Bridging the gap between implicit and explicit understanding: How language development promotes the processing and representation of false belief

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Recent advancements in the field of infant false-belief reasoning have brought into question whether performance on implicit and explicit measures of false belief is driven by the same level of representational understanding. The success of infants on implicit measures has also raised doubt over the role that language development plays in the development of false-belief reasoning. In the current paper, we argue that children's performance on disparate measures cannot be used to infer similarities in understanding across different age groups. Instead, we argue that development must continue to occur between the periods when children can reason implicitly and then explicitly about false belief. We then propose mechanisms by which language associated with false-belief tasks facilitates this transition by assisting with both the processes of elicited response selection and the formation of metarepresentational understanding.

In recent years, an abundance of research examining infants' perception of false belief has reignited the debate of when the cognitive ability to impute and reason about others' beliefs develops during childhood. Traditionally, it has been accepted that children do not develop this ability until the late preschool years, based on the robust finding that children do not typically pass standard false-belief tasks (Perner, Leekam, & Wimmer, 1987; Wimmer & Perner, 1983) until approximately 4 years of age (Wellman, Cross, & Watson, 2001). In a typical false-belief task, children must infer the impending actions of a protagonist who, through a series of interactions, acquires a false belief about the location or identity of a target object. For example, in a *change-of-location task*, children must infer where a protagonist, who has not seen the displacement of a target object from its original location, will search for this object upon his/her return (Wimmer & Perner, 1983). Other typical tasks require children to infer what a protagonist will say is in a familiar box with unexpected contents that have been seen by the child but not the protagonist (Perner *et al.*, 1987). Critically, most tasks require that children make

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elicited, verbal responses to questions about how the protagonist will act (e.g., '*Where will Maxi look for the chocolate*'), thereby restricting the window of assessment to an age when children can meet these linguistic demands. Recently, advancements in technology and methodology have produced false-belief paradigms that eliminate the need for verbal response and instead rely on spontaneous behavioural measures. Over the past 5 years or so, these paradigms have been used successfully with both infants and toddlers and have produced substantial evidence of early understanding (Baillargeon, Scott, & He, 2010; Kovács, 2009; Southgate, Senju, & Csibra, 2007; Surian, Caldi, & Sperber, 2007). Changes in assessment methods, however, have also brought forth questions regarding the role that language development plays in false-belief reasoning and whether the cognitive structure underlying infant processing is the same as that exhibited in the preschool years. Some researchers argue that the accuracy exhibited by preverbal infants on spontaneous measures is indicative of fully formed representations of belief (Baillargeon *et al.*, 2010), thereby limiting the role that subsequent language development can play on the understanding of false belief. Conversely, other researchers have argued that the structure of infants' false-belief representations is qualitatively different from that of older children (Perner, 2010; Perner & Ruffman, 2005; Ruffman & Perner, 2005) and that language development plays a critical role in the development of explicit false-belief understanding (Astington & Jenkins, 1999; de Villiers, 2007).

Despite the ongoing disagreement about when and how children acquire a representational understanding of belief, one factor that remains consistent across both camps is the acknowledgement that children's performance on early measures of false-belief understanding is not directly comparable to their performance on later measures. Importantly, the paradigms used to assess false-belief understanding in younger children are qualitatively different from those used to assess older children. Paradigms designed for use with infants and toddlers are referred to as *spontaneous* or *implicit* because they exclusively make use of children's involuntary responses (e.g., violation-of-expectation looking times, anticipatory-looking patterns) as measures of their epistemic understanding. In contrast, traditional measures of false-belief understanding are typically referred to as *explicit* because children are prompted to make direct inferences regarding the belief states of themselves and/or others. As mentioned previously, these latter measures are typically verbal, although they need not always be so (e.g., Call & Tomasello, 1999). The important contrast is that in explicit tasks, children must make controlled, as opposed to automatic, responses regarding false belief. Further, explicit tasks have been designed to assess understanding across a wide range of false-belief contexts (e.g., change of location, unexpected contents, appearance/reality) and sources of belief induction (e.g., belief by appearance, belief by inference, belief by misinformation). Due to their relatively recent implementation, however, implicit paradigms are still limited to a far narrower range of tasks (e.g., contexts that lend themselves to a forced-choice looking paradigm). Studies with younger children are also rarely conducted using a repeated measures design, further limiting the extent to which knowledge generalization can be assessed.

Given the number of discrepancies that exist between early and later false-belief measures, it does not seem reasonable to use children's responses on these disparate tasks as evidence for, or against, similarities in their representational understanding. Indeed, the fact that a large gap exists between the time when children can pass implicit and explicit measures of false-belief understanding suggests that a certain amount of development must occur between the two periods of assessment. What this development primarily consists of is still a matter for debate, but what is evident is that

children's performance on early and later measures of assessment are *not* equivalent and continuing to acquire evidence using disparate paradigms is unlikely to further elucidate the problem. What will perhaps be more beneficial to the current field is the <mark>construction of a cohesive developmental theory that explains *how* children progress from passing implicit to explicit measures of understanding and the factors that are necessary for this change to occur.</mark>

That is the purpose of the current paper. First, we will review how current developmental accounts of false-belief understanding explain the discrepancies that exist between implicit and explicit false-belief task performance. Second, we will briefly review the evidence for a relationship between language and the development of explicit false-belief understanding. Third, we will propose an account that gives language a primary role in bridging the gap between implicit and explicit false-belief understanding. Specifically, the acquisition of epistemic verbs and their related syntax – that is, verbs such as *think* and *know* that denote states of belief – will be discussed as a mechanism for producing change both in children's processing and representation of false belief.

Differing accounts of the development of false-belief understanding

Theories that explain the shift in children's performance on traditional measures of false-belief understanding typically fall into one of two camps: (a) <mark>constructivist conceptual shift accounts and (b) nativist modular accounts.</mark> Across both accounts, change is assumed to occur between children's earlier and later abilities to reason about false belief. Where these accounts critically differ, however, is in defining *what* develops across childhood and what factors contribute to children's successful performance on explicit measures of false-belief understanding. How each account would explain the differences in children's implicit and explicit false-belief task performance is reviewed in this section.

Conceptual shift accounts

Over the years, a number of theories have proposed that a conceptual shift in children's epistemic reasoning occurs between 3 and 5 years of age (e.g., theory theory, Gopnik & Wellman, 1992; simulation theory, Harris, 1992; metarepresentational theory; Perner, 1991). Although these theories vary in details of how mental state reasoning develops and functions, all share the underlying assumption that children's mental state <mark>representations undergo structural change between early and later childhood.</mark> For the purpose of the current paper, we will focus on theories that propose changes in metarepresentational understanding (Perner, 1991) because they offer the most detailed description of how children's concepts of belief change over time.

The assumption of conceptual change is largely supported by the <mark>pronounced shift observed in children's elicited responses</mark> on traditional measures of false-belief understanding. Proponents of this view argue that the point at which children are able to successfully pass direct measures of false-belief understanding is the point at which they are able to <mark>metarepresent and reason explicitly about belief.</mark> By the same logic, it is questioned whether infants' accuracy on spontaneous-response measures is indicative of the same level of understanding or whether they are derived exclusively from <mark>automatic patterns of processing.</mark>

Explicit reasoning is typically assessed via elicited, often verbal responses, because it is assumed that conscious awareness is necessary in order to accurately communicate

one's knowledge (Dienes & Perner, 1999). Because implicit false-belief tasks require only spontaneous, non-verbal responses as indicators of understanding, it is unclear how much, if any, of children's reasoning on these tasks occurs at a conscious level. In fact, for children who fail explicit measures of false-belief reasoning, a clear dissociation appears to exist between their elicited verbal and spontaneous non-verbal responses. Children may show correct anticipatory eye patterns upon presentation of an implicit cue (e.g., correctly anticipate that a protagonist who has not seen a target object displaced will search for it in its original location), while still failing to provide a correct response to the elicited measure of understanding (Clements & Perner, 1994). Further, there is evidence that children are completely unaware of the knowledge conveyed through their eye gaze (Ruffman, Garnham, Import, & Connolly, 2001). These findings suggest that children can maintain implicit representations of belief that exist in complete dissociation from their explicit state of understanding.

Second, proponents of a conceptual shift account have questioned whether infants' responses on implicit false-belief assessments are indicative of a true metarepresentation of belief. Metarepresentational understanding requires that children not only represent and distinguish the content of a belief from the true state of reality (e.g., believing that an object is in one location when it is really in another), but also embed this understanding within a higher order representation of belief. That is, the child must represent the agent's belief representation – hence, *meta*-representation – which allows the child to reason about the content of the agent's belief, independent of the current state of reality (Dienes & Perner, 1999). Although it is possible that young children's responses on implicit measures are driven by metarepresentational understanding, some researchers have argued that children's spontaneous responses may be more parsimoniously explained by lower level behavioural representations, or rules (Perner, 2010; Perner & Ruffman, 2005; Ruffman & Perner, 2005). For example, in a typical change-of-location task, children must predict where a protagonist will search for a target object after it has been displaced. A prediction based on metarepresentational understanding would require children to (a) represent their own belief (i.e., knowledge) of the object's location based on their experience with the object (i.e., witnessing the displacement), (b) represent the false belief of the protagonist based on his/her experience with the object (i.e., not witnessing the displacement) and, most critically (c) recognize that both beliefs, although their content is different, make reference to the same situation (Perner, 1991). Alternatively, a prediction could also be made if children form a representation that associates a specific situation (e.g., the protagonist last witnesses the object placed in location A) with a particular action (e.g., the protagonist searches for the object in location A). Either process or reasoning would lead children to accurately predict the protagonist's behaviour on this task, but critically, the latter process does not require them to metarepresent the protagonist's state of belief. Because young children can only show accurate patterns of prediction in measures where they are not directly asked to reason about the epistemic states of others, some researchers have concluded that their level of understanding is strictly limited to the representation of behavioural associations. The practice of examining infant false-belief understanding using primarily between-subjects designs has also led to speculation that young children are incapable of the flexible reasoning inherent in the development of metarepresentational understanding (Perner, 2010). The ability to generalize knowledge across multiple contexts, after all, is considered by many to be the hallmark of higher order reasoning (Gelman & Kalish, 2006). Although violation-of-expectation paradigms have successfully been adapted to measure infant false-belief reasoning across different contexts of belief induction

(Baillargeon *et al.*, 2010), the bulk of the research demonstrating accurate response patterns has been conducted between different children and different age groups. No study to date has demonstrated that within the same infant, patterns of response are coherent across different contexts of belief induction. If accuracy on implicit measures is truly indicative of infants' ability to impute and reason about the belief states of others, then generalization of reasoning should be evident within the same individual.

In summary, proponents of a conceptual shift account argue that the level of understanding necessary to succeed on spontaneous measures of false-belief understanding is qualitatively different from that needed to pass explicit measures. Before they are able to explicitly reason about epistemic states, children are said to rely on automatic, situation-based representations of behavioural patterns. Once children are able to respond to elicited measures of assessment, it is assumed that they are able to consciously represent the content of another's belief and embed this content within a higher order representation of belief (i.e., metarepresentation). Beyond distinguishing the developmental differences in children's processing, however, most conceptual shift accounts offer little explanation of how children transition from implicit to explicit reasoning and whether implicit representations of mental states directly influence children's later understanding. While it is possible to assume that implicit patterns of processing may develop into higher order representations of belief, evidence from analogous fields of cognition suggest that both implicit and explicit representations can co-exist in complete dissociation from each other (e.g., memory, Schacter, Chiu, & Ochsner, 1993; grammar learning, Gomez, 1997). Recently, evidence has begun to suggest that implicit knowledge measures in infancy may be predictive of children's performance on later, explicit measures of false-belief understanding (Clements, Rustin, & McCallum, 2000; Low, 2010), but it is yet unclear how direct this effect is.

Innate modular accounts

In contrast to theories that propose a conceptual shift in children's ability to represent mental states, innate modular accounts propose that concepts of belief and desire are present at birth (Baillargeon *et al.*, 2010; Gergely & Csibra, 2003; Leslie, German, & Polizzi, 2005). As evidenced by children's remarkable aptitude for early social interactions, proponents of these accounts argue that from an early age, children are not only able to perceive and represent the internal mental states of others but can also make multiple inferences regarding social behaviour. What is said to develop between infancy and early childhood is not the ability to represent epistemic states themselves but, rather, the cognitive abilities necessary to process these representations. Proponents of this view argue that children are late to succeed on more traditional measures of false-belief understanding because these measures require children to make *controlled, elicited* responses regarding the epistemic states of others (Baillargeon *et al.*, 2010). Moreover, elicited response tasks are especially taxing on the cognitive abilities needed to engage in the process of response selection. For example, in a false-belief task, children must not only retrieve and consider alternate perspectives within a given context (e.g., where a target object is actually hidden and where a protagonist thinks it is), but they must also actively inhibit the prepotent response of selecting a perspective that is congruent with their own (i.e., selecting the current location of a target object; Leslie *et al.*, 2005). Conversely, when false-belief paradigms are adjusted so that children's understanding is *indirectly* accessed via their *spontaneous* responses, it is possible to reduce the inhibitory demands associated with response selection to a level that allows for accurate predictions to be made. Because children do not need to actively consider alternate

responses before making a spontaneous response, it is argued that these measures are more pure assessments of a child's representational abilities (Baillargeon *et al.*, 2010). Children's ability to succeed in these paradigms is evidenced by the growing body of research using both violation-of-expectation and anticipatory-looking eye patterns as measures of spontaneous responses. To date, spontaneous measures have been used to demonstrate that children younger than 3 years of age are able to accurately infer the behaviour of a protagonist acting on a false belief about an object's location (Onishi & Baillargeon, 2005; Southgate *et al.*, 2007), an object's appearance (Song & Baillargeon, 2008), and an object's identity (Scott & Baillargeon, 2009)

Beyond describing the cognitive abilities that underlie discrepancies between children's implicit and explicit task performance, however, innate modular theories are not as clear in explaining how social factors contribute to shifts in performance between the ages of 3 and 5 years. The ability to reason about the belief states of others is, after all, an inherently social form of cognition and, as research has indicated, it is heavily influenced by individual differences in social and linguistic experiences (de Rosnay & Hughes, 2006). According to modular accounts, however, concepts of belief develop early in life, if they are not present at birth, and changes in false-belief reasoning are primarily influenced by developments in decision-making and inhibitory processes. Such accounts therefore leave little room for social factors to play a direct role in developing children's performance accuracy on explicit measures of false-belief understanding. To date, modular accounts have not clearly outlined how these various social factors interact with the development of response-selection processes to influence children's performance on explicit false-belief tasks.

In the end, it is clear that current accounts do not offer a sufficiently comprehensive story of how children progress from implicit to explicit forms of false-belief processing. As it currently stands, children's success on early measures of false-belief understanding is either considered in isolation of their performance on more traditional measures or it is taken as an indication of children's fully formed representation of belief. For an account to be truly developmental in nature, however, there needs to be a more detailed explanation of how change occurs between different periods of development. A comprehensive account must also address how both social-linguistic and cognitive factors work together to produce changes in children's false-belief reasoning.

Relationship between language and false-belief understanding

Although children typically succeed on direct, elicited response false-belief tasks at approximately 4 years of age (Wellman *et al.*, 2001), the precise age of success varies among children from 3 to 5 years. Thus, considerable research effort has been expended on investigating the basis of individual differences in performance. It is now well established that language is a significantly important correlate of explicit false-belief reasoning (Astington, 2006). The term 'language' is used here in a broad sense to refer to semantic, syntactic, and pragmatic abilities, internal to the child, and also to the external social-linguistic environment in which development occurs (Astington & Baird, 2005). Many studies have shown strong correlations between explicit false-belief understanding and language when the latter is assessed using various measures of general, semantic, and syntactic linguistic ability. In a meta-analysis, Milligan, Astington and Dack (2007) showed that general language ability (which includes semantics and syntax) explained 27% of the variability in explicit false-belief task performance. They also showed that semantics alone, assessed by receptive vocabulary measures (Peabody Picture Vocabulary Test,

British Picture Vocabulary Scale) and by discourse-level semantic measures, accounted for 12% and 23%, respectively, of the variance in explicit false-belief task scores. Measures of syntactic ability accounted for 29% of the variance.

For both semantics and syntax, a particular focus has fallen on epistemic verbs. Children typically start to use these terms before the age at which they typically pass explicit false-belief tasks (Bartsch & Wellman, 2005), although full comprehension of the terms may not be evident until later (Nelson, 2005). Indeed, children's comprehension of terms such as *think* and *know* in experimental tasks is related to explicit false-belief understanding (Moore, Pure, & Furrow, 1990) and even production of such terms in naturalistic play is associated with explicit false-belief task performance (Hughes & Dunn, 1998). Epistemic verbs are frequently used in complex sentences that allow for reference to false beliefs, for example, 'Bert thinks [that] the earth is flat'. The sentential complement 'the earth is flat' (the 'that' complementizer is optional) expresses a false proposition even though the whole sentence may be true. Jill de Villiers (2005, 2007) argues that mastery of such syntactic complementation is the critical aspect of language that underlies the development of explicit false-belief understanding. And indeed, in the meta-analysis cited earlier (Milligan *et al.*, 2007), complement syntax ability accounted for 44% of the variance in false-belief task scores. This effect was not significantly different from that of the other language measures, however, perhaps because only four of the 104 studies included in the meta-analysis had used a complement syntax measure. Moreover, some researchers (e.g., Ruffman, Slade, Rowlandson, Rumsey, & Garnham, 2003) argue that the high correlations are not surprising, given that de Villiers's complement syntax task (e.g., de Villiers & Pyers, 2002) assesses children's memory for false propositions embedded under epistemic (*think*) or communication (*say, tell*) verbs (e.g., 'He said he found a ring but it was really a bottle cap. What did he say he found?'). In consequence, therefore, children's understanding of falsity is confounded with their understanding of complementation. Relevantly, a recent study that included a measure in which memory for complement syntax was independent of falsity, showed no significant correlation between complement syntax and explicit false-belief understanding (De Mulder, 2011).

In addition, children's pragmatic abilities to use and interpret language appropriately in communication are also related to explicit false-belief reasoning. For example, Dunn and Cutting (1999) showed that false-belief task scores were related to connected and successful communication between friends in a naturalistic play situation. Explicit false-belief understanding is also related to performance on pragmatic tasks, such as referential communication tasks that require children to take account of the knowledge states of others (Astington, 2003).

The studies cited so far show significant correlations between semantic, syntactic, and pragmatic aspects of language and explicit false-belief task performance, but this of course does not establish that language plays any causal role in the development of explicit false-belief understanding. However, findings from longitudinal studies provide more support for a causal argument (Astington & Jenkins, 1999; de Villiers & Pyers, 2002). Moreover, although other longitudinal studies have shown that the relation between language and false belief is bi-directional (Slade & Ruffman, 2005), the Milligan *et al.* (2007) meta-analysis showed that the effect size of the relation from language to false belief is significantly greater than in the reverse direction. Moreover, evidence from training studies adds to this causal argument. For example, Lohmann and Tomasello (2003) showed that false-belief understanding was promoted by conversation about deceptive objects (i.e., objects with an appearance that is false given their true nature, such as a sponge painted to look like a rock) even though no epistemic terms and no

syntactic complements were used in the discourse. In addition, specific training on the syntax of complementation in the absence of any deceptive objects also promoted false-belief understanding. However, the largest training effect occurred in a third condition that combined these two (i.e., conversation about deceptive objects using complement constructions).

So far, we have focused on the contribution of children's own linguistic abilities to the development of explicit false-belief understanding. Although it is obvious that these internal abilities will be related to their social-linguistic environment, it is important to note that environmental-social aspects of language may also contribute to the development of explicit false-belief understanding. Even though it may be difficult to separate the roles these two factors play, it is possible to control for the child's own language abilities when considering the effects of the social-linguistic environment. For example, in a longitudinal study (Ruffman, Slade, & Crowe, 2002) mothers' use of mental state terms (which included epistemic verbs) predicted children's later explicit false-belief understanding even when controlling for the children's earlier explicit false-belief task performance, as well as their own earlier language ability, including use of mental terms. Ensor and Hughes (2008) report similar findings but, importantly, it was mothers' use of cognitive terms in connected conversation that was significantly related to false-belief understanding. These findings suggest a causal link between the social discourse environment and the development of explicit false-belief understanding. Further, it is not just exposure to mental state terms that matters but a 'meeting of minds' in conversation. It should be noted that the studies did not have a separate measure of complement understanding, and so it is still possible that discourse scaffolds children's linguistic representation of complementation, which is the proximal cause of the development of explicit false-belief understanding. Or discourse and complementation may have additive effects, as in the Lohmann and Tomasello (2003) training study mentioned earlier.

Evidence from children with atypical development also supports causal arguments for the influence of language on the development of explicit false-belief reasoning. Deaf children of deaf parents who acquire language (i.e., sign language) from birth show no deficit or delay in the development of explicit false-belief understanding, whereas deaf children of hearing parents who do not have access to language (sign language or spoken English), until later in development, show a related delay in explicit false-belief understanding (Schick, de Villiers, de Villiers, & Hoffmeister, 2007). Children with autism, whose language skills do not develop typically, also do not develop explicit false-belief understanding within the typical time frame. Moreover, the verbal ability of children with autism who do eventually pass false-belief tasks is higher than that of typical children when they first succeed on the same tasks (Happé, 1995).

Thus, it is obvious that many aspects of language are related, most likely causally, to the development of explicit false-belief understanding. It should be noted that the studies included in the Milligan *et al.* (2007) meta-analysis, as well as other studies cited above, used explicit false-belief tasks that were verbal tasks, which may account for at least part of the correlation found between false-belief understanding and language. Nonetheless, the evidence from longitudinal and training studies, and from studies with atypical children, all suggest that the relationship between language and explicit false belief is not simply an artifact of task factors. Moreover, Low (2010) has shown that language ability (semantic ability measured by PPVT scores and syntactic ability measured by the complements task) is related to children's performance on non-verbal versions of explicit (i.e., elicited response) false-belief tasks.

In contrast to the multitude of studies referred to above, there is little information regarding the relation of language to indirect, spontaneous-response false-belief measures. However, implicit false-belief understanding is evident in infants as young as 7 months of age (Kovacs, 2009), when language, at least individual linguistic ability, can play no contributing role. Revealingly, Low's (2010) study showed that language ability (PPVT semantic ability, and complements-task syntactic ability) was not correlated with implicit, spontaneous-response false-belief task performance. Importantly, these language measures showed typical correlations with explicit false-belief task performance in the same sample of children aged 3–5 years. Although this is not a longitudinal study, Low's data also show that complement syntax ability and implicit false-belief understanding make unique, independent contributions to the variability in explicit false-belief task performance. This suggests that despite the dissociation referred to above (Ruffman *et al.*, 2001), there is some continuity between implicit and explicit understanding. Thus – and this is the over-arching issue addressed in this paper – does language play a role in the evolution of explicit from implicit false-belief understanding and, most important, if it does, by what mechanism(s) does it play this role?

How language may influence the development of explicit false-belief understanding

As the previous section makes clear, many aspects of language ability are significantly related to children's performance on explicit false-belief measures. Because most of these explicit tasks are verbal tasks, researchers who hold the innate, modular view of false-belief understanding, argue that the relation with language simply shows that it is a limiting factor in elicited response false-belief task performance and the only role it plays is in enabling existing understanding to be revealed. On the other hand, researchers who hold the conceptual shift view of the development of false-belief understanding maintain that language provides children with resources that promote or permit explicit false-belief understanding, which is qualitatively different from implicit understanding. How language promotes development from implicit to explicit forms of knowledge, however, requires further clarification. Some researchers focus on the environmental-social aspect of language, arguing that children become aware of beliefs and false beliefs through conversations and stories. Other researchers focus on individual, child-cognitive aspects of language, arguing that acquisition of the semantics and syntax of epistemic verbs is key to the development of false-belief understanding. On our view, both aspects are important. Language acquired and used in social interaction then can operate as an internal representational device underlying the development of metarepresentational ability (Astington, 2006). However, what is needed is a more detailed and precise account of the mechanism whereby this is achieved.

In this section, language that is used to describe contexts of false belief will be discussed as a mechanism for developmental change between early and later false-belief understanding. In particular, we will focus on how the acquisition of epistemic language may play a unique role in bridging the gap between early and late false-belief task performance by assisting with both the process of controlled response selection and the formation of higher order epistemic state representations.

Response selection

Proponents of accounts that primarily attribute shifts in children's task performance to development in response selection processes have inevitably relegated language to having an indirect influence on this change. The necessity of a certain threshold of

language development is acknowledged for the comprehension of explicit, and mostly verbal, tasks but it is less clear if language is necessary for the processing of explicit false belief. In this section, we argue that language does play a direct role in explicit reasoning about false belief because it reduces the cognitive demands associated with making a controlled, elicited response. Specifically, language may assist with the process of response selection by assisting children with the internal representation of the alternate perspectives in a false-belief scenario.

The process of elicited response selection entails the ability to simultaneously consider distinct representations for the same context and then inhibit selecting an incorrect prepotent response (Baillargeon *et al.*, 2010; Leslie *et al.*, 2005). In a standard false-belief task, this would require children to maintain a separate representation of their own perspective (e.g., knowing where the target object has been displaced) and the perspective of a protagonist with a false belief (i.e., believes the target object is in its original location). When inferring the protagonist's subsequent actions, children must then inhibit the prepotent response of aligning the protagonist's perspective with their own (i.e., assuming that the protagonist also knows where the object has been displaced). Language may directly reduce the cognitive demands associated with this process by providing concrete, external representations of the conflicting perspectives inherent in a false-belief task. Moreover, language can be used to explicate different perspectives in two ways: through direct labelling of alternate perspectives and through the acquisition of complement syntax.

First, labelling different perspectives in a false-belief task may assist with elicited response selection by providing children with the cognitive distance necessary to flexibly switch attention between alternate perspectives and inhibit selecting a prepotent response (Deak, 2004; Jacques & Zelazo, 2005). Because labels are concrete symbols that are arbitrarily associated with the concepts that they denote, they naturally provide a separation between the information that is being represented (e.g., an object in the immediate environment) and the representation itself (e.g., the label used to describe this object). Importantly, labels also tend to be static, thereby allowing them to act effectively as salient, external markers for information that may otherwise be difficult to perceive or mentally represent. Labelling has been shown to successfully improve children's flexible switching on tasks that require children to alternatively sort different objects along conflicting perceptual dimensions (Kirkham, Cruess, & Diamond, 2003). In a false-belief task, labels can be similarly applied to denote the alternate responses that correspond to the content of a false belief (e.g., explicitly labelling where the target object was originally placed) and the true state of reality (e.g., explicitly labelling its new location). By making these alternate responses more salient, labels may thus significantly decrease the cognitive demands associated with simultaneous consideration and switching between conflicting representations. In a study conducted by Low and Simpson (in press), 4-year-olds did in fact show an advantage in explicit false-belief reasoning when labels were used to denote both the content of a false belief (i.e., protagonist's perspective) and the true state of reality (i.e., child's perspective). Similar improvements in false-belief task performance were also demonstrated when only the protagonist's perspective was labelled, suggesting that the use of labels may induce children to override pre-existing biases and consider candidate responses that directly conflict with the salient state of reality. Interestingly, in the same study, these results were not replicated with 3-year-old children. This difference suggests that labels used to denote alternate perspectives may only have an effect on the processing of explicit false-belief reasoning when children have begun to develop the underlying representational structure needed to support this level of reasoning.

Beyond labelling the alternate responses in an explicit false-belief measure, language that is associated with the representation of epistemic states may further provide the most direct means of representing dual perspectives. Specifically, the acquisition of syntactic frames typically associated with epistemic verbs may provide children with a unique external structure for representing both the content of a protagonist's belief and the true state of reality. As previously mentioned, complement syntax, which is typically used in conjunction with epistemic verbs such as *think*, allows for the embedding of a proposition that can be false (e.g., 'the chocolate is in the cupboard' after the chocolate has been displaced) within a sentence that is otherwise true ('Fred thinks [that] the chocolate is in the cupboard'). While researchers have demonstrated that comprehension of complement syntax may be more predictive of children's explicit false-belief task performance than other components of language (de Villiers & Pyers, 2002; Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003), less is known about the mechanism by which this syntactic structure assists with the cognitive processing of false belief. However, assuming that language can be used to explicate and consider distinct perspectives during the process of response selection, the acquisition of complement syntax may similarly be construed as a tool for making controlled, elicited response decisions. Within a false-belief task, the perspective of a protagonist who has acquired a false belief can be described using a complement syntax construction (e.g., 'Fred thinks the chocolate is in the cupboard'.). Alternatively, the formation of these constructions can also be cued through elicited response questions that are posed to the child (e.g., 'Where does Fred think the chocolate is'?). If children understand that the proposition embedded under the verb *think* can be false, and can potentially generate these constructions themselves, then the use of this structure should assist them with the representation of perspectives that conflict with the true state of reality. Specifically, the structure relates the content of belief described by the proposition (i.e., 'the chocolate is in the cupboard') directly to the agent and thereby makes this association more salient during the process of response selection. Although there is no direct evidence that complement syntax works in this way to assist with the process of response selection, evidence from training studies cited above has demonstrated that improvements in explicit false-belief task performance are most pronounced when children are exposed to false-belief scenarios that are paired with complement syntax constructions (Lohmann & Tomasello, 2003). This suggests that the use of complement syntax constructions may promote the processing of explicit false-belief information at a procedural level.

In summary, children's comprehension of language used to describe and elicit responses on explicit false-belief tasks may lead to improvements in task performance by directly influencing the process of controlled response selection. By explicating and distinguishing the alternate perspectives in a false-belief scenario, language may significantly decrease the cognitive demands associated with dual representation, flexible switching, and inhibition of prepotent responses. Moreover, the syntax associated with verbs that denote epistemic states may provide children with a uniquely suited structure for explicitly representing perspectives that conflict with the true state of reality (i.e., false beliefs).

Formation of metarepresentational understanding

The acquisition of epistemic verbs may also play a direct role in the formation of metarepresentational understanding by promoting the generalization of knowledge across different contexts of belief. Specifically, by encouraging children to attend to and compare information across different instances of false belief, epistemic verbs may

play a direct role in the development of higher order representations of belief (Baldwin & Saylor, 2005). According to the theory of structure mapping, proposed by Gentner and colleagues (e.g., Gentner, 2003; Gentner & Medina, 1998; Loewenstein & Gentner, 2005), processes of comparison are essential to the formation of higher order representations because they support the abstraction of relational patterns across related contexts or events. Importantly, the process of structural alignment favours the mapping of higher order relational patterns over situation-based surface similarities. In this way, structure mapping promotes change from knowledge that is based on context-specific patterns, or rules, to knowledge that is flexible and transferable across different contexts. In this theory, language is also posited to play a critical role in the formation of higher order representations by assisting with the abstraction, retention, and comparison of relational patterns. Because structure-mapping theory offers a detailed description of the processes by which language may assist with the formation of higher order cognitive structures, we will use this theory as a basis for explaining the potential role of epistemic verb acquisition in the development of metarepresentational false-belief understanding.

Gentner and colleagues (Gentner, 2003; Loewenstein & Gentner, 2005) propose that the acquisition of language that denotes relational knowledge (e.g., verbs and prepositions) can assist with the explication of patterns that may otherwise be non-obvious to perceive. Specifically, language may assist with the process of structure mapping through five key mechanisms: (1) abstracting relational patterns from their initial contexts, (2) retaining initial representations of relational patterns, (3) promoting uniform encoding of relational patterns through habitual use, (4) explicating non-obvious and complex patterns of relation, and (5) selectively focusing attention on similar patterns in novel contexts. To date, this role of language in assisting structural alignment has successfully been demonstrated in the domains of spatial mapping (Lowenstein & Gentner, 2005; Rattermann & Gentner, 1998) and object categorization (Baldwin, Markman, & Melartin, 1993; Graham, Namy, Gentner, & Meagher, 2010). In these studies, children are able to use relational labels to infer underlying relational similarities between objects (e.g., corresponding spatial positions or non-obvious object functions) in contexts where these relations are in direct conflict with more obvious surface similarities (e.g., similarity of appearance).

With respect to the explicit representation of false-belief understanding, epistemic verbs seem well suited to act as appropriate relational terms that would promote the abstraction of relational similarities across different contexts of false belief. Unfortunately, this possibility has yet to be examined because the acquisition of epistemic concepts and, by relation, epistemic verbs has traditionally been considered too complex to test with the same paradigms that are used to examine other relational terms (Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005; Papafragou, Cassidy, & Gleitman, 2007). Specifically, one of the main problems associated with the study of epistemic understanding, is that, by virtue of being internal and imperceptible, epistemic states are especially difficult to identify and abstract from a given context. Recent findings from the field of infant false-belief reasoning, however, suggest that the ability to abstract relational patterns from epistemic contexts is not impossible. Even if infants' knowledge of false beliefs exists strictly at an implicit, situation-based level, there is strong evidence to suggest that accurate patterns of inference regarding epistemic states can be gleaned from the external environment.

Using the mechanisms outlined by Gentner (2003), we therefore propose that the acquisition of epistemic verbs may assist with the formation of higher order false-belief representations in the following stages:

(1) *Abstraction of relational patterns.* Assuming young children can implicitly track relational patterns of false belief before they can pass explicit measures of understanding, the use of epistemic language in conjunction with contexts of false belief may assist them with the initial perception of these patterns. Specifically, the use of epistemic verbs to describe the false belief of a protagonist (e.g., 'Fred thinks the toy is in the box') may help children identify not only the content of the protagonist's belief (e.g., falsely believes the toy is in the box), but also the patterns that relate this belief to subsequent actions (e.g., searches for the toy in the box). Moreover, epistemic verbs and complement syntax constructions may be unique in their ability to abstract relational patterns of false belief because they allow children to represent the content of a false belief in relation to the agent.

(2) *Retention of initial representations.* Pairing non-obvious relational patterns with salient relational markers, such as epistemic verbs, should also increase the likelihood that these patterns will be represented and retained in memory. Information that is retained can then be used to form relational patterns, or rules, of inference. For example, children may represent the inferential rule that protagonists will search for an object in its original location if she/he did not witness the object being displaced. When children later encounter similar contexts of false belief, these patterns can be retrieved to make appropriate inferences. Before children have formed higher order representations of false belief, however, these rules would remain context specific.

(3) *Uniform encoding.* Habitual use of the same epistemic terms with the same relational patterns will strengthen their association over time. Perception of the epistemic verb in a similar context may therefore increase the likelihood that the same relational pattern will be perceived and represented in a uniform manner.

(4) *Explication of relational patterns.* Through repeated pairing of epistemic verbs with specific inferential rules, children may begin to gain conscious awareness of these patterns. Moreover, children may begin to ascribe meanings to epistemic verbs, and accompanying complement syntax constructions, by associating these terms with specific contexts of belief. This suggestion is in keeping with social-pragmatic accounts of word learning that propose that the meanings of words are derived from the social contexts in which they are used (Nelson, 2005, 2007; Tomasello, 1999). This is also supported by evidence suggesting that children's comprehension of epistemic verbs is still developing throughout the preschool years (see Astington & Peskin, 2004, for a review). Initially, it is possible that children may not directly associate relational patterns with specific epistemic verbs but, rather, with the complement syntax constructions in which these terms occur. This is based on theories that propose that the acquisition of syntactic structure bootstraps the acquisition of semantic understanding of associated verbs (de Villiers 2005; Gleitman *et al.*, 2005). Specifically, Gleitman and her colleagues suggest that children use both their knowledge of the grammatical role that a verb has within a syntactic construction and information from the immediate environment to constrain their understanding of a verb's meaning. Over time, meaning that is initially associated with specific syntactic constructions may thus be transferred to associated verbs themselves. Currently, there is some evidence to suggest that the use of complement syntax constructions in contexts of false belief assist both children and adults in the identification of epistemic states (Papafragou *et al.*, 2007).

(5) *Selective attention and comparison in novel contexts.* Once children have associated relational patterns to epistemic verbs and/or their complement syntax constructions, then subsequent use of these terms in novel contexts would invite

children to compare and contrast similar relational patterns. Critically, it is this process of comparison that should lead to the formation of higher order representations because children may be forced to re-structure their knowledge if relations do not match across different contexts. In the case of false belief, these differences may include sources of belief induction, the content of the belief, and/or the subsequent actions that result from the false belief. Because the same epistemic term (e.g., *think*) can be used to describe related contexts of belief, children would thus be encouraged to form explicit representations that can be used to generalize inferences across varying contexts.

In summary, the acquisition of epistemic language may promote the development of higher order representations of belief by assisting with the abstraction and generalization of inferential patterns of processing. Based on the above proposal, children's ability to succeed on explicit measures of false belief would thus be dependent on their implicit ability to track relational patterns of false belief as well as their individual experience with both epistemic contexts and epistemic language.

Conclusion

In the current paper, we have proposed mechanisms by which language development may directly influence both the process of elicited-response selection and the formation of metarepresentational understanding. This account is not intended to imply that the relationship between language and epistemic concept development is not dynamic or bi-directional at different points throughout the lifespan. Instead, it is offered as a suggestion for how concrete external input (i.e., labels) may scaffold the development of explicit false-belief reasoning within a specific window of time (i.e., between the toddler and early preschool years). The obvious question that remains to be answered is how to test these proposals. Thankfully, advancements in the field of false-belief reasoning have only opened up the possibility to further examine the mechanisms of developmental change. The following are some suggestions for how paradigms could be adapted to examine the role of language in bridging the gap between implicit and explicit understanding.

First, it seems critical that more paradigms be developed that allow for the measurement of both spontaneous and elicited responses across varying contexts of belief induction. This would allow for direct comparison of representational understanding across different age groups. Such manipulations may also inform us about the structure of infants' early understanding of false belief and the factors that contribute to subsequent performance on elicited measures of understanding. For example, it is still an empirical question how well infants' reasoning about false belief transfers across different epistemic contexts. Examining young children's ability to reason both implicitly and explicitly across different scenarios would thus inform us whether children's early representations of false belief are indeed situation based or flexible in nature.

Second, the manipulation of language in both implicit and explicit measures of false belief may also inform our understanding of the role of language in response-selection processes. Specifically, it would be possible to determine if language that denotes alternate perspectives in a false-belief scenario would influence processing on both spontaneous and elicited response tasks. Manipulating the type of language

used (i.e., epistemic vs. non-epistemic) would further clarify what aspects of language are unique in their ability to assist with the representation of conflicting perspectives.

Finally, by introducing relational language to paradigms that have been designed to primarily measure implicit knowledge (i.e., visual forced-choice paradigms that allow for the measure of spontaneous responses), it may be possible to determine if language has any effects on the abstraction of relational patterns across different contexts of epistemic reasoning. We are currently examining this possibility in a study looking at the effects of epistemic verbs on both implicit and explicit false-belief understanding. In our study, children who initially fail measures of explicit false-belief understanding are assigned to one of three epistemic training conditions, where the critical manipulation is the verb input presented in conjunction with scenes depicting both true and false belief. Specifically, children are presented with either (a) a narration that describes the actions of a protagonist but makes no reference to his/her epistemic state (e.g., *'Sam is going to put it with the apples'.*), (b) a narration that contains a familiar epistemic verb (e.g., *'Sam thinks that it is an apple'.*) and does not vary across epistemic contexts, or (c) a narration that contains a familiar epistemic verb in contexts of true belief (e.g., *'Sam thinks that it is a toy'*) or a novel epistemic verb in contexts of false belief (e.g., *'Sam gorps that it is an apple'*). Following training, children are tested for both implicit and explicit understanding of true and false belief in novel contexts where the verb input is presented as an indirect cue (e.g., *'I wonder where he is going to put it?'* vs. *'I wonder what he thinks/gorps that it is'?'*). By manipulating the verbal input associated with different contexts of epistemic reasoning, the results from this study may therefore clarify the role that epistemic verbs play in the abstraction and retention of relational patterns. The extent to which children are then able to generalize these patterns to novel contexts of belief would additionally speak to the importance of epistemic verbs in the explication of this knowledge.

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