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Children's Understanding of Behavioral Consequences of Epistemic States: A Comparison of Knowledge, Ignorance, and False Belief

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ABSTRACT. The author addressed the issue of the simultaneity of false belief and knowledge understanding by investigating children's ability to predict the behavioral consequences of knowledge, ignorance, and false belief. The second aim of the study was to explore the role of counterfactuals in knowledge understanding. Ninety-nine (99) children, age 3–7 years old, completed the unexpected transfer task and a newly designed task in which a protagonist experienced 1 of the following 4 situations: knowing a fact, not knowing a fact, knowing a procedure, and not knowing a procedure. The results showed that factual ignorance was as difficult as false belief for the children, whereas the other conditions were all easier than false belief, suggesting that the well-known lag between ignorance and false belief may be partly methodologically based. The results provide support for a common underlying conceptual system for both knowing and believing, and evidence of the role of counterfactual reasoning in the development of epistemic state understanding. Methodological variations of the new task are proposed for future research.

Keywords *epistemic state understanding, false belief, knowledge, theory of mind*

Children's understanding of false beliefs has received a great deal of attention in the literature compared to their understanding of knowledge or lack of knowledge. Moreover, when false belief and knowledge understanding have been compared, they have not been assessed in the same way (Bradmetz & Bonnefoy-Claudet, 2003). Research on knowledge understanding has examined how children conceptualize the basic relationships between context and human knowledge and whether they are able to make judgments on the knowledge of a protagonist, predict future knowledge, or explain how a particular state of knowledge was formed (for a review, see Miller, 2000). Most studies have examined children's grasp of the origins of knowledge regarding a physical situation (the identity of an object or its location; Moll, Carpenter, & Tomasello, 2014; O'Neill & Chong, 2001; Pillow, 1989, 1993; Sodian & Wimmer, 1987; Tang & Bartsch, 2012; Wimmer, Hogrefe, & Perner, 1988), while other studies have investigated children's assumption that some individuals may be more knowledgeable than others because of their expertise, age,

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or intention to help or deceive (Jaswal, 2004; Koenig & Harris, 2009; Robinson, Champion, & Mitchell, 1999; Vanderbilt, Liu, & Heyman, 2011). Recent studies have brought together these two lines of research by exploring the relative weight children assign to situation-specific or person-specific cues to different kinds of knowledge (Brosseau-Liard & Birch, 2011). Some authors have also examined how children conceive of the relationship between belief and certainty (Rimbert, 2001, in Thommen & Rimbert, 2005; Ruffman, 1996). To date, no study has evaluated children's understanding of knowledge and ignorance by assessing their ability to predict the behavior of a protagonist in these epistemic states, as has been done for false belief and other mental state understanding.

EVALUATING THE BEHAVIORAL CONSEQUENCES OF MENTAL STATES

In the theory of mind literature, children's mental state understanding is often estimated by assessing their ability to predict the behavior of a protagonist given his or her mental state. This is the case for false belief understanding, assessed using the unexpected transfer task (Wimmer & Perner, 1983), and for all other mental state understanding, namely, desire, intention, and emotion understanding. In the case of desire understanding, researchers have tapped the relationships between desire and its behavioral consequences by investigating whether children are able to predict the action of a protagonist given his or her desire, (Wellman & Woolley, 1990), whether they can differentiate the behavior from the desire that gives rise to it (Astington & Gopnik, 1991), or whether they can predict a protagonist's behavior given his or her desire, even when this desire conflicts with their own (Cassidy et al., 2005). When evaluated for their understanding of intention, children have been asked to predict the action that should follow a protagonist's expression of an intention (Astington, 1993; Lee, 1995), and retrospectively infer the intention based on the action, thus showing that they distinguish intentional actions from accidental ones (Feinfeld, Lee, Flavell, Green, & Flavell, 1999; Lee, 1995) and grasp that different intentions could lead to the same action (Baird & Moses, 2001). In tasks designed to appraise emotion understanding, children have been asked to identify the expected behavior given a protagonist's emotion (Deneault & Ricard, 2013; Deneault et al., 2008; Gouin Décarie, Quintal, Ricard, Deneault, & Morin, 2005; Nader-Grosbois, Houssa, & Mazzone, 2013; Russell, 1990), or to retrospectively infer the emotion felt by a protagonist given his or her behavior (Widen & Russell, 2004, 2011).

Evaluating children's ability to predict the behavioral consequences of mental states contributes to the knowledge of their grasp of mental states that would not be available otherwise. For instance, it is now known that children distinguish causes from consequences of emotions and more easily understand the contexts leading to the emotions than the behaviors that these emotions give rise to (Widen & Russell, 2011). It also helps to characterize the development of social cognition in some groups of children compared to others and identify which indices of mental state understanding are related to different variables of social adjustment. While children's performance on causes-of-emotion tasks has been shown to be associated with their social competence (Denham et al., 2003), their performance on consequences-of-emotion tasks has proven to be more related to internalizing problems (Deneault & Ricard, 2013; Fine, Izard, Mostow, Trentacosta, & Ackerman, 2003; Trentacosta & Fine, 2010). Moreover, compared to typically developing children and children with intellectual disabilities, children with externalized behavior have been shown to be less proficient at understanding the causes of emotion but not to differ in their understanding of the

consequences of emotion (Nader-Grosbois et al., 2013). In the case of knowledge understanding, the use of a task assessing the behavioral consequences of knowledge or ignorance could also contribute to refining the understanding of theory of mind development by clarifying the issue of the order of acquisition of knowledge and false belief understanding.

Understanding of Ignorance and of False Belief: Which Comes First and Why?

Prior research has shown that the understanding of ignorance develops earlier than false belief understanding (Hogrefe, Wimmer, & Perner, 1986; Wellman & Liu, 2004). In Hogrefe et al.'s study, many children correctly answered the question regarding another child's ignorance in the unexpected content task (Experiments 1 and 2) or in the unexpected transfer task (Experiment 4) without being able to identify the other child's false belief. In contrast, the reverse pattern was rare. The six experiments ruled out many procedural biases that could have explained the lag between knowledge and false belief understanding, which the authors attributed to the representational complexity of the false belief situation compared to the ignorance situation. According to this explanation, what children find difficult with understanding false belief is holding two representations of the same situation simultaneously (Hogrefe et al., 1986; Perner, 1991).

This explanation was questioned by Bradmetz and Bonnefoy-Claudet (2003), who hypothesized that ignorance appeared to be easier for the children to understand than false belief because of the way these two states were assessed. The false belief task required the child to link the false belief to its behavioral consequences ("What will the protagonist *say* . . . ?" or "Where will he *look for* . . . ?"), while the knowledge task did not ("Does the protagonist *know* . . . or does he does not know that . . . ?"). To verify their claim, Bradmetz and Bonnefoy-Claudet designed three experiments in which false belief was assessed without its usual behavioral counterpart, in line with the way knowledge understanding has typically been evaluated. Three questions were addressed to the children: one on the protagonist's knowledge, one on his or her false belief, and one on the behavioral consequence of this false belief. The results showed that nearly all the children (92% in the first two experiments involving 224 children) answered the first and second questions the same way (giving either two correct or two incorrect answers). As hypothesized by Bradmetz and Bonnefoy-Claudet, more children (29%) correctly answered both the first and second questions while failing the third one—which required predicting the action of the protagonist holding a false belief—compared to the number of children who, as per the expected pattern, succeeded at the knowledge question while failing both false belief questions (only 7% of the children). These results were interpreted as supporting the idea that the progressive understanding of epistemic states (usually described by the sequence *understanding knowledge-understanding false belief*) may be better described by the parallel development of a theory of mind and a theory of action (which progressively enables the child to relate mental states to their behavioral consequences), than by the understanding of representational complexity or counterfactuals. According to this proposition, young children can understand the formation and content of knowledge or belief states before being able to link these mental states to actions (Bradmetz, 1999; Bradmetz & Amiotte-Suchet, 2001; Bradmetz & Bonnefoy-Claudet, 2003).

Although Bradmetz and Bonnefoy-Claudet's (2003) conclusions are compelling, there may be other explanations for their findings. As the authors themselves proposed, children might have

succeeded at both the knowledge question and the false belief question because the latter was interpreted as a synonym for the first. This phenomenon, which has since been studied by many researchers (Fabricius & Imbens-Bayley, 2000; Fabricius & Khalil, 2003; Garnham & Ruffman, 2001; Perner & Horn, 2003; Rimbert & Thommen, 2003), was first revealed by Ruffman (1996), who found that children tended to attribute a false belief to an ignorant doll. According to the Ruffman effect, children who succeeded in the unexpected transfer task assessing false belief chose the empty place (from which the object had been moved) not because they understood false belief, but because not knowing meant falsely believing and necessarily being mistaken by a situation, or, as stated by Perner and Horn (2003), ignorant people look in wrong places, and cannot believe something that is true (Ruffman, 1996). Bradmetz and Bonnefoy-Claudet attempted to rule out this interpretation of their results by adding a third location to the false belief task in their third experiment (i.e., adding another wrong place), but this attempt failed because the third alternative was not sufficiently integrated into the story to be really attractive to the children (in the scenario, the object was never placed in the third location).

Further research is needed to investigate the well-known lag between knowledge and false belief understanding and to verify whether this lag can be ascribed to the fact that the two mental states have been assessed differently. Bradmetz and Bonnefoy-Claudet (2003) chose to assess false belief the same way that knowledge is usually assessed (i.e., without considering the protagonist's action or behavior). Another way would be to do the opposite and assess children's ability to predict the protagonist's behavior given his or her knowledge.

Aim of This Study

This study specifically addressed this issue by investigating children's ability to predict the behavioral consequences of knowledge and ignorance in others. Drawing on the consequence-of-emotion-task (Deneault & Ricard, 2013; Gouin Décarie et al., 2005; Quintal, 2001), I created a new task assessing children's ability to identify the expected behavior of a protagonist who knows or does not know a fact or procedure. The children's performance on this task was compared to their ability, assessed using an unexpected transfer task, to identify the expected behavior of a protagonist with a false belief.

Bradmetz and Bonnefoy-Claudet (2003) suggested that the development of epistemic state understanding may be better described by the development of a theory of action that completes the theory of mind than by children's progressive ability to reason counterfactually. However, counterfactual reasoning was not directly assessed in their study because all the protagonists' epistemic states were counterfactual. Moreover, in most standard false belief scenarios, the protagonist's false belief has concerned a fact (the location of an object in the unexpected transfer task or the content of a box in the unexpected content task) and the child has had to go beyond the real state of affairs in order to predict the behavior of the protagonist holding a counterfactual belief. Generally, children have tended to give too much weight to reality over unreal psychological matters and their performance has been influenced by a reality bias in responding to false belief situations (Mitchell, 1994). In fact, a decrease in the relative saliency of reality in false belief tasks has led to a precocious understanding of false beliefs in children (Mitchell & Lacohée, 1991; Smaltmarsh & Mitchell, 1998). The second aim of the present study was thus to explore the role of counterfactuals in a knowledge understanding task. To this end, two types of stories were presented to the children in the new behavioral-consequence-of-knowledge task: stories involving

factual knowledge and stories involving procedural knowledge. The children's performance on these tasks was compared to their performance on the unexpected transfer task assessing false belief.

These comparisons were planned to help identify which of the three explanations evoked in the literature for the lag between knowledge and false belief understanding, that is, representational complexity (Perner, 1991), different means of assessment (Bradmetz & Bonnefoy-Claudet, 2003), or the difficulty inhibiting reality (Riggs, Peterson, Robinson, & Mitchell, 1998), accounts for children's difficulty with false belief. These explanations led to three different predictions in the present study:

Hypothesis 1: If what makes false belief difficult for children is holding two representations of the same situation simultaneously (Perner, 1991),[1] then the false belief task should be more difficult than all knowledge and ignorance conditions (as, in the false belief task, the child knows X and the protagonist thinks Y, whereas in the knowledge task, the factual ignorance condition does not involve two representations of the situation since the child knows X while the protagonist does not know X).

Hypothesis 2: If the difficulty with false belief is identifying the behavioral consequence of an epistemic state (Bradmetz & Bonnefoy-Claudet, 2003), then the children's performance on the false belief task should be equal to their performance in all other conditions (as all the conditions require that the child identify the protagonist's expected behavior).

Hypothesis 3: If the difficulty with false belief can be explained by the fact that it has been assessed through the ability to identify the behavioral consequences of epistemic states (Bradmetz & Bonnefoy-Claudet, 2003) and by the vividness of reality and the inability of children to inhibit this reality (Riggs et al., 1998), then the false belief task (requiring that the children handle a counterfactual situation) should be more difficult than all the knowledge and ignorance conditions except the factual ignorance condition (which is also counterfactual).

METHOD

Participants

Ninety-nine French-speaking children (41 girls) aged 3–7 years took part in the study. Given that the task assessing knowledge and ignorance was new, a large age range was preferred. This age range was similar to that used in Bradmetz and Bonnefoy-Claudet's (2003) study, which addressed the same issue (difference between knowledge and false belief understanding), but where false belief and knowledge understanding were assessed without their behavioral counterparts. Given the presumably more demanding nature of the new task, I extended the age range (3;6 years [or, 3 years and 6 months] to 6;3 years) used in Bradmetz and Bonnefoy-Claudet's study. Children were divided into four age groups: 3;5 to 4;4 years (M age = 46.14 months, SD = 3.33 months; n = 28), 4;5 to 5;4 years (M = 57.87 months, SD = 3.30 months; n = 23), 5;7 to 6;4 years (M = 70.86 months, SD = 3.38 months; n = 29), and 6;5 to 7;4 years (M = 80.68 months, SD = 3.18 months; n = 19).

The children were recruited through schools and childcare centers in Rimouski (Québec, Canada). A consent form describing the study was sent to the children's parents. Only children whose parents signed the consent form participated in the study. The study was approved by the Research Ethics Committee of the Université du Québec à Rimouski.

Tasks

False belief

An unexpected transfer task, involving two different stories, was administered to the children (Wimmer & Perner, 1983) to assess their understanding of another child's false belief. Each story was acted out with little dolls, doll-sized material (e.g., cupboards, desks, ball) and doll-sized scenes. In one of the stories, a little girl named Camille (or a little boy, matching the participating child's gender) was playing ball with her friend Max. Then Max had to leave. Before leaving, Max put the ball in the box (here, the child was asked a prompt question: "Where did Max put the ball?"). Then Max left. While he was away, Camille took the ball, played with it and put it in the basket. At this point, the test question was asked: "When Max comes back, where will he look for the ball?" Then, in order to verify the child's memory of the critical story events, he or she was asked two control questions: "Where is the ball really?" (reality question) and "Where did Max put the ball at the beginning?" (memory question). If the child did not answer the test or control question spontaneously, he or she was asked a forced choice question: "Where is the ball really, in the box or in the basket?" Children were scored as passing only if they were able to answer both the control and the test questions correctly. The other story involved Martine (or François, depending on the participant's gender) and her mother coming back from the store with chocolate.

Knowledge and ignorance

This newly designed task was modeled on Gouin Décarie et al.'s (2005) task designed to assess children's understanding of the behavioral consequence of emotions (for an English version, see Deneault & Ricard, 2013), which was based on Lefebvre and Nadel's (1999) work on intentionality. Eight illustrated stories were used to evaluate the child's ability to identify the expected behavior of a protagonist in one of the following four conditions: knowing a fact,[2] not knowing a fact (counterfactual), knowing a procedure, or not knowing a procedure (not counterfactual).[3] For each condition, two stories were told to the child, who had to identify the expected behavior given the protagonist's epistemic state. For each story, two coloured drawings depicted the script, told in French by the experimenter, who explicitly pointed out the knowledge state of the protagonist. The knowledge state was also represented in the second drawing by a thought bubble, which was empty in the ignorance stories and contained a light bulb in the knowledge stories.[4] A blank frame completed the sequence of drawings. The child was asked to finish the story and fill in the blank by choosing from among three drawings (in which the protagonist behaved in an appropriate, neutral, or inappropriate way) the one that best illustrated the expected behavior given the protagonist's knowledge state (see the response drawings in an English translation of the scripts in the Appendix). The three possible answers were verbally described to the child, who was then asked to choose one of them either by pointing to a drawing or telling the experimenter.

Because this was a new task, I wished to examine the children's reasoning regarding the behavioral consequences of knowledge and ignorance. The children were thus asked to justify their answer by explaining their choice ("Why is she . . . ?"). This was done whether their answer was correct or incorrect so as to ensure that the children did not take the questioning as feedback

for their answers. Questions eliciting children's explanations for actions are not considered more difficult than the simple prediction questions usually used in traditional theory-of-mind tasks (Wellman, 2011; Wellman & Lagattuta, 2004; see also Wimmer & Mayringer, 1998).

The eight stories were presented in four different orders. The three response drawings for each story were presented at random. The protagonist was always the same gender as the child.

Procedure and Scoring

Each child was tested individually by a female experimenter (not the author). The children were administered the false belief task and the knowledge tasks in a counterbalance order. For the knowledge and ignorance tasks, children who correctly identified the expected behavior were assigned a score of 1. Because there were two stories for each of the four conditions (knowing a procedure, knowing a fact, not knowing a procedure, and not knowing a fact), the children could receive a maximum score of 2 for their performance in each condition, which was then compared to their performance on the false belief task, for which the total score also ranged from 0 to 2.

The justifications following correct answers in the knowledge and ignorance tasks were assigned a score of 0 to 3. The levels of justification took into account the extent to which the children referred to the epistemic state of the protagonist (whether in an explicit or implicit manner) or referred to the protagonist's desire (nonepistemic state). Desire and knowledge are foundations of human intentional causality, and the theory of mind literature recognizes both as the principal causes of behavior for children (Perner, 1991; Wellman, 1991), who refer to these mental states when explaining human behaviors (Wellman & Lagattuta, 2004). With age, children show a progressive ability to justify a protagonist's behavior in false belief tasks. In Bradmetz's (1999) experiment (a replication of Wellman, 1991), 96 children aged 3–6.5 years were asked to justify the behavior of a protagonist who held a false belief and the types of justification (referring to desire, to the content of the epistemic state, or explicitly to the protagonist's epistemic state) respectively characterized groups of children of increasing mean age (Bradmetz, 1999). In a longitudinal study by Mélançon and Ziarko (2011) in which the children were asked to predict the protagonist's action, the justifications given by the children in explaining this action also evolved from implicit reference to explicit reference to epistemic states between the end of kindergarten (6 years old) and the end of Grade 1 (7 years old).

In the knowledge and ignorance tasks, children who chose the appropriate expected behavior and justified their answer by explicitly referring to the protagonist's knowledge state ("Because he knows . . . " "Because he doesn't know . . . "), or by describing the bubble that conveyed this state ("Because there's no light bulb") were assigned a score of 3. Referring to the fact that the protagonist " . . . can't . . . " was considered a synonym for "he doesn't know how . . . " and was also assigned a score of 3. Children who gave justifications that implicitly referred to the protagonist's knowledge state were assigned a score of 2. In the knowledge stories, for example, these justifications did not refer to the protagonist's knowledge, but rather to the content of this knowledge (Julie goes to the park. Why? "Because Simon's there" instead of "because she knows that Simon's there," which would explicitly refer to the protagonist's knowledge). In the ignorance stories, implicit reference to the protagonist's ignorance took the following forms: "Because the teacher knows," "Because he needs help" (meaning implicitly that the protagonist does not know). Correct answers were also justified by referring to the protagonist's desire ("Because she wants to play with Simon"). A score of 1 was assigned for these justifications. Inappropriate justifications

("I don't know" or repetition of the terms of the question) were assigned a score of 0. One child, who repeatedly answered, "Because he wants to" to all problems without being able to specify what exactly the protagonist wanted, received a score of 0 for her justifications. The justifications given by the child following his or her answers were transcribed during the task and scored later by the female experimenter who was unaware of the hypotheses of the study.

RESULTS

Descriptive data on the tasks and analyses of the effects of age and type of task will be presented first. These analyses were conducted to examine whether there was a difference in performance on the false belief, knowledge, and ignorance tasks. They are followed by an analysis of the justifications provided in the knowledge and ignorance tasks.

Understanding the Behavioral Consequences of False Belief, Knowledge, and Ignorance

The children's performance on the false belief task was compared with their performance on the knowledge and ignorance tasks. Given that the children were not asked to justify their answers in the false belief task, the justifications they provided in the knowledge and ignorance tasks were not included in these analyses.

The mean scores for each story are presented in Table 1. The Wilcoxon tests first showed that the mean scores for each of the two stories making up each task condition were not significantly different from one another (knowing a fact: $z = -1.23$, $p > .05$, knowing a procedure $z = -1.00$, $p > .05$; not knowing a fact $z = -1.80$, $p > .05$; not knowing a procedure $z = -0.19$, $p > .05$; and false belief $z = -1.39$, $p > .05$). The two stories were thus combined for the main analysis (scores from 0 to 2).

The performance on the knowledge and ignorance tasks was then compared to the performance on the false belief task. A 4 (Age Group) $\times$ 5 (Task) analysis of variance was conducted to evaluate the effects of age and type of task. The dependant variable was the mean score for their performance for all five task conditions, with a possible range of 0 to 2. The mean scores and standard deviations for each task are presented in Table 2.

The results showed a significant effect of age, $F(3, 95) = 20.3$, $p < .001$, $\eta^2 = .39$, and a significant effect of the within-subjects factor task (Wilks's $\Lambda = .78$), $F(4, 92) = 6.53$, $p <$

TABLE 1
Mean Score and Standard Deviation for Each Story

	Story 1		*Story 2*	
Tasks	M	SD	M	SD
Knowing a fact	0.80	0.40	0.86	0.35
Knowing a procedure	0.81	0.40	0.86	0.35
Not knowing a fact	0.64	0.48	0.73	0.45
Not knowing a procedure	0.77	0.42	0.78	0.42
False belief	0.69	0.47	0.74	0.48

$N = 99$. Scores ranged from 0 to 1 for each story.

TABLE 2
Mean Scores and Standard Deviations for Each Condition in the Knowledge and Ignorance Tasks and the False Belief Task for Each Age Group

	Tasks											
	Know facts		*Know how*		*Not know facts*		*Not know how*		*False belief*		*Total*	
Gr.	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
3;5 to 4;4 years	1.29	0.60	1.25	0.65	1.00	0.82	1.11	0.69	0.64	0.91	1.05	0.43
4;5 to 5;4 years	1.57	0.66	1.69	0.56	1.30	0.76	1.48	0.67	1.70	0.70	1.54	0.39
5;7 to 6;4 years	1.89	0.41	1.86	0.35	1.51	0.78	1.83	0.47	1.55	0.74	1.73	0.39
6;5 to 7;4 years	1.95	0.23	1.94	0.23	1.74	0.56	1.84	0.37	1.53	0.70	1.80	0.24
All groups	1.66	0.57	1.67	0.55	1.36	0.79	1.55	0.64	1.32	0.88	1.52	0.48

Note. Scores could range from 0 to 2. $N = 99$.

.001, multivariate $\eta^2 = .22$. No interaction effect was found. Eight pairwise comparisons were conducted on the mean scores of the entire sample to determine the differences between the tasks (see the last row in Table 2). Four paired comparisons involved ignorance and knowledge crossed with the facts versus procedure conditions, whereas the other four examined the differences between false belief and all the other tasks. As seen in Table 3, the factual ignorance condition ($M = 1.36$, $SD = 0.79$) was as difficult for the children as the false belief task ($M = 1.32$, $SD = 0.88$), whereas the other conditions (procedural ignorance, procedural knowledge, and factual knowledge), which did not differ from one another, were all easier than the false belief condition.

When using the Holm's sequential Bonferroni procedure (at the .05 level) to control for Type 1 errors, all the differences identified in the preceding analyses remained significant, except the difference between not knowing a fact and not knowing a procedure, the probability of which had to be under .0125 to reach significance. Again, the scores for false belief were lower than the scores for all other tasks assessing knowledge or ignorance except the factual ignorance task.

Follow-up tests were also conducted to identify differences between the age groups (see the last column of Table 2 for the means and standard deviations). The Tukey test showed that the

TABLE 3
Pairwise Comparisons Conducted Between the Mean Scores for the Tasks

	t*(98)*	*Sig. (two-tailed)*
Knowing a fact/knowing a procedure	−0.168	.867
Knowing a fact/not knowing a fact	3.486	.001*
Knowing a procedure/not knowing a procedure	1.679	.096
Not knowing a fact/not knowing a procedure	−2.337	.021*
False belief/knowing a fact	−4.104	.000**
False belief/knowing a procedure	−4.154	.000**
False belief/not knowing a fact	−0.387	.700
False belief/not knowing a procedure	−2.672	.009**

*$p < .05$. **$p < .01$.

TABLE 4
Percentage of Succeeded (S) and Failed (F) Problems for Each Age Group for Each Task

	Tasks								
	Know facts		*Know how*		*Not know facts*		*Not know how*		
Group	*F*	*S*	*F*	*S*	*F*	*S*	*F*	*S*	*No. of problems*
3 years	35.7	64.3	37.5	62.5	50	50	44.6	55.4	56
4 years	21.7	78.3	15.2	84.8	34.8	65.2	26.1	73.9	46
5 years	5.2	94.8	6.9	93.1	24.1	75.9	8.6	91.4	58
6 years	2.6	97.4	2.6	97.4	13.2	86.8	7.9	92.1	38

youngest group ($M = 1.05$, $SD = 0.43$) scored significantly lower ($p < .05$) than the three older groups, which did not differ from one another.

Secondary Analyses: Explaining Chosen Behaviors in Knowledge and Ignorance Tasks

The children were asked to justify their answers in the knowledge and ignorance tasks. This was done to examine their evolution toward explicit reference to the epistemic mental state when explaining the protagonist's expected behaviors. Because the ANOVA showed that neither the tasks nor the groups were equivalent, the percentage of justification types provided by the children following a correct answer was considered for each condition and each age group. It should be noted that even children from the youngest age group were able to choose the appropriate behaviors in the stories of the four conditions (see Table 4 for the percentage of successes and failures—justifications not included—for the four tasks for each age group).

The percentages of justification types provided by the children are shown in Table 5 (factual and procedural knowledge) and 6 (factual and procedural ignorance). As for factual knowledge stories, reference to the protagonist's desire (scored 1) when justifying the choice of an appropriate behavior (e.g., the children answered "Julie goes to the park *because she wants to play with Simon*" instead of "*because she knows that Simon's there*") was equally frequent among 3-, 4-, and 5-year-olds, but declined among 6-year-olds (dropping from 30.9% to 2.7%). A similar decline

TABLE 5
Percentages of Justification Types (0, 1, 2, 3) Following a Correct Answer for the Two Knowledge Tasks

	Knowing a fact				*Knowing a procedure*			
	0	*1*	*2*	*3*	*0*	*1*	*2*	*3*
3 years old[a]	40.0	28.6	8.6	22.8	28.6	45.7	0	25.7
4 years old	5.5	36.1	8.3	50	15.4	23.1	0	61.5
5 years old	9.1	30.9	9.1	50.9	7.4	14.8	0	77.8
6 years old	5.4	2.7	10.8	81.1	2.7	16.2	0	81.1

[a]A 3-year-old child was not asked to justify his response in one story, which led to one piece of missing data in the factual knowledge condition for this age group.

TABLE 6
Percentages of Justification Types (0, 1, 2, 3) Following a Correct Answer for the Two Ignorance Tasks

	Not Knowing a Fact				*Not Knowing a Procedure*			
	0	*1*	*2*	*3*	*0*	*1*	*2*	*3*
3 years old	21.4	3.6	32.1	42.9	16.1	16.1	9.6	58.1
4 years old	6.7	10.0	16.7	66.7	2.9	0	20.6	76.5
5 years old	9.1	2.3	13.6	75	1.9	0	3.8	94.3
6 years old	0	0	3.0	97.0	0	0	2.9	97.1

(from 45.7% to 16.2%) was found in the procedural knowledge stories. However, this latter decline appeared to be more gradual since justifications based on the protagonist's desire were never completely abandoned even at 6 years of age. It should be noted that, in the procedural knowledge stories, none of the justifications given were based on any reference to the protagonist's knowledge (scored 2), in contrast to the stories involving factual knowledge, where the child could either refer to the content of the epistemic state or to the fact that the protagonist knew ("Julie goes to the park because Simon's there") without referring explicitly to his or her knowledge (e.g., "because she knows that Simon's there" . . .). In the procedural stories (. . . "because he knows how to count"), it was difficult to refer to the specific content of the knowledge (the content was a procedure, which was not detailed and was not easily describable) without referring to the knowledge per se. Lastly, most of the justifications given by the 4-, 5-, and 6-year-olds explicitly referred to the protagonist's knowledge (scored 3) in both knowledge tasks. Explicit reference to knowledge by the children was frequent in all age groups but represented most of the justifications given to explain the protagonist's behavior by the children aged 4 years and older.

In the ignorance stories, the children did not resort much to desire explanations (scored 1; see Table 6). Reference to desire is not a real option in ignorance situations. Although the protagonist had a desire at the beginning of the narrative, the fact that he or she could not go through with it satisfactorily (due to his or her ignorance) momentarily changed this desire into a desire to know. The focus was thus more on the protagonist's epistemic state (knowing or not knowing) than on his or her initial desire. The frequency of justifications referring to desire was thus low for both kinds of ignorance tasks. Many children (in all age groups) justified the appropriate action (getting help in order to know) by referring to the protagonist's ignorance, whether they referred to this ignorance implicitly or explicitly. Implicit reference to the protagonist's mental state (scored 2) occurred mostly among 3-year-olds justifying their answers in the factual ignorance task. Implicit reference to factual ignorance decreased at 4 years old. In the procedural ignorance task, the frequency of implicit reference to ignorance was not as high, since, as mentioned above, it is more difficult to refer solely to the content of ignorance without referring to the ignorance per se. Overall, most justifications referred explicitly to the protagonist's ignorance (scored 3) in both the factual and procedural ignorance stories.

The qualitative analysis of the justifications in the four conditions suggests that inappropriate justifications (score of 0) were relatively rare across the entire sample, but their frequency dropped between 3 and 4 years old. The frequency of explicit reference to the protagonist's knowledge and ignorance increased mainly between 3 and 5 years old in the procedural stories but continued to increase up to 6 years old in the factual stories.

DISCUSSION

The aim of this study was primarily to examine children's understanding of knowledge, ignorance, and false belief by assessing their ability to predict the behavioral consequences of these mental states. The children's performance on the knowledge and ignorance tasks were considered under two conditions, which varied with regard to the nature of the knowledge considered, that is, factual and procedural knowledge and ignorance.

The results showed that understanding the behavioral consequences of ignorance was as difficult as understanding the behavioral consequences of false belief when ignorance concerned a fact. In contrast, in all other conditions (knowing a procedure, not knowing a procedure and knowing a fact), the behavioral consequences of knowledge and ignorance were easier to grasp than the behavioral consequences of false belief. Moreover, the relative difficulty of the knowledge and ignorance tasks was the same for children from 3 to 7 years old because no interaction effect was found between age and type of task (conditions). In all tasks, the youngest group (3;5 to 4;4 years) did worse than the children in the older groups (4;5 to 5;4 years, 5;7 to 6;4 years, and 6;5 to 7;4 years), who performed similarly to one another. However, the children's justifications in the new task showed a progression from the youngest to the oldest group, suggesting that the ability to explicitly refer to a protagonist's epistemic state when explaining the latter's behavior develops slowly.

These findings can easily be reconciled with previous results on knowledge and false belief and yield two main contributions. First, they expand the empirical verification undertaken by Bradmetz on the development of epistemic states (Bradmetz, 1999; Bradmetz & Amiotte-Suchet, 2001; Bradmetz & Bonnefoy-Claudet, 2003). Ignorance has usually been found to be easier to grasp by children than false belief. Explaining this lag, Bradmetz and Bonnefoy-Claudet pointed out that false belief has usually been assessed through the ability to predict its behavioral consequences while ignorance has not. They argued that apprehending the content of knowledge and belief occurs at the same time in the child's development and precedes the capacity to link both states to action, implicitly suggesting that a child should understand ignorance and false belief simultaneously when both are considered at the action level. This assumption, empirically unverified until now, was examined in the present study and received some support. Although it was not the case for all conditions (thereby discrediting Hypothesis 2 as a whole), being asked to predict the behavioral consequences of ignorance did make ignorance as difficult for children to grasp as false belief in the case of factual ignorance.[5] The results, combined with those of Bradmetz and Bonnefoy-Claudet, first suggest that the understanding of false belief and ignorance develop in parallel (Bradmetz, 1999) and that grasping the behavioral consequences of epistemic states may constitute a part of children's understanding that should be explicitly considered in a comprehensive conceptual framework on the development of epistemic state understanding. Future researchers should compare children's performance on tasks that involve predicting the behavioral consequences of knowledge and ignorance to their performance on standard tasks assessing knowledge and ignorance (without their action counterpart) to confirm the assumption that the formation of epistemic states is understood before their connection to action, which has been described as the first step in a theory of action (Bradmetz & Bonnefoy-Claudet, 2003).

Second, this study highlighted the importance of another aspect inherent to epistemic states: their possible counterfactual nature. Using a behavioral consequence task did not suffice to equate

the difficulty of false belief and ignorance. Moreover, the theory of action, as I understood it, cannot, in itself, explain the findings.[6] The children's performance on the ignorance and false belief tasks was similar only when both required that they inhibit their knowledge of a fact in order to correctly predict the protagonist's behavior. In other words, in the factual ignorance stories where children knew precisely what the protagonist did not know, the difficulty of predicting the behavioral consequences was the same as in the false belief task (where the child also knew the real state of affairs and had to consider a counterfactual epistemic state). Stories where the protagonist knew (or did not know) a procedure may not have conveyed as concrete a reality for the child (since the procedure known or not known by the protagonist was not described) and, in fact, the children were better at identifying the appropriate expected behavior in these conditions than in the false belief or factual ignorance conditions. Overall, the pattern of results suggests that the difficulty children have with false belief compared to knowledge, as brought out in previous studies, might not be due to their inability to hold two representations of the same situation simultaneously (as mentioned in Hypothesis 1), but rather to methodological differences in the way these mental states have been assessed and to the difficulty for children of inhibiting reality and reasoning counterfactually, as argued in Hypothesis 3.[7]

In previous studies, counterfactual reasoning was found to be related to and to explain some of the variance in false belief performance, (Drayton, Turley-Ames, & Guajardo, 2011; Guajardo, Parker, & Turley-Ames, 2009; Muller, Miller, Michalczyk, & Karapinka, 2007),[8] but most of this evidence was correlational. To my knowledge, the present study is the first to have compared children's understanding of counterfactual and noncounterfactual knowledge and to show that children found it more difficult to identify the appropriate expected behavior in the case where the protagonist did not know a fact than when he or she did not know a procedure. The problem in the factual situations did not appear to stem from the child's difficulty linking ignorance to the behavior of "asking for help," since this was the appropriate behavior to choose in both situations and children made this choice easily in the procedural ignorance stories. Preschool children develop adaptive help-seeking skills and know when, how and what to ask in many real-life or experimental contexts and tend to report these help-seeking strategies when they are questioned about them (Newman, 2000). The problem may lie in the nature of factual knowledge per se. A study conducted by Esbensen, Taylor, and Stoess (1997) showed that 4- and 5-year-olds were better at reporting that they had acquired new knowledge when this knowledge concerned new behaviors than when it concerned new facts. In the latter case, children had difficulty recognizing their previous ignorance, as if they had always known. Esbensen et al.'s results and ours suggest that, compared to procedural knowledge, factual knowledge combines a less tangible or concrete nature[9] with a more absolute status for children because it may be judged according to a truth values system (whether true or false, at least for young children). In contrast, procedures are not true or false. They may be better or more efficient in some circumstances and it can be appropriate to change the way we do things (parents frequently suggest that children do so), hence the lifelong relative status of procedures, which may have helped the children grasp the procedural knowledge change in Esbensen et al.'s study and facilitate their understanding of others' procedural ignorance in the present task.

In fact, it is known that factual knowledge can also take multiple forms, being true or false or somewhere in between. Factual knowledge thus combines both the absolute status of referring to and representing the real state of affairs (the world) and a relative status (may be false, uncertain about the extent to which it represents the world), which makes it more complex and difficult

for children to apprehend, either for others (as in this study) or themselves (as in Esbensen et al.'s [1997] study), particularly in the case of factual knowledge denial (i.e., ignorance).[10] The difficulty posed by reasoning counterfactually and inhibiting reality—either to restate past self-ignorance (as in Esbensen et al.'s [1997] study or in studies using the unexpected content task to assess false belief) or consider others' current ignorance (as in the factual ignorance task)—is similar to the difficulty posed by the unexpected transfer task assessing false belief. In the development literature, tasks assessing children's understanding of factual knowledge relate to many situations that differ on a representational level, some of which are not equivalent to the situation of false belief: (a) when the protagonist knows something (reality and representation being the same, there is simply no need for the child to take the protagonist's epistemic state into account); and (b) when the protagonist does not know something that the child also does not know (the reality is not known, so there is no reality to overcome in order to consider the protagonist's epistemic state). This may explain why knowledge (ignorance) was understood at younger ages in many studies and shows that an account of children's understanding of epistemic states cannot disregard the representational diversity of epistemic states in terms of the degree of counterfactuality.

On a developmental level, the analysis of the children's answers in the knowledge and ignorance tasks suggests that these tasks should be submitted to younger children than those I met. In the most difficult condition (factual ignorance stories), the youngest group (3-year-olds) succeeded in half of the problems and their answers regarding the protagonist's behavior in these problems did not differ from those of the 4–6-year-old groups. However, the analysis of the children's justifications showed that their understanding of epistemic states continued to progress from 3 to 6 years old. In the factual knowledge stories, a third of the children between 3 and 5 years old explained the appropriate expected behavior by referring to the protagonist's desire, while desire barely factored into the 6-year-olds' justifications. In the factual ignorance stories, the children did not refer to the protagonist's original desire since the ignorant protagonist's desire was changed to a desire to know (the condition needed to satisfy the original desire). This situation resembles that described by Bradmetz in referring to outcome intention (related to desire) and to action intention (related to belief about how to fulfill this desire), which changes to a new action intention when the action fails to satisfy the desire (Antoine & Bradmetz, 2008; Bradmetz & Amiotte-Suchet, 2001). Submitting the tasks to younger children may help to better identify the moment when children begin to refer implicitly to a mental state when justifying their answers in counterfactual stories (which almost one third of the 3-year-olds in the study already did) and would contribute to defining the progression of their understanding of ignorance toward a more explicit verbalization of this understanding. Moreover, asking children to justify their answers could also play a role in the process of knowledge acquisition, particularly if children are given feedback on their explanations (Amsterlaw & Wellman, 2006; Legare, 2012) and benefit from training. Recent work has shown that preschoolers who had one practice session were less overconfident about their future recall of factual knowledge than children who had no practice (Lipowski, Merriman, & Dunlosky, 2013). Tasks in which children have to explain their view and could benefit from adult questioning may serve developmental and educational aims. Future research should explore this avenue and encourage the inclusion of justification requirements in tasks assessing children's understanding of epistemic states in order to foster their development.

Limitations

Further research is needed to strengthen the conclusions drawn from this exploratory study. The task designed to evaluate the behavioral consequences of knowledge and ignorance was not intended to perfectly mimic the unexpected transfer task assessing false belief. Drawing on previous work on the behavioral consequences of emotions (Deneault & Ricard, 2013; Gouin Décarie et al., 2005) and intentionality (Lefebvre & Nadel, 1999), the knowledge and ignorance tasks presented three possible answers (appropriate, neutral and inappropriate behavior), whereas, in the false belief task, the children were asked to identify the protagonist's behavior among two possibilities (although they had to correctly answer the control questions to succeed at the task). The knowledge and ignorance tasks also differed from the unexpected transfer task in that the protagonist's mental state was given by the narrator, whereas, in the false belief stories, the child had to infer it. In most of the false belief tasks used in the literature, neither the mental state, nor the action is given to the child. In the knowledge and ignorance task, the mental state was given to the child, who was asked to choose a behavior that would logically derive from the given mental state. In his false belief scenarios, Bradmetz (1999) did the reverse by presenting the action of the protagonist without giving the latter's mental state to the child.[11] It is not clear how these variations affect children's performance, but, as suggested by Miller (2000), researchers should develop more complex false belief tasks in which the scenarios provide a wider scope of contexts for evaluating children's false belief understanding. This also applies to their understanding of epistemic states.

Last, the knowledge and ignorance stories were illustrated in a narrative-like fashion whereas the false belief stories were acted out with dolls and 3D materials. Previous research has shown that using images to illustrate false belief stories and asking the child to restate the narrative of the story increase false belief performance compared to the standard task with dolls (Lewis, 1994). This may mean that, in the present study, the ignorance stories were facilitated compared to the false belief stories. Comparing children's performance on the new task and on narrative false belief stories in future research could add further evidence that the lag between ignorance and false belief understanding has essentially been methodologically based.

In sum, the task assessing children's ability to identify the behavioral consequences of knowledge and ignorance is a new task. Further empirical research is needed to identify the methodological factors that affect children's performance on this task compared to other tasks assessing epistemic state understanding. Initially designed to be more similar to the tasks used in the theory-of-mind perspective, the behavioral-consequence-of-knowledge task and the methodological variations that could be brought to it may help better circumscribe children's conceptualization of epistemic states and their potential explicative power in the matter of human behavior.

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NOTES

1. In contrast with Perner (1991), some scholars maintain that children do not have to consider both representations simultaneously in order to perform on standard false belief tasks (see Gauthier & Bradmetz [2005] who suggested that children may focus alternatively on one or the other). However, this issue is beyond the scope of this study.
2. Where a thing or a friend was or what the habitat of an animal is.
3. How to count or how to sort objects by color.
4. The children had previously been exposed to two familiarization tasks: one for the thought bubble and one for the stories. The stories in the familiarization task were similar to those presented in the test phase except that the child was corrected or given positive feedback.
5. As all false belief tasks in the literature concern factual knowledge, one could assume that Bradmetz's and Bonnefoy-Claudet's (2003) prediction also concerned factual knowledge.
6. Bradmetz and Bonnefoy-Claudet (2003) appeared to sense that the understanding of counterfactuality could not be completely rejected as an explanation for children's difficulty with epistemic states (see the authors' precision in parentheses): "a stage-like development based on the progressive understanding of counterfactuality is not satisfactory and can be replaced (or completed) by a conception of a parallel development of a theory of mind and a theory of action" (p. 111).
7. For the purpose of this article, I chose to distinguish the ability to hold two representations of the same situation (Hypothesis 1) from the ability to consider the reality and its representation (Hypothesis 3). However, both abilities can be considered to be the same (see Bradmetz [2001] on intentional figures whose bipolarity can be grasped by children because of their emerging new operatory tools).
8. However, see Perner, Sprung, and Steinkogler (2004) for a different point of view.
9. Procedures are embodied in gestures, while facts are represented.
10. Children as young as 6 years old are known to reason about the existence of truth and grasp the subjectivity of different epistemic states (e.g., regarding facts and opinions) but these abilities continue to develop over the school years (10-year-olds explicitly recognized that opinions, contrary to facts, cannot be wrong; see Banerjee et al., 2007) and later. The development of intentional figures others than belief (Mathy & Bradmetz, 2005) and, more generally, the understanding of logical indeterminacy follows the same developmental progression (Byrnes & Beilin, 1991; Fay & Klahr, 1996).
11. The stories were presented on video. Here is an example: Jean, Isabelle, and Marc are resting on a couch side by side. Jean, who is sitting on the extreme left, begins to snore. Isabelle, who is seated in the middle, picks up a newspaper and taps him on the head, and then puts the newspaper on Marc's knees. Jean opens his eyes, looks at the paper, and then pulls Marc's hair. The question asked to the child is: Why did Jean pull Marc's hair?

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APPENDIX: SAMPLES OF STORIES IN THE KNOWLEDGE AND IGNORANCE TASK

Story for "Knowing a Fact"

E points to the first drawing.
Julie wants to play in the park with Simon after school.
E points to the second drawing.
Julie knows that Simon is waiting for him in the park to play.
What does Julie know?
If needed E points to the light bulb: *Does she know that Simon is waiting for her at the park?*
E shows the blank frame.
So what is Julie going to do?
E returns the three drawings depicting the choices of response.

a) Does she go to the park?
b) Does she ask a friend where Simon is?
c) Does she go home after school?

Why?

Story for "Not Knowing a Fact"

Raphael wants to help his father who cannot find the garden hose. Raphael does not know that the hose is in the garage. What does Raphael not know?
So what is Raphael going to do?

a) Does he ask his mother where the garden hose is?
b) Does he tell his father that the hose is in the garage?
c) Does he go outside to play?

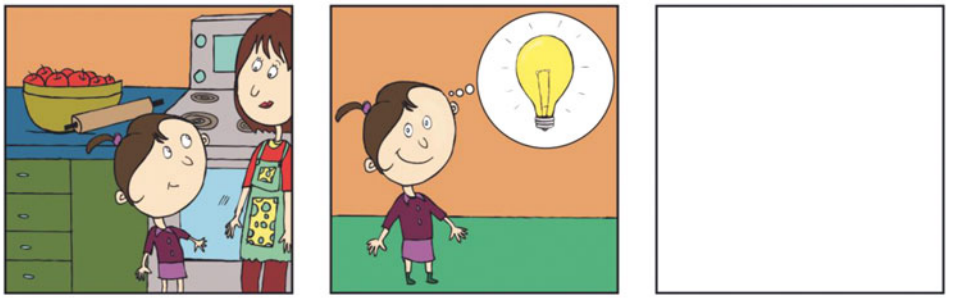
Why?

Story for "Knowing a Procedure"

Lynn's mother needs five apples to make a pie, and Lynn wants to count the apples for her mother. Lynn knows how to count. What does Lynn know?
So what is Lynn going to do?

a) Does she choose five apples for her mother?
b) Does she ask her older sister to help her count?
c) Does she put the dishes in the cabinet?

Why?



Appropriate response | Inappropriate response | Neutral response

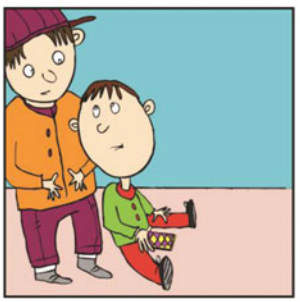
Story for "Not Knowing a Procedure"

John wants to play cards with his friend. John wants to give ten cards to his friend. John does not know how to count. What does John not know how to do?

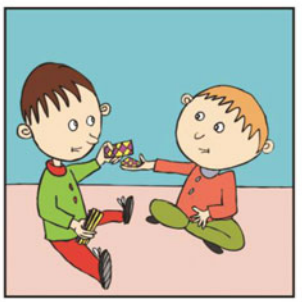
So what is John going to do?

a) Does he ask his old brother to help him count?
b) Does he give ten cards to his friend?
c) Does he feed his goldfish?

Why?



Appropriate response



Inappropriate response

Neutral response