, a boring one (e.g. a grey line) and an interesting one (e.g. a brightly coloured animal), were pinned the board, one on each side. The child was asked first which sticker should go in the book (children virtually always chose the interesting sticker). Then Rudi exclaimed 'No!' and expressed the opposite desire. Next, the child was asked again, and finally Rudi repeated his 'No!' and expressed the opposite desire again. If a child on her second turn changed her desire and agreed with Rudi, so that there could be no further quarrelling, the task was terminated and excluded from analysis (see below).

After the two characters had expressed their desires and quarrelled, the experimenter took the marble, held it close to the opening of the upper tube, and asked the first question pair (Q1) 'You want the marble to go where?' and 'Rudi wants the marble to go where?' (with the order of these two sub-questions counterbalanced across children). Then E dropped the marble and it rolled to its (unbeknownst to the child) pre-determined location. Then the second question pair (Q2) was asked: 'The marble is now here. Are you happy or sad now?' and 'The marble is now here. Is Rudi happy or sad now?' (with the order of these two sub-questions counterbalanced across children). After children had answered this last pair of questions, the sticker in the indicated location was taken and put into the booklet. Across children, it was counterbalanced who won the first trial, the child or Rudi.

Conflict inhibition: Bear–Dragon. The Bear–Dragon task as originally developed by Reed, Pien and Rothbart (1984) and adapted by Kochanska *et al.* (1996) was administered. First, children were asked to perform 10 simple movements and gestures (such as 'touch your ears', 'stick out your tongue' etc.). After ensuring that children were capable of carrying out 10 such movements, two puppets were introduced by E. The 'good' puppet (usually a bear – in this study a hedgehog[2]) was introduced in the following way: 'The hedgehog is very nice, he's our friend; we do what he says'. The 'mean' puppet (usually a dragon – in this study a snake) was introduced as 'mean and nasty; we do not do what she says'. Then came two kinds of practice trials. First, E animated the bear, spoke on his behalf with a friendly high-pitched voice, and issued one command, for example, 'touch your tummy!'. Children had no trouble with these trials. Second, E animated the dragon, spoke on his behalf in a low gruff voice and said, for example, 'put your hand on your eyes!'. Children frequently failed this dragon practice trial. In such cases, E repeated the rules of the game after each failed trial, and gave the child another dragon practice trial. Children got up to six such practice trials. If a child did not pass the sixth trial, E gave the child negative feedback and explained the rules again ('No, don't do what the dragon says! He's not our friend, you know, so we don't do what he says…'). After the practice trials, and before the test trials began, participants were tested to ensure they understood the rules (i.e., 'If the bear asks you to do something, are you going to do it?' and 'If the dragon asks you to do something, are you going to do it?'). Two children repeatedly failed to answer these control questions correctly. Their data in the Bear–Dragon tasks were therefore removed from analysis[3]. Then the 10 test trials followed: 5 bear, 5 dragon trials in alternating order. After the 5th trial, E reminded children of the rules of the game.

[2] Although actually a hedgehog was used for the bear and a snake for the dragon, I'll refer to 'bear' and 'dragon' trials to keep in line with previous studies and to avoid confusion.

[3] In an experimental error, E forgot to ask the control questions in the case of five children. However, all of these five children had mastered the first practice trials and had very high scores on the subsequent test trials (at least 11 out of 15 on the dragon trials), so it seems safe to assume that they understood the rules.

Observational and coding procedure

Each session was videotaped with a single camera filming the child frontally. For the Bear–Dragon task, a second camera was operated from the side of the child, thus supplying a view of what the child was doing below the table. A single observer transcribed and coded all tasks from tape (making use of the second tape for the Bear–Dragon task if necessary).

The Bear–Dragon task. The same coding scheme as in Kochanska *et al.* (1996) and Sabbagh *et al.* (2006a) was used. As children made hardly any mistakes in bear trials, only dragon trials were taken into account for scoring purposes. For each dragon trial, children were given a score of 3 if they did not carry out the commanded action; a score of 2 if they carried out a different action instead; a score of 1 if they partially carried out the target act; and a score of 0 if they fully carried it out. Over the five dragon trials, then, a sum score was computed, ranging from 0 to 15. A second, independent observer coded a 20% sample of randomly selected tape for reliability, which was excellent (bear trials: ordered κ = .96; dragon trials: ordered κ = .98).

Results

The data from 66 children for all tasks could be used in the final analysis. Fourteen children failed to complete one task, and their data in this specific task therefore had to be removed from analysis. Of these, two children repeatedly failed to answer FB control questions correctly. In the conflicting-desires task, 4 children repeatedly adapted their preferences to the puppet's ones so that the task could not be administered. Furthermore, the data from 8 children on the Bear–Dragon tasks had to be removed: 2 children failed the control questions (see above), and 6 children were uncooperative during the task. As preliminary analyses revealed that there were no effects of sex on either of the dependent measures, this factor was dropped from further analyses.

False-belief and conflicting-desires tasks

The mean scores (0–1) of the three FB and the four conflicting-desires tasks are depicted in Figure 1. For the purpose of comparing children's performance across tasks, scores across the three FB tasks were collapsed (0–3), and a proportion-correct score was computed. Similarly, for children's performance in the conflicting-desires tasks: for each Q1 pair, children got a score of '1' only if they answered both sub-questions (about Rudi and about themselves) correctly (otherwise a '0'). Over the two tasks, then, a sum score for Q1 (0–2) and a proportion-correct score (0–1) was computed, and analogously for

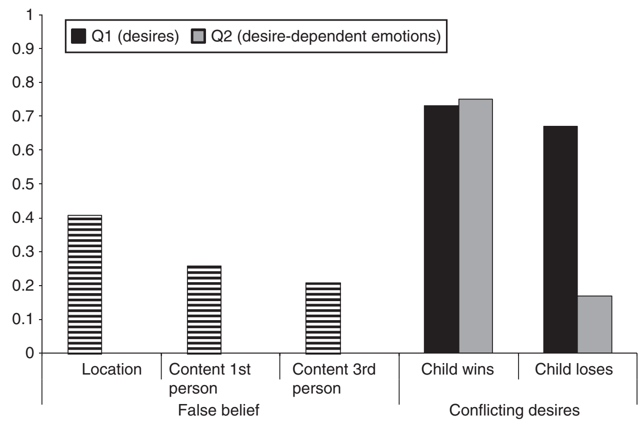

Figure 1 *Mean proportion scores of the false-belief and the conflicting-desires tasks (both sub-questions correct) in Study 1.*

Table 1(a) *Contingency table of children's performance on Q2 of the conflicting-desires task when the child herself wins or loses (Study 1)*

		Child wins	
		Incorrect	Correct
Child loses	Incorrect	19	44
	Correct	0	13

Q2. As preliminary analyses revealed that there was no effect of the order of FB and conflicting-desires tasks on children's performance in the two types of tasks, order was not considered in further analyses. Children performed significantly better on conflicting-desires Q1 (mean proportion score, $M = .70$) than on FB ($M = .28$), $t(75) = 8.99$, $p < .001$. Similarly, children performed better on conflicting-desires Q2 ($M = .45$) than on FB, $t(75) = 3.59$, $p < .001$[4].

Children's performance across the different conflicting-desires tasks was relatively uniform, with the clear exception of Q2 when the other player's rather than the child's own desire was fulfilled, that is, when the child lost. Only 13 out of 76 children solved this task, compared to 57 out of 76 in the case of Q2 when the child won (McNemar's test, $p < .0001$; see Table 1a). Of the 63 children who answered Q2 incorrectly after losing, 42 said both Rudi and themselves were 'happy', 9 claimed both were 'sad', and the remaining 12 made double mistakes (claimed that they were happy, but that Rudi was sad; see Table 1b).

These results might well reflect false negatives in one of the following ways: children might have understood the question about their own emotion less in an intentional way ('Are you happy/sad *about* the fact that the marble is here?') and more in a general mood way ('How do you feel generally?'). Or children might actually – although having desired the contrary event originally – have been happy for Rudi the puppet (a few children said things like 'I'm happy nevertheless' or 'I'm a bit happy' or 'Rudi is happy and therefore I'm happy, too'). And finally, children might have been sad about the event and knew that but were unwilling to admit that publicly.

Conflict inhibition

Two dependent measures were taken. First, the number of practice dragon trials children needed until they succeeded (if children failed the 6th practice trial, this was scored as a '7') – yielding a mean of 3.01 such practice trials ($SD = 2.40$). Second, on the test trials, children's sum score for the dragon trials (0–15) was computed, yielding a mean of 11.05 ($SD = 4.60$). These two measure were significantly negatively correlated, $r(73) = -.65$, $p < .0001$. Therefore, following previous studies (e.g. Carlson & Moses, 2001; Carlson *et al.*, 2001, 2004; Sabbagh *et al.*, 2006a), the scores were standardized (with reverse scoring for practice trials) and summed to form a composite Bear–Dragon score.

Relations between conflict-inhibition, false-belief and conflicting-desires tasks

The raw and age-controlled correlations between the EF composite score and FB and the conflicting-desires measures are presented in Table 2. For the conflicting-desires tasks, Q1 and Q2 sum scores were used as different measures. However, given that Q2 when the child lost might reflect false negatives and thus be of only limited validity, an adapted sum score (0–3) was computed out of the two Q1 sub-tasks and Q2 when the child won.

The FB tasks and the conflicting-desires tasks were correlated, with this correlation being clear and significant in both raw and age-controlled correlations regarding Q1, and the adapted sum score. Regarding FB and EF, the FB task and the Bear–Dragon task were correlated in both raw and age-controlled correlations. Similarly, conflicting-desires Q1 and the adapted sum score were correlated, both raw and age-partialled, with the Bear–Dragon score.

Finally, the correlation between FB and Bear–Dragon remained significant even when age and conflicting-desires Q1 were controlled for, $r(65) = .29$, $p < .02$ (and similarly, when age and the conflicting-desires adapted

Table 1(b) *Types of mistakes on Q2 of the conflicting-desires tasks*

	Child wins	Child loses
Correct	57	13
Mistake 'both happy'	18	42
Mistake 'both sad'	4	9
Double mistakes	0	12

[4] Control analyses with arcsin transformations over the proportion scores yielded the same results (in this study and in Study 2).

Table 2 *Raw/age-controlled correlations (with valid N) between the false-belief (FB) and conflicting-desires tasks and the Bear–Dragon measure*

	Bear–Dragon composite score	FB	Conflicting desires Q1	Conflicting desires Q2	Conflicting desires adapted sum score#
Age	.48** (73)	.57** (78)	.41** (76)	.32** (76)	.42** (76)
Bear–Dragon composite score		.53**/.35** (71)	.53**/.35** (71)	.22 ^{t} /.08 (69)	.50**/.37* (69)
FB			.40**/.23 ^{t} (74)	.23 ^{t} /.06 (74)	.41**/.24* (74)
Conflicting desires Q1				.34**/.24* (76)	

Notes: ** $p < .01$; * $p < .05$; ^{t} $p < .10$. **#** Sum score of Q1 and Q2 without Q2 after child lost (0–3)

sum score (0–3) were controlled for, $r(65) = .29$, $p < .02$). Similarly, the correlation between conflicting-desires Q1 and Bear–Dragon remained even when controlling for age and FB, $r(65) = .36$, $p < .01$ (and analogously for the partial correlation between the conflicting-desires adapted sum score (0–3) and FB, $r(65) = .32$, $p < .01$).

Discussion

First, the present study replicated and extended previous findings on children's belief versus desire understanding: children were better at ascribing incompatible desires (Q1) and desire-dependent emotions (Q2) to two characters than they were at ascribing false beliefs. This is the clearest evidence to date against the symmetry claim that children develop an understanding of subjective perspectical desires and an understanding of beliefs simultaneously. Second, the well-established finding was replicated that performance on FB tasks is highly correlated with CI performance. Third, however, the novel finding of the present study was that CI performance was not specifically correlated with FB only, but correlated substantially with the incompatible-desire tasks as well.

One potential concern might be that the current findings regarding belief versus desire ascription are difficult to interpret given the structural difference between the tasks. Although the two kinds of tasks were matched in terms of logical deep structure (both constituting perspective problems), they differed not only in the kind of attitude to be ascribed, but also in that the desire tasks, in contrast to the FB task, involved explicit linguistic expressions of attitudes by the characters, and they involved two characters (rather than one). Given, however, that the phenomenon of interest in the domain of desire understanding is the ascription of strongly subjective (i.e. mutually incompatible) desires, it was virtually impossible to make the desires task more similar to the standard FB task (with only one person and no explicit expression of the protagonist's attitudes). In order to match the tasks superficially more closely, one could, then, only have made the FB task more similar to the desires tasks by introducing two rather than one character and by introducing explicit expressions of the characters' attitudes (beliefs). Almost certainly, however, this would have yielded comparable results. FB tasks have proved to be very robust regarding variations on the surface structure (Wellman, Cross & Watson, 2001), and superficially quite diverse FB tasks correlate with EF in comparable ways (Moses *et al*., 2007, Study 2). More specifically, several studies have shown that explicit expressions of the character's false belief do not affect children's FB performance (Flavell, Flavell, Green & Moses, 1990, Exp. 3; Matsui, Rakoczy, Miura & Tomasello, in press; Wellman & Bartsch 1988, Exp. 3), and neither does the number of protagonists (Robinson & Mitchell, 1995, Investigation 2).

Prima facie, the present results (conflict inhibition correlates equally with FB and with understanding incompatible desires) thus suggest that inhibition – in contrast to recent claims (e.g. by Sabbagh *et al*., 2006a) – is not specifically related to understanding beliefs (and other representations aiming at truth). The asymmetry between desire and belief understanding thus cannot be accounted for by the specific EF demands of belief ascription. Rather, the present findings seem highly compatible with the alternative possibility that inhibition is related to the coordination of perspectives generally – one common denominator of the FB and the incompatible-desires tasks.

However, from the present study it remains unclear what could explain the correlation between inhibition and incompatible-desire understanding. Only age was controlled for, and thus other factors such as verbal intelligence have to be ruled out. Another plausible candidate is working memory: the incompatible-desires task clearly involves working memory, and so does the Bear–Dragon task (Carlson *et al*., 2002). So one possibility is that whereas FB substantially correlates with inhibition even if controlling for working memory (as shown by Carlson *et al*., 2002), the correlation between inhibition and incompatible-desire understanding is mediated by working memory. Study 2 therefore included working memory control measures.

Another interesting question is whether inhibition is specifically related to first-person involvement in desire-ascription tasks. Study 2 therefore included desire tasks both with and without first-person involvement.

Study 2

Study 2 followed up on Study 1, with basically the same design but with the following additions: verbal intelligence and working memory were controlled for, and desire-ascription tasks were added in which the child herself was not one of the desirers.

Method

Participants

Fifty-four participants were included in the final sample (41–55 months, mean age 48 months; 28 girls). Two additional children were tested but had to be excluded from analysis because they were uncooperative.

Design

Each child was tested by a single experimenter (E) in one single session (35–45 minutes) in which she received five types of tasks: false-belief (FB) tasks; conflicting-desires tasks (with additional third-person-plural versions in which two third persons played against each other); and executive function (EF) tasks as in Study 1. Additional tests used in this study were a vocabulary test (the vocabulary sub-scale of the K-ABC; Kaufman & Kaufman, 1999), and two working memory (WM) tasks used by Carlson *et al.* (2002): a backward word memory span task (after Davis & Pratt, 1996), and the so-called 'counting and labelling' task developed by Gordon and Olson (1998).

The order of the tasks was partly fixed: children always received the vocabulary tasks first, and a block of the two WM tasks last. Intermediate were a block consisting of the FB tasks and the Bear–Dragon task (in this order), and another block consisting of the conflicting-desires tasks. Across children, the order of the latter two blocks was counterbalanced. Furthermore, within the block of the conflicting-desires tasks, it was counterbalanced whether the first- or third-person-plural version came first, and whether in the former the child herself won on the first or second task.

Material and procedure

False-belief tasks. The same tasks as in Study 1 were used.

Conflicting-desires tasks. The same conflicting-desires warm-up and two first-person-plural tasks (child plays against puppet) as in Study 1 were used. In addition, there were two third-person-plural trials in which two third-person characters played against each other (as in Rakoczy *et al*., 2007). The characters (toy figurines) were enacted by E, who moved them and spoke for them. At the beginning of each trial, two stickers were pinned to the board, one on each side. The two characters then expressed their mutually incompatible desires regarding which sticker should go into the book. As in the first-person-plural case, the child was then asked where each character wanted the marble to go (Q1), and – after the marble had ended up at one of the two locations – how each character felt about it (Q2).

Conflict inhibition: Bear–Dragon. The same Bear–Dragon task as in Study 1 was used, with one minor modification: following Carlson *et al*. (2002), if children failed five dragon practice trails, E assisted the child by holding her hands on the table (so that the child couldn't comply with the dragon's command) and gave her positive feedback afterwards.

Working memory tasks. Two commonly used WM tasks were administered as follows.

(1) *Backward word span* after Davis and Pratt (1996) and Carlson *et al*. (2002). Children were asked to repeat a list of monosyllabic, semantically non-related words in reverse order. E used a puppet called 'Seppl' to illustrate the task. For example, E said 'Seppl is doing weird things, I say "Dog–tree", but he says "Tree-dog". Children were given up to three practice trials with two words, and received negative feedback if they failed the practice trial. Then the test trials began, in which children first received three trials with two words each. If they failed all three, the task was terminated; if they passed at least one, three trials with three words each began (and if children mastered any of these, they received another three trials with four words each). The number of trials passed (0–9) was the dependent measure.

(2) *Counting and labelling*. In this task, developed by Gordon and Olson (1998) to measure dual-task performance, children have to count and label a set of three toys simultaneously. E first presented a set of three toys, counted them (while pointing to them consecutively), then labelled them ('See, I say the names of each: dog – cat –elephant' while pointing to them consecutively), and then explained to the child 'And now I'm going to do both: counting and labelling'. She then pointed to each in turn and said 'One is a dog, two is a cat, three is an elephant'. Children then received two test trials, each with their own set of three different toys in which they were asked to repeat the steps: (i) count, (ii) label, (iii) count and label. Children were corrected if necessary in steps (i) and (ii), but not in step (iii). On each trial, if children mastered step (iii) on the first attempt, they received a score of '2' and moved on to the next trial. If they did not spontaneously master step (iii), E modelled step (iii) again with her own set of toys and the child was given another chance. If she succeeded then, she received a score of '1' for this trial. Children thus received a total score for the counting and labelling ranging from 0 to 4.

Observational and coding procedure

The same basic observational and coding procedure as in Study 1 was used. A second, independent observer coded

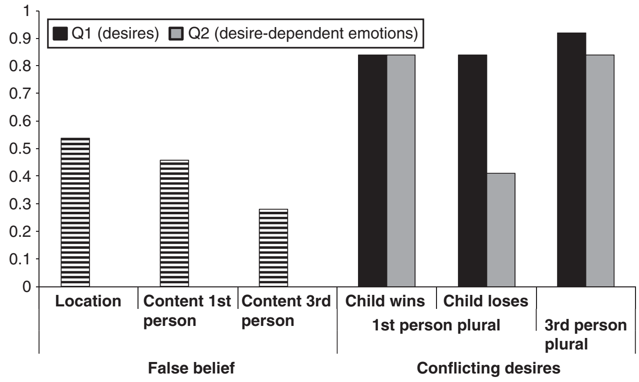

Figure 2 *Mean proportion scores of the false-belief and the conflicting-desires tasks (both sub-questions correct) in Study 2.*

a 20% sample of randomly selected tape for reliability of the Bear–Dragon coding, which was excellent (bear trials: ordered $\kappa = 1$; dragon trials: ordered $\kappa = .98$).

Results and discussion

The data from 49 children on all tasks could be included in the final analysis. Five children repeatedly kept on adapting their desire to the puppet in the first-person-plural version of the conflicting-desires task so that these sub-tasks could not be analysed for these children. As preliminary analyses revealed that there was no effect of sex on either of the dependent measures, this factor was dropped from further analyses.

False-belief and conflicting-desires tasks

The mean proportion scores of the FB and conflicting-desires tasks are depicted in Figure 2. Again, children's performance across the different conflicting-desires tasks was relatively uniform, with the clear exception of Q2 in the first-person-plural version when the other player's rather than the child's own desire was fulfilled (i.e. the child lost), which was significantly more difficult than the corresponding task when the child won (McNemar's test, $p < .0001$; see Table 3). A comparison between the first- and third-person-plural versions revealed that on Q1 children were significantly better for the third- than for the first-person plural ($t(48) = 3.71$, $p < .001$); on Q2 there was a trend in the same direction ($t(48) = 1.93$, $p < .06$).

For the purpose of comparing children's performance across different types of tasks, scores across the three FB tasks were collapsed (0–3), and a proportion-correct score was computed[5]. Similarly, for children's performance in the conflicting-desires tasks in both the first- and the third-person plural versions, a Q1 score (0–2) and a proportion-correct score were computed, and analogously for Q2. Children performed significantly better on all four conflicting-desires scores than on the FB score (first-person plural Q1: $t(48) = 7.00$, $p < .001$; first-person plural Q2: $t(48) = 3.45$, $p < .001$; third-person plural Q1: $t(48) = 8.74$, $p < .001$; third-person plural Q2: $t(48) = 7.73$, $p < .001$).

Table 3 *Contingency table of children's performance on Q2 of the first-person-plural conflicting-desires tasks when the child herself wins or loses (Study 2)*

		Child wins	
		Incorrect	Correct
Child loses	Incorrect	8	21
	Correct	0	20

Conflict inhibition and working memory

On the Bear–Dragon task, the mean number of practice dragon trials children needed until they succeeded was 2.13 ($SD = 1.65$). The mean sum score on the dragon trials (0–15) was 11.15 ($SD = 5.83$). These two measure were significantly negatively correlated, $r(54) = -.63$, $p < .0001$. Therefore, the scores were standardized (with reverse scoring for practice trials) and summed to form a composite Bear–Dragon score.

The mean score on the backward word span task was .59 ($SD = 1.31$); the mean score on the counting and labelling task was 1.67 ($SD = 1.68$). As these two tasks were inter-correlated ($r(54) = .40$, $p < .001$), they were standardized and summed to form a composite WM score. The WM composite score and the Bear–Dragon composite score were correlated, $r(54) = .46$, $p < .001$.

Relations between conflict inhibition, working memory and false-belief and conflicting-desires tasks

For the purpose of the correlations, for the conflicting-desires tasks composite scores for the first-person-plural sub-tasks (Q1 and Q2, which were correlated, $r(49) = .41$, $p < .01$)[6] and for the third-person-plural sub-tasks (Q1 and Q2, which were correlated, $r(49) = .48$, $p < .001$) were used. The raw and age-controlled correlations between the EF composite score, the WM composite score and the FB and the conflicting-desires measures are presented in Table 4.

FB performance and performance on the conflicting-desires tasks were correlated, with this correlation being clearest and most significant both in raw and in partial

[5] As preliminary analyses revealed that there was no effect of the order of FB and conflicting-desires tasks on children's performance in FB tasks, and in the conflicting-desires task, this factor was not entered into the main analyses.

[6] Because Q2 in the first-person-plural version when the child lost might again reflect false negatives (see above, Study 1), an adapted sum score (0–3) of the remaining three first-person-plural sub-tasks was also computed. The results using this adapted sum score were analogous.

Table 4 *Raw/partial correlations (controlling for age and verbal intelligence) (with valid N) between the false-belief (FB) and the conflicting-desires tasks and the executive function and working memory measures*

	Verbal intelligence (K-ABC)	FB	Conflicting desires first person plural	Conflicting desires third person plural	Bear–Dragon composite score	Working memory composite score
Age	.50** (54)	.50** (54)	.23 (49)	.17 (54)	.57** (54)	.30*. (54)
Verbal intelligence (K-ABC)		.39** (54)	.23 (49)	.36** (54)	.45** (54)	.37** (54)
FB			.47**/.40** (49)	.31*/.22 (54)	.57**/.37** (54)	.51**/.41** (54)
Conflicting desires first person plural				.50**/.47** (49)	.56**/.52** (49)	.37*/.30* (49)
Conflicting desires third person plural					.34*/.25^{t} (54)	.37*/.23 (54)

Note: ** $p < .01$; * $p < .05$; ^{t} $p < .10$.

(age- and vocabulary-controlled) correlations regarding the first-person-plural sub-tasks (note, however, that part of the reason for this might be that performance on the third-person-plural versions was generally very good and close to ceiling).

Regarding CI, and its relation to belief and desires understanding, Bear–Dragon performance was correlated (both in raw and in partial correlations controlling for age and vocabulary) with conflicting-desires task performance, with this pattern being clearest in the first-person-plural version, and with FB performance. Similarly, the WM composite score was correlated (both in raw and in partial correlations controlling for age and vocabulary) with FB, and with performance on the conflicting-desires tasks, in particular in the first-person-plural version.

Correlations between CI, FB and the desire tasks were computed where in addition to age and vocabulary working memory was controlled for: CI was still correlated with FB performance, $r(49) = .29$, $p < .05$, and with performance on the first-person-plural desire tasks, $r(44) = .47$, $p < .001$ (but was not significantly correlated with the third-person-plural desire tasks, $r(49) = .19$, $p < .18$).

These results were confirmed by separate multiple regression analyses with FB and conflicting-desires performance as dependent measures in which age, vocabulary, the Bear–Dragon composite score and the WM composite score were all entered simultaneously (see Table 5). Both the Bear–Dragon composite score and the WM composite score predicted FB performance. The conflicting-desires first-person-plural score was predicted by the Bear–Dragon composite score over and above age, vocabulary and WM as well, with the WM composite failing to predict the conflicting-desires score over and above the Bear–Dragon score. For the conflicting-desires third-person-plural task none of the predictors turned out to be significant (which might, again, result from the fact that performance on these desire tasks was close to ceiling and the variance was therefore low).

All in all, the present study thus replicates the findings of Study 1 (ascribing incompatible desires and desire-dependent emotions is easier than FB ascription, but correlates with EF at as high a level as FB does) and extends them (by showing that ascription of incompatible desires correlates with EF quite specifically, even if controlling for extraneous factors).

General discussion

The two present studies replicate previous findings that young children ascribe subjective (i.e. mutually incompatible) desires earlier and more proficiently than they do subjective (i.e. potentially false) beliefs. They extend previous findings, in that children were also more proficient at ascribing desire-dependent emotions based on such subjective desires than they were at belief ascription[7]. All in all, these findings provide the most robust evidence to date against a developmental symmetry in children's belief–desire psychology such that a subjective conception of desires develops along with an analogous conception of beliefs.

One methodological qualification is in order, though: the findings speak against the symmetry account *on the assumption* that the tasks used here are (the most) valid operationalizations of belief and desire understanding. This assumption might come to be challenged in future research. First, regarding belief understanding, the present study, following previous work in using standard FB tasks, might underestimate young children. It has been argued, for example, that simplified tasks that sometimes have been found to be easier for younger children are the more valid measure (e.g. Siegal & Beattie, 1991)[8] or even that habituation studies with infants tap early belief understanding (e.g. Onishi & Baillargeon, 2005; for skepticism, see, for example, Perner & Ruffman, 2005). However, no consensus has yet emerged regarding whether such

[7] It remains an open question for future research to explain the dramatic difference found in both studies between children's ascriptions of desire-dependent emotions to others and to themselves (Q2) depending on whether their desires had been fulfilled or not (children performing much worse in the latter case). Is there a genuine difficulty for young children in ascribing negative emotions to themselves? Or is this result an artifact (e.g. such that children did not want to admit that they were sad etc.)?

[8] Note, however, that both this and a previous study (Rakoczy *et al.*, 2007) actually used a 'look first' modification after Siegal & Beattie (1991) in change-of-location FB tasks and still found the same results as with more traditional unexpected-content tasks, for example.

Table 5 *Multiple regressions for predicting false belief (FB), and the conflicting-desires scores*

	FB				Conflicting desires first person plural				Conflicting desires third person plural			
	B	S.E. B	Beta	*t*	B	S.E. B	Beta	*t*	B	S.E. B	Beta	*t*
Age	.72	.037	.26	1.91[t]	−.28	.04	−.10	−.64	−.28	.04	−.13	−.78
Vocabulary	−.21	.06	−05	.75	−.03	.08	−.07	−.42	.08	.06	.22	1.31
Bear–Dragon composite score	.18	.09	.29	2.10*	.36	.10	.56	3.52**	.12	.08	.23	1.38
WM composite score	.23	.09	.33	2.47*	.13	.11	.18	1.17	.10	.09	.19	1.17
	R = .67, R^2 = .45, adjusted R = .40				R = .58, R^2 = .34, adjusted R = .28				R = .45, R^2 = .20, adjusted R = .14			

Note: ** p < .01; * p < .05; [t] p < .10. WM, working memeory.

simplified and more implicit tasks tap real belief understanding. Second, regarding desire understanding, it might be argued that the present tasks (again following previous research) potentially overestimate young children. In these tasks, children might still only work with a notion of objective desirability and re-describe the situation such that the different desires are not strictly incompatible (e.g. by changing the temporal structure into 'A wants the marble to go left *at some time* and B wants it to go right *at some other time*'). But while such a possibility cannot be strictly ruled out by the present study, it does not seem very plausible on the face of it.

All in all then, in the absence of agreed-upon alternative tasks, it seems well warranted to consider the standard tasks used here as the currently most valid operationalizations of belief and desire understanding and to consider the desire–belief asymmetry found real and significant.

Belief–desire psychology, perspective problems and executive function

One potential factor in this asymmetry might be the difference in logical structure: beliefs have a mind-to-world direction of fit, aiming at truth, and truth is their normative default. Desires, in contrast, have world-to-mind direction of fit, aiming at fulfillment. They do not have a default analogous to truth in the case of beliefs.

Consequently, beliefs might be more difficult to grasp than desires, as only they require keeping in mind, and potentially deviating from, this normative default of truth – an achievement of inhibition or EF in the broadest sense. To test for such a possibility, children's performance on belief- and desire-ascription tasks was investigated in relation to their conflict inhibition (Bear–Dragon task). Although previous specific correlations of this task with FB performance were replicated, the major novel finding was that performance on conflicting-desires tasks also correlated with conflict inhibition.

This stands in contrast to previous findings that, when controlling for age and intelligence, EF correlated with the FB task specifically, but not with understanding non-cognitive mental attitudes and representations that do not aim at truth, such as desires or pretence (Moses *et al.*, 2003; cited in Moses *et al.*, 2005). In contrast to previous work, however, the present study was the first to use desire tasks that differed from FB tasks in the kind of attitude to be ascribed (desire versus belief) while presenting stringent perspective problems just like the FB task does. When both belief and desire tasks had such a more stringent structure, EF correlated not only with belief, but also with desire ascription.

With respect to the role of EF in the development of belief–desire psychology, this pattern of findings puts into question the claim that EF is required only for reasoning about cognitive attitudes and representations (with mind-to-world direction of fit). At least when desires are strongly subjective (creating perspective problems), and perhaps in particular when they imply some first-person involvement, conative attitude ascription involves EF in comparable ways. What these results rather suggest is that EF seems to be related to tasks requiring the coordination of perspectives – regardless of whether the attitudes creating these perspectives are cognitive or conative ones.

Several questions, however, remain in this context for future research. First of all, if EF and coordinating perspectives generally are correlated, what is the foundation of this correlation? Is one a developmental prerequisite for the other? Do they share underlying neurocognitive machinery? Or are the two phenomena more deeply conceptually related such that necessarily tasks tapping the two phenomena share some logical deep structure (see Perner & Lang, 1999)?

Second, if there is EF involvement in different kinds of perspective problems, is this a unitary, relatively domain-general phenomenon? Or are there actually different kinds of domain-specific forms of inhibition involved in different kinds of perspective problems? And if the latter is true, how are different inhibitory mechanisms (say, in understanding cognitive and conative perspective problems) brought together in complex belief–desire reasoning (for some computational proposals regarding such inhibitory combinations, see the work of Leslie and colleagues, e.g. Friedman & Leslie, 2004; Leslie & Polizzi, 1998; Leslie, German & Polizzi, 2005)?

Finally, a third set of questions concerns the breadth of the correlation of EF with perspective problems. For example, is EF involved in perspective coordination problems other than in the domain of belief–desire reasoning, such as in linguistic or visual perspective problems (see Perner *et al*., 2002, 2003)?

Perspective problems and first-person involvement

A related question concerns the role of first-person involvement in perspective coordination. All existing studies documenting correlations between EF and FB ascription (including the present one) have used standard FB tasks. These tasks involve a conflict between reality as seen from the child's perspective and a protagonist's belief about reality, and therefore require ascribing beliefs to another person while inhibiting one's own perspective (e.g. Apperly *et al*., 2005[9]). The present study in addition showed that EF was correlated with understanding desire perspective problems, and this correlation was clearest in the case when the child herself was one of the desirers. This leaves open the possibility that EF plays a particularly prominent role in perspective coordination when one of the perspectives is that of the first person, and when at the moment of ascribing attitudes to someone else these conflict with one's own attitude. Future studies that systematically vary the first-person involvement in perspective problems, above all by using a belief-ascription task with no or less need to suppress one's own perspective (such as the FB task developed by Call and Tomasello, 1999), are needed to test for such a possibility.

Appendix 1. Understanding perspective problems according to Perner and colleagues

Perner and colleagues formally define a perspective problem in the following way: something constitutes a perspective problem iff there are at least two representations involved (mental attitudes, pictures, sentences etc.) the content of which (for example: p, q) cannot be joined by simple conjunction (p AND q) to yield a consistent representation. To take an example from the domain of visual perspectives (two objects A and B seen from opposite sides of a room): 'A is in front of B' and 'A is behind B'. The simple conjunction 'A is in front of and behind B' is inconsistent. Rather, each content has to be relativized to a standpoint or perspective or marked as a (mental) representation. (In the visual example: 'A is in front of B from perspective 1, but behind B from the opposite perspective…'.)

Applied to the case of desire understanding: simple desires, even different ones, do not present perspective problems, as the contents of different people's desires can be easily re-described as objective values in the world and joined by simple conjunction without reference to perspectives or mental attitudes. For example, the young child can make sense of a Repacholi & Gopnik scenario in the following way: 'Broccoli in adult's mouth is good, but broccoli in my mouth is bad'. Mutually incompatible propositional desires, however, do present perspective problems as simple conjunction breaks down here. For example, when I desire that p (e.g. that X be president next year), and you desire that q (e.g. that Y be president next year) when p and q exclude each other, we cannot just re-describe this in terms of objective value: 'p and q is good' (e.g. 'that X be president and that Y be president next year is good'). What we have to do is to relativize 'p' to my conative perspective, and 'q' to yours: 'I desire that X be president next year, but you in contrast desire that Y be president next year'.

Appendix 2. Warm-up for the conflicting-desires tasks

1 **Introduction of the 'chance machine'**
Before the proper session began:
To introduce the 'chance machine' to the child, E put a marble into the upper tube repeatedly and made it emerge in (seemingly) random fashion.

2 **Explanation of the game**
E explains basic logic to the child ('Look! Here is a sticker (points to the left sticker), and there is one (points to the right). Now we can put the marble in. The marble sometimes comes out here (points). If it comes out here this sticker above (points) goes in the book…')

3 **Introduction of the puppet**
Rudi, the puppet, is introduced, and the booklet, which belongs to the child and Rudi together.
E tells the child that Rudi was very tired and had to sleep for a while (at which point E put away Rudi)

4 **Warm-up trials 1 + 2 (without questions)**
E pins one sticker and one boring object to the board.
E drops the marble, points out where it rolled to, and takes the corresponding object.

5 **Warm-up trials 3 + 4 (with questions)**
E pins two stickers (one interesting, one boring) to the board.
E asks child which sticker she wants to have in the booklet.
During the game, E asks the child questions (which sticker she wants to be in the book; where she wants the marble to roll etc.) and gives feedback if necessary.

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[9] A recent neuropsychological case study by Samson *et al*. (2005) suggests that these two aspects – ascribing beliefs to another person and inhibiting one's own perspective – are functionally dissociable in adults to some degree. A patient with a right fronto-temporal lesion was unable to ascribe false beliefs to someone else only when he himself knew about the current state of affairs in question at that moment: failing standard FB tasks, he succeeded on a modified FB task (by Call & Tomasello, 1999) in which the participant himself is agnostic at the moment when the belief has to be ascribed.

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