Putting the pieces together:
The development of theory of mind and (mental) language

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Putting the pieces together: The development of theory of mind and (mental) language

De puzzelstukjes op hun plaats:
De ontwikkeling van theory of mind en (mentale) taal
(met een samenvatting in het Nederlands)

Proefschrift

ter verkrijging van de graad van doctor aan de Universiteit Utrecht op gezag van de rector magnificus, prof.dr. J.C. Stoof, ingevolge het besluit van het college voor promoties in het openbaar te verdedigen op vrijdag 4 maart 2011 des middags te 4.15 uur

door

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geboren op 3 juli 1983 te Capelle aan den IJssel

Promotoren: Prof. dr. F.N.K. Wijnen
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Acknowledgements

Of course, this was bound to happen: I am writing the only part of this dissertation that people who do not *have* to read this book might actually read in a bit of a rush. Having relished not doing very much during the Christmas period, now is the time to dot the i's and cross the t's and finish this dissertation for once and for all. Unfortunately, this rush is probably going to entail that I will forget to thank people who really deserve to be thanked, so I shall start off with an apology to them. However, the list of people who will be mentioned is long, as one of the things that has become clear to me over the last four years is that you do not write a thesis on your own. True, I may have been the one in solitary confinement, with only my computer for comfort during the writing stage of this thesis (actually, I had my cats for comfort as well, but I will return to them later), but I could not have completed it if it hadn't been for a great many people who helped and supported me on my way. It is said that it takes a village to raise a child (or at least, Hillary Clinton and "African tribes" say so), but it surely takes an environment like the UiL OTS to raise a researcher.

The first and foremost mention goes to my supervisors Frank Wijnen and Peter Coopmans. If I was the village child, they were definitely the village shamans. But let's not get carried away with the metaphor… They were a source of constant support and advice and were always on hand as a sounding board for my ideas. The regular meetings we had with the three of us were always good for forcing me to think of something new to say to them and to gather my thoughts and articulate them properly. I'm not sure that I was always particularly successful in that respect though, as I sometimes had the feeling that what I was throwing at them was more stream of consciousness than rational scientific discourse. Anyway, I thank them both for helping to make this thesis what it is. Peter, your attention to detail was always striking to me: no typo or grammatical mistake went undetected by you, even though I am quite the stickler for accuracy in that domain myself. You were also the one who would always catch me out whenever I resorted to hand waiving in my explanations. Your requests for additional information were very useful in making my thoughts more concrete. Frank, you never lost track of the bigger picture. It is easy to lose yourself in fine-grained analysis of the data, but you always prompted me to think about how the results related to deeper questions regarding the architecture of cognitive development. You were also the one who started my train of thought on the relationship between spatial language and theory of mind. Hopefully, we will get the chance to delve into that more deeply in years to come.

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Whereas all of these schools were in a 500-meter radius from my own house, I had to travel significantly further to go to the Overlaet school in Rosmalen. It was worth it, however, as this school was a pleasure to go to as well. Teachers and children at the Overlaet, thank you so much for agreeing to participate! A number of other schools also have to be mentioned, even though I was not directly in contact with them. As part of her master's thesis, Annette Watzema collected data on autistic children's theory of mind and (mental) language abilities, the results of which can be found in chapter three of this thesis. The schools she went to are: De Tender in Schagen, Bommelstein in Heerhugowaard and De Schoter Duijn and De Dijk in Den Helder. Although I did not get to meet you, I thank all of you who were willing to participate!

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Although sometimes being a PhD student necessitates social isolation, the last four years have by no means entailed all work and no play. In fact, during my time at the UiL OTS much fun was had. Be it at our regular VrijMiBo's, lunches and dinners with the Dutch posse (cf. Zondervan, 2010), conferences (Roberta Tedeschi and Loes Koring, special thanks to you two for some truly memorable ones) or LOT-schools, things were never boring. In this respect especially the aforementioned Dutch posse consisting of Frans Adriaans, Tom Lentz, Arjen Zondervan, Arnout Koornneef and Loes Koring played a large role. You have gone from being colleagues to, dare I say it, friends. Of this group, Arjen and Arnout deserve special mention. Thank you, guys, for being my paranymphs (for those of you not familiar with the term: I am not alluding to some weird fetish, look it up). I am the last in line in our little paranymphic circle and then all of us will be doctors. The end of an era…

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But let's get back to thanking people again. And very important people at that: friend of the family, Nessie, my brothers, Bobbie and Jamie, and especially my parents, Helen and Richard, who provided endless help and advice on all things academic and personal. Having done his PhD some decades ago, my father was always on hand with help on how to approach all aspects of PhD life. Thank you for all your good advice! Coincidentally, my mother was busy writing her PhD at the same time as I was (you beat me though, well done!), so we could share the trials and tribulations of working on a PhD during our regular lunches together. Thank you for your listening ear!

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General Introduction

Traditionally, a book about cognition, particularly one in the field of linguistics, has to start off by considering the perspective of our extraterrestrial neighbour, the Martian scientist. What characteristic of Homo sapiens would strike the foreign visitor most? The answer to this question likely depends on your academic orientation: cultural practices if you are an anthropologist, religion if you are a theologist, society if you are a sociologist etc. Lacking a real-life E.T., it is impossible to say what feature of humans would be most striking. However, being a psycholinguist, I can offer two possibilities: humans' capacity for language and their understanding of other people's mental states. Even non-psycholinguists would have to admit that these two features of mankind are pretty impressive. Of course, other species have communication systems that, in some cases, resemble that of humans in some respects (vervet alarm calls and bee dances spring to mind), but none have developed anything as varied and complex in nature as the human linguistic system, capable of encoding and decoding an infinite number of utterances relating to an infinite number of concepts, in principle limited only by the individual's life span and boredom-threshold.

Similarly, in the realm of mental state understanding, humans are not entirely alone in their ability to consider themselves and their conspecifics as intentional agents (they are joined in this by some primates, most notably chimpanzees and bonobos, and potentially a small number of other species). However, the level of representational complexity that humans are capable of in their understanding of other people's behaviour is unparalleled by even the most socially aware creature. Complex thoughts like "John assumes that Mary thinks that Ken is gorgeous, but really Mary likes John best" that allude to various levels of representation (the real and the supposed state of affairs) and different characters' beliefs are perfectly comprehensible, indeed even part and parcel of everyday life, to anyone from at least puberty onwards, if not much earlier. Indeed, already in infancy, humans display behaviour that suggests that they view others around them as intentional agents with goals and plans ready to fulfil those goals (cf. Woodward, 1999). However, sometime between three and five years old, children become capable of passing a test that has come to be considered the litmus test of true understanding of other people's mental states: the "false belief test". Inspired by Dennet (1978), Wimmer & Perner (1983) reasoned that if it could be shown that a child can put aside her own point of view on an event and take into account the belief state of another person who has an outdated view of that event (i.e. a false belief regarding that event), that would demonstrate her ability to represent other people's mental states at an advanced level. On passing this task, then, the child demonstrates an advanced understanding of the nature of beliefs and, as the terminology would have it, is said to have a "representational Theory of Mind" (ToM) [1]. At this point in time, ToM in this sense has not been demonstrated in any non-human species, although some primates do display some of the developmental precursors to false belief understanding (e.g. understanding that seeing leads to knowing, cf. Hare, Call, Agnetta & Tomasello, 2000, and Hare, Call & Tomasello, 2001).

So then, the Martian and even the non-psycholinguist would agree: language and ToM are both domains worth studying. In fact, this dissertation takes it one step further and considers the developmental relationship between these two areas of cognition. Is there a developmental relationship between language and ToM? If so, what is the nature of the relationship between these two domains: does the development of language influence the child's capacity to attribute mental states to others or is the child's understanding of other people crucial in the development of language? These are the questions at the heart of this dissertation, highly relevant from the point of view of both cognitive and linguistic development. After all, the answers to these questions should cast light on the process by which the child becomes a full partner in human social and linguistic interaction.

1. The Backdrop: The Relationship Between Language and Thought

Of course, considering the development of these major milestones of cognition, ToM and language, is a worthy enough backdrop for a dissertation. However, at a more fundamental level, the key questions of this dissertation also address the nature of the relationship between thought and language. Does language make abstract symbolic thought possible or is the presence of abstract symbolic thought a precondition for language? Although this question has been under scientific scrutiny since at least the 18th century with the writings of Humboldt (although already in the 4th century St. Augustine described his ideas on the relationship), there is by no means a consensus on how best to characterise the relationship between language and thought. Throughout the centuries, the pendulum has swung backwards and forwards between the assumption that thought must precede language (entailing a world view that stresses the commonality of human cognition) and the idea that language is fundamental for thought (suggesting that non-linguistic cognition may differ across humans depending on the particular language they speak; cf. Gumperz & Levinson, 1996, for a review).

[1] See the general conclusion for remarks on recent findings suggesting that 15-month-olds may already have an understanding of false beliefs.

The general question regarding the relationship between language and thought has also been addressed from a developmental point of view: does the acquisition of a linguistic system have an effect on the development of other, non-linguistic, areas of cognition? Or are advances in (particular areas of) cognition necessary for language acquisition to be possible? Again, the pendulum has swung between these two points of view since at least the beginning of the 20th century with the work of Jean Piaget propounding the idea that language acquisition proceeds by mapping words onto pre-existing concepts and Lev Vygotsky suggesting instead in the 1930's that language is fundamental in providing concepts to the child and in elaborating their meaning (see Bowerman & Levinson, 2001, for a collection of studies addressing the relationship between language acquisition and conceptual development). In something of an irony of fate, the reader will see that the conclusions reached in the individual chapters in this thesis follow the pendulum swing of the historical debate: the findings described in the first three chapters suggest a strong link from thought to language, but the results from the final two chapters provide evidence for the opposite direction. Evidently then, the pendulum exerts its power even in the microcosm that is a four-year PhD thesis.

2. The Relationship between Language and ToM

But first things first: what is known currently about the relationship between language and ToM development? In the last few decades, quite a number of studies have considered the relationship between these two prominent cognitive domains. Many researchers find that there is a significant relationship between their development (cf. Jenkins & Astington, 1996; Ruffman, Slade, Rowlandson, Rumsey & Garnham, 2003), but what the direction of causality is between them is the topic of heated debate. There are those who suggest that language is crucial for ToM development and those who claim that ToM is fundamental in the development of language. Of course, if we consider ToM broadly to refer to a child's sensitivity to other people's mental states, it must be true that language depends on ToM. After all, if children didn't have some appreciation of the fact that the sounds emanating so frequently from their caretakers' mouths *mean* something (i.e. that the people uttering them have an underlying *intention* to refer to something in uttering these sounds), they would just simply ignore them instead of trying their hardest to assign a representation to them. Some understanding of others as intentional agents with mental states must thus be present for one of the first steps in language acquisition process, the learning of words, to be possible[2]. Indeed, many studies suggest that infants use information

[2] Although one could argue that various animals have some understanding of the meaning of words as well (e.g. dogs can learn to respond appropriately when they hear words like *walk* or *food*), the magnitude of the word learning task, involving around 60.000 of these word-referent pairings, suggests that this associationist type of learning (presumably the basis of the dog's "word learning process") is not going to be powerful enough and too prone to erroneous pairings for an adult-size vocabulary to be able to be acquired.

regarding a speaker's intention to refer to a particular object or action (as conveyed by, for example, gaze direction or pointing behaviour) in order to assign meaning to the sounds they hear (cf. Baldwin, 1993; Baldwin & Moses, 2001; Happé & Loth, 2002; Tomasello & Barton, 1994; Tomasello, Strosberg & Akhtar, 1996). By narrowing the hypothesis-space for potential word meanings, this understanding of speakers' intentions converts the word learning task from an insurmountable problem into something achievable during childhood (of course, word learning does not stop after childhood, but the amount of new words one hears and has to commit to memory is reduced significantly over time). It is noteworthy in this respect that those who have deficiencies in understanding others' intentions (as is the case for autistic individuals, cf. Baron-Cohen, Baldwin & Crowson, 1997; Baron-Cohen, Leslie & Frith, 1985) are generally also impaired in their word learning ability. At the most basic level then, it seems that some appreciation of other people's mental states must be at the basis of language acquisition.

However, we can question whether this direction of causality still remains if we look at more advanced indicators of the child's understanding of mental states (e.g. their ability to understand false beliefs). Yes, basic understanding of others as intentional agents is necessary for language acquisition, but do we need a more sophisticated understanding than that in order to become fully proficient speakers of a language? Do we need an understanding of false beliefs for more complex forms of language to develop? Available experimental evidence (e.g. the longitudinal study by Slade & Ruffman, 2005, and the meta-analysis by Milligan, Astington & Dack, 2007) suggests that the more advanced understanding of others as indicated by the ability to pass standard ToM tasks does have an effect on the development of language. At a more specific level, a number of researchers have claimed that the development of ToM may play a role in enabling the acquisition of those areas of language that relate to other people's mental states ("mental language"). At the lexical level, the acquisition of words that refer to mental concepts (e.g. mental state verbs like *think* and *know* or modal terms like *probably* or *definitely* that express the speaker's belief in the truth of the proposition) have been found to be related to the development of ToM (cf. Moore, Pure & Furrow, 1990; Ziatas, Durkin & Pratt, 1998). Similarly, at the discourse level, most prominently in the understanding of indirect requests and referential communication[3], there is work suggesting a link with ToM development (cf. Loukusa & Moilanen, 2009, for understanding of indirect requests in autistic children and Astington, 2003, and Resches & Pereira, 2007, for the relationship between referential communication and ToM). There is thus evidence that even the more advanced aspects of understanding others' mental states play a role in the development of (mental) language.

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[3] Indirect requests require an appreciation of an underlying request intended by the speaker, e.g. "It's cold in here" said to someone next to an open window; referential communication refers to the ability to specify a referent in such a way that a listener can identify it (e.g. using a full noun phrase when the referent has not been specified before and a pronoun when the referent is easily identifiable from the (linguistic) context).

On the other hand, there is also quite a considerable body of evidence that suggests that language is a crucial factor in the development of ToM. Although the longitudinal and meta-analytic studies described above found an effect of ToM on language development, there was also an effect in the opposite direction: from language to ToM. In fact, the meta-analytic study demonstrated that this effect was considerably larger in size than the reverse effect. Sensitivity to mental states may thus be ontogenetically prior to language, but it is possible that at some point in development this direction of causality flips, with full ToM development requiring certain advances in linguistic ability. While there are many researchers who would endorse claims of this nature (cf. Astington & Baird, 2005 for a collection of papers on this topic), there is considerable debate about what kind of linguistic advances would be necessary for ToM development to take place. The hypotheses range from the general to the specific. Some researchers (Astington & Jenkins, 1999; Cheung, Chen, Creed, Ng, Wang & Mo, 2004) claim that there is not one particular aspect of language that is relevant for the development of ToM, but that the child has to have a certain level of general linguistic ability in order to be able to deal with the representational complexities inherent in conceptualising the different levels of representation necessary for false belief understanding. In contrast to this general view on the relationship between language and ToM, other researchers claim that there are specific aspects of language that promote the development of ToM. The most prominent version of this idea is offered by de Villiers and her colleagues (cf. de Villiers, 2005, 2007, and de Villiers & Pyers, 2002) who claim that understanding of sentential complementation constructions is a necessary prerequisite for ToM development. Only if the child can understand sentences like "John thought the dog was in the garden" (consisting of a, possibly false, sentential complement "the dog was in the garden" in a matrix sentence containing a mental state verb), will she be able to make sense of false beliefs. Yet other researchers (e.g. Cheung, Chen & Yeung, 2009, and Pyers & Senghas, 2009) would claim that it is mental state terms, mental language at the lexical level, that bootstrap the child's understanding of mental states. Instead of ToM providing the conceptual underpinning for the acquisition of mental language, then, according to this view, it is the acquisition of mental state terms that is paving the way for ToM development.

3. Putting the Pieces Together: ToM, Language and Mental Language

In summary, it can be said that although there are many ideas on the nature of the relationship between ToM and language, there is by no means a consensus on how the development of these cognitive domains interacts. ToM may influence the development of language in general and/or mental language in particular or language in general and/or mental language in particular might influence ToM development. How can we proceed from this stalemate? This is the starting point of this dissertation: we know there is a relationship between language and ToM, but it would be useful if the nature of this relationship could be specified more exactly. More studies on this topic considering various aspects of language in relation to ToM development in various age groups and in various clinical populations may thus prove to be enlightening. This, then, is what one can find in this dissertation: a collection of five chapters that each contribute to current knowledge of the relationship between ToM and language.

The first chapter (*Children's production of referring expressions: Contributions from executive function, theory of mind and linguistic development*) starts off with the youngest age group tested in this collection of studies: three-year-old typically developing Dutch-speaking children. The main focus of this chapter is on one aspect of mental language at the discourse level: referential communication, i.e. the ability to refer to a referent with a linguistic form that is in line with the cognitive status of the referent for the addressee, e.g. a full noun phrase like *a man* if this referent was not previously known to the addressee or a pronoun like *he* in cases where a specific singular male character can be easily identified in the given context. In particular, this chapter considers the ability of three-year-olds to use referential expressions appropriately and the role that language, ToM and the inhibition component of Executive Function (EF), a third relevant cognitive domain, play in this ability to produce appropriate referential expressions. The inhibition component of EF is potentially also relevant in the debate regarding the relationship between ToM and (mental) language, as it has been suggested that the correlation between ToM and language may not be due to any fundamental links between these two cognitive domains, but that it may be the by-product of a relationship that both ToM and language share with a third variable. A prime candidate for this third variable is Executive Function (Frye, Zelazo & Palfai, 1995; Sabbagh, Moses & Shiverick, 2006), a cognitive domain that encompasses domain-general skills like planning, working memory and inhibitory control; all skills that are required in ToM and language tests (and potentially even required for the *development* of ToM and language, cf. Perner & Lang, 1999 and Schneider, Lockl & Fernandez, 2005). Given this suggestion, the role of EF in referential communication is thus also considered.[4] The question at the heart of this chapter is how EF, ToM and general language relate to referential communication. Which of these three variables will prove to be the most highly correlated with referential communication? If EF is most strongly correlated with performance on the referential communication task, this would support the idea that tasks involving language and ToM require high levels of EF. On the other hand, if the highest correlation turns out to be between ToM and referential communication, this would suggest that understanding of other people's mental states is important in at least this domain of language, thereby enforcing the idea that language development requires ToM development. Conversely, if referential communication is more strongly correlated with general language ability, this would be in line with the idea that general linguistic ability is fundamental in the

[4] Although EF is potentially a relevant variable for all the studies presented in the five chapters of this dissertation, the particular measures that were used turned out to be relatively easy for children older than three. No significant effects were found for the role of EF in the other studies, so this variable is not further reported on.

child's ability to understand other people's mental states as encoded in certain linguistic forms (in this case, the appropriate use of referring expressions).

In the second chapter (*Children's understanding of epistemic modality: Contributions from theory of mind and linguistic development*), a set-up somewhat similar to the first chapter is used. Like the first chapter, this chapter considers the effect of ToM and language on mental language. The difference between the two chapters lies in the subject population, four-year-olds instead of three-year-olds, and the domain of mental language considered, i.e. mental language at the lexical level instead of the discourse level. Specifically, the domain of mental language that is investigated in this chapter is the child's understanding of epistemic modal terms (the epistemic modal auxiliaries *moeten* 'must' and *kunnen* 'might' and the modal adverbs *zeker* 'definitely' and *misschien* 'maybe') that convey the level of certainty regarding the speaker's belief that a proposition is true. Epistemic modals can thus be seen as the linguistic encoding of speaker certainty and, as such, are at the interface of ToM and language. The aim of this chapter is to consider Dutch children's understanding of epistemic modals and whether their understanding of these terms would be most highly correlated with linguistic or ToM ability. Again, if the highest correlation turns out to be with language, this would suggest that linguistic encodings of mental states rely more strongly on language ability and to a lesser extent on a child's understanding of other people's mental states. Conversely, if the strongest correlation is between ToM and epistemic modal understanding, this would suggest that ToM is important in this aspect of linguistic development.

It should be noted that both the first and the second chapter present findings from correlational studies. These studies are thus not informative with respect to the direction of a possible causal link. If ToM is found to be strongly correlated with referential communication or epistemic modality, this could mean that ToM predicts mental language (and hence potentially is a causal factor in mental language development), but it could equally mean that mental language development is predictive of ToM development. A correlational study with one measurement point cannot determine the direction of a possible causal link. Although the third study did not employ multiple testing sessions, its set-up does allow stronger conclusions to be drawn regarding the nature of the causal link between ToM and language than the preceding two studies. The focus of the third study (*Modal auxiliaries in typically developing and autistic children: A theory of mind account*) is quite similar to that of the second study as it also looks at children's understanding of epistemic modals. However, the age group is older, involving six-year-olds instead of four-year-olds, and, more importantly, it also involves a clinical population as well as typically developing individuals. The particular clinical population involved in this study consists of children who have been diagnosed with a disorder in the autistic spectrum. This population is particularly interesting from the point of view of ToM research as one of the clinical markers of this disorder is that sufferers have impairments in their understanding of mental states; more specifically, they are assumed to have a deficient ToM (cf. Baron-Cohen, Leslie & Frith, 1985; Frith, 2003; Leslie & Thaiss, 1992; Yirmiya, Erel, Shaked & Solomonica-Levi, 1998). The reasoning is, then, that if ToM is relevant in the development of mental language, individuals who have ToM impairments should also display mental language impairments, in other words, the autistic subjects should demonstrate poorer understanding of epistemic modal terms than their typically developing peers.

Considering a group with a ToM impairment represents an improvement on purely correlational studies with regards to assessing the nature of the causal link between (mental) language and ToM. However, it could still be claimed that any problems in (mental) language development are not causally related to the ToM impairment, but to another underlying deficit inherent to autism. Although it is often assumed that the deficiency in attributing mental states is the primary disorder in autism, this is not agreed upon by all autism researchers. Some claim that the autistic profile can better be characterised by other, more general deficits (e.g. executive dysfunction theories, cf. Hughes, Russell & Robbins, 1994, and Russel, Saltmarsh & Hill, 1999) that may in turn explain the ToM deficit. Potentially, then, any problems in linguistic development may follow from this more general deficit, instead of being directly related to poor ToM development. In determining cause and effect in the development of ToM and (mental) language, a better approach thus might be to conduct a longitudinal study of the development of these three cognitive domains. This type of design has the benefit that it does not just consider correlations at one point in time (thereby making it impossible to distinguish cause and effect), but that it can analyse whether earlier performance in one of the three domains can significantly predict later performance in another domain. More specifically, it can thus be considered whether earlier ToM predicts later (mental) language or whether earlier (mental) language predicts later ToM. This kind of analysis thus allows stronger conclusions to be drawn regarding the predictive value of each of the cognitive domains for the other. This, then, is the tack taken in the final two chapters of the dissertation.

The fourth chapter (*Developing communicative competence: The acquisition of mental state terms and indirect requests*) and the fifth chapter (*Interrelationships between theory of mind and linguistic development*) both consider the same subject population: 101 typically-developing Dutch-speaking four-year-olds who are tested twice with eight months intervening between the two times of testing. The research questions underlying these two chapters are somewhat similar, but they each look at the relationship between ToM and language from a distinct perspective. The topic of the fourth chapter is the development of mental language at both the lexical and the discourse level (specifically, the understanding of mental state terms and indirect requests) between four and five years old and the role that ToM and language play in this development. Which is the better predictor of children's later understanding of indirect requests and mental state terms: earlier ToM or earlier linguistic ability?

If earlier ToM proves to be the better predictor, then this would support the idea that ToM is a relevant factor in the development of at least these areas of mental language. Conversely, if (particular aspects of) earlier linguistic ability is the better predictor, this would suggest that the development of mental language abilities in the tested domains more strongly depends on linguistic abilities instead of children's understanding of mental states. This fourth chapter thus zooms in on the general question regarding the relationship of ToM and language by looking at how ToM and linguistic ability relate to the development of an area of cognition at the interface of ToM and language: mental language. In contrast, the fifth chapter zooms out again and considers whether earlier understanding of mental states can predict the various aspects of language that have been suggested to be relevant in previous studies (i.e. general language comprehension and vocabulary, sentential complementation and mental state terms) or whether earlier performance on the various language measures predicts later performance on the false belief tests. Furthermore, this chapter also addresses methodological concerns regarding the traditional testing procedure for assessing understanding of sentential complementation constructions and employs a novel test of sentential complements that bypasses these methodological concerns.

Each of the five chapters individually offers a contribution to the existing knowledge regarding the relationship between ToM and (mental) language. Taken together, this dissertation investigates the relationship between language and thought, ToM and (mental) language, in three- to six-year-old children, in typically and atypically developing populations, in correlational and longitudinal studies involving not only traditional and standardised assessment materials, but also novel methods of testing. Finally, putting all these pieces together, the concluding chapter gives an overview of the findings from the individual chapters and details how these findings, which initially may seem somewhat contradictory, fit together.

Chapter 1

Children's production of referring expressions: Contributions from executive function, theory of mind and linguistic development

Abstract

This study considers the role of Theory of Mind (ToM), language and executive function (EF) in the production of referring expressions. Which is the better predictor of children's ability to use referring expressions appropriately: understanding of others, general linguistic capacities or inhibitory control? This question was addressed by giving 38 preschoolers a modified referential communication task and various EF, ToM and linguistic tasks. The results show that ToM is a significant predictor of performance on the referential communication task, but that language and EF are not. This finding suggests that ToM plays a more fundamental role in learning to produce referring expressions appropriately than EF or language. This finding is also discussed in light of the debate regarding the interrelationships between EF, ToM and language.

Key words

Theory of mind; language acquisition; referential communication; executive function

1. Introduction

I am standing in the middle of a toy-filled room in a Dutch playschool. “Look at that! Look at that!” one of the three-year-old children says to me excitedly whilst pointing at something that has caught her attention. “At what?”, I ask her, as her pointing doesn’t make clear what she’s referring to and there are many things in the room that she may be interested in. “At that! At that!”, she says even more excitedly. I still don’t know what she intends to refer to, so I pick up some toys that are in the general direction of her point. “This?” “No, that!” “This?” “No, that!” After a few tries I give up and tell her that I don’t know what she means. Later on in the day, however, I happen to pick up a toy and suddenly hear her cry “that!, that’s it!”. Finally then, we had found what she had been trying to show me earlier: a brightly coloured crown.

This anecdote illustrates a general characteristic of young children’s communication: in their production of referring expressions, children often use terms that are not sufficient in order for the listener to be able to uniquely identify a particular object (cf. Deutsch & Pechmann, 1982; Glucksberg, Krauss & Weisberg, 1966; Krauss & Glucksberg, 1969). The general finding is that children often use unclear or ineffective descriptions for referents until they are at least six years old. In formal terms, this means that they do not use linguistic forms that are in line with the cognitive status of the referent for the addressee (i.e. the nature of the addressee’s knowledge and attention state in the particular context in which the expression is used; cf. Gundel, Hedberg & Zacharski, 1993).

This observation is generally made in assessments of children’s performance on so-called referential communication tasks. In a standard referential communication task, both the child and an addressee are presented with the same set of objects (physical objects or pictures). The child and the addressee cannot see each other’s objects, however, as there is a barrier between them (e.g. the child and the addressee may have an opaque screen between their respective sets of objects or they may be in different rooms or have to talk to each other over the telephone). The child is then required to describe one of the objects in such a way that the listener is able to find the same object using only the child’s verbal description (the set-up is such that pointing is not a valid means of communication). Successful referential communication in this task thus draws on various cognitive capacities: the child has to discern what dimensions differentiate the intended object from the other objects, take into account the fact that the listener has a different knowledge state than the child herself has and encode all this information in the correct linguistic form, thereby not only using the correct type of referential expression, but also appropriate lexical items and syntactic constructions.

Which aspect of referential communication is most taxing for children under six years old is not entirely clear, however. Various suggestions have been offered to explain their difficulties. Children may have problems with the linguistic aspects of referential communication: they may not know the words that best describe the intended object or they may have difficulty with the syntactic forms that are generally associated with referential communication tasks (children often must use complex noun phrases like "the big blue ball" in order to describe a referent unambiguously). It is also possible that they do not know which phrase types go with which levels of accessibility for the listener (cf. Pechmann & Deutsch, 1982). Noun phrases, for example, are generally used when the referent is not known to the listener; pronouns, on the other hand, can only be used when the referent is salient in the discourse and/or the context. Children may also experience difficulty in taking the perspective of the addressee. Referential communication requires children to consider what information the addressee needs in order to make the appropriate selection. The child thus has to reason from the point of view of another person's knowledge, not her own knowledge. This advanced understanding of other people's mental states, commonly referred to as Theory of Mind (ToM), is known to be problematic for young children (cf. Perner, Leekam & Wimmer, 1987; Wimmer & Perner, 1983). Another potential explanation lies in the demands that the task places on the executive function (EF) capacities of the child. Although EF is a broad term that is used to refer to domain-general skills like working memory, attention and planning, the inhibition component of EF has been claimed to be the most relevant in referential communication (cf. Brown-Schmidt, 2009; Nilsen & Graham, 2009). Being able to inhibit means that a child is capable of ignoring (salient) aspects of a situation and focussing only on those features that are relevant for the task at hand. In the referential communication task, the child must discern what aspects of the intended object make it uniquely identifiable, whilst ignoring distracting attributes of non-target objects. Furthermore, children also have to inhibit their own perspective on the object and focus instead on the perspective of the addressee. These inhibitory demands may be problematic for young children (cf. Frye, Zelazo & Palfai, 1995; Sabbagh, Moses & Shiverick, 2006).

Whereas it is thus plausible that the demands of the task regarding all three of these cognitive domains (ToM, EF and language) impair the child's performance in referential communication, there are also various studies that demonstrate that children do have the requisite cognitive skills in these domains before the age of six. At least in naturalistic conversation with an adult, even children as young as two years old have been shown to select the appropriate referential expression given the cognitive state of the addressee (cf. De Cat, 2004; Skarabela & Allen, 2002; Rozendaal & Baker, 2008). Furthermore, studies by O'Neill and colleagues demonstrate that even at two years old, children are sensitive to the knowledge states of their interlocutors. In O'Neill (1996), for instance, two-year-old children asking a parent for help in finding a hidden toy were significantly more likely to name the toy, mention its location and gesture to its location when the parent had not witnessed the hiding event than when the parent had witnessed it. In O'Neill & Topolovec (2001), two-year-old children were shown to be sensitive to situations in which a pointing gesture to a desired object would be effective (i.e. when two objects were spatially far apart) and when it would not be (i.e. when two objects were too close together for the pointing gesture to be able to pick out one particular object). Tomasello & Haberl (2003) demonstrated that at even younger ages (12 months old) children are already capable of appreciating what is new for another person in a particular discourse situation even though it is not new for the infant herself. More recently, a number of studies have even demonstrated what seems to be implicit understanding of false beliefs in infants as young as 15 months old (see Baillargeon, Scott & He, 2010, for a review).

Similarly, regarding the inhibition component of EF, in their first year of life children already show some inhibitory capacity in their detour-reaching performance (Diamond, 2006). When faced with an object behind a transparent barrier, children have to inhibit the tendency to reach straight for their goal object and start off by reaching away from their object in order to finally get to it. When they are around four years old, children demonstrate more advanced inhibition capacities in one of the standard tests of EF: the dimensional change card sort task (Frye et al., 1995). This task requires children to first sort a number of cards by one dimension (e.g. colour) and then to sort the same set of cards by another dimension (e.g. shape). For the second sorting task, the children thus have to inhibit the initial rule they used for sorting the cards ("sort according to colour") and sort the same objects according to a new rule ("sort according to shape"). Given that children thus display at least some understanding of the nature of referential communication and the component skills that underlie it before age six, it may be possible to demonstrate more advanced referential communication in children younger than six if the demands of the task are lowered somewhat in comparison to the standard form of the referential communication task.

The question still remains, however, which of the three cognitive domains underlying referential communication is the primary driving force in the child's ability to produce referring expressions appropriately. Is the child's referential communication primarily dependent on her linguistic ability, her inhibition capacity or her understanding of other people's mental states? When taking into account all of these factors, which will prove to be the most important? These questions are not just of interest in light of the development of referring expressions; they also bear on a bigger issue that has been debated quite extensively in the literature. How is the development of these three cognitive domains, ToM, EF and language, related? Most researchers would accept that there is some kind of relationship between them, as many studies find high correlations between standard measures of ToM, language and EF (cf. Astington & Baird, 2005, Jenkins & Astington, 1996, Milligan, Astington & Dack, 2007 and Ruffman, Slade, Rowlandson, Rumsey & Garnham, 2003 for the relationship between language and ToM; cf. Schneider, Lockl & Fernandez, 2005 for the relationship between language and EF; cf. Carlson & Moses, 2001, Frye et al. 1995, Perner & Lang, 1999 and Perner, Lang & Kloo, 2002 for the relationship between ToM and EF; cf. Schneider, Schumann-Hengsteler & Sodian, 2005 for various contributions regarding this issue). The precise nature of the interrelationships is, however, considerably less clear.

The relationship between EF (or at least the inhibition component of EF) and language has received little attention (but see Schneider et al., 2005, who suggest that language plays an important role in the development of EF), however, a relatively large body of research has concentrated on the direction of the causal relationship between ToM and language and ToM and EF. In a meta-analysis of a number of studies on the relationship between ToM and EF, Perner & Lang (1999) find evidence for a functional interdependence between ToM and EF. The direction of a possible causal link is debated, however, with some researchers claiming that ToM influences EF and others stating that EF is a prerequisite for ToM development. Evidence of a bi-directional influence between ToM and EF has also been found, however (Kloo & Perner, 2003). Regarding the relationship between ToM and language, some researchers claim that language is fundamental in ToM development, stating that only once the child's general language abilities are sufficient, is she able to represent other people's mental states properly (cf. Astington & Jenkins, 1999). On this view, language provides the scaffolding that allows the child to make sense of the different layers of representation that are necessary for understanding others' beliefs as distinct from one's own. In contrast to this view, however, other studies have found that ToM development influences the acquisition of language. Slade & Ruffman (2005), for example, show in a longitudinal study that whereas earlier linguistic development can be shown to predict later ToM development, the reverse relationship also holds. Similarly, Milligan et al. (2007) also find evidence for a bi-directional relationship in their meta-analysis of the relation between language ability and ToM. More specific links from ToM to language have been reported by Papafragou and her colleagues (Papafragou, 1998; Papafragou, 2001a; Papafragou 2001b; Papafragou, Li, Choi & Han, 2007). They claim that the development of ToM constrains the acquisition of epistemic modal terms (e.g. auxiliary verbs like *may* and *must* that indicate the speaker's belief in the truth of the proposition) and evidential markers (that indicate source of the speaker's belief, like the hearsay marker *allegedly* in English).

Given this diversity of points of view and experimental findings, it is thus not clear how exactly the development of the three cognitive domains, EF, language and ToM, is related. Is language a prime contributor to, or even a prerequisite for, the development of ToM? Or is ToM development fundamental for the acquisition of language? Is ToM necessary for EF to develop? Or is EF the basis for ToM ability? Framed in this general way, these questions are very hard to answer, however, as all three of these domains of cognition are so broad in their scope. It may be more illuminating, then, to consider the impact of particular aspects of these three domains on a fourth, more specific, domain of cognition that clearly relates to language, EF and ToM. Children's production of referring expressions is a prime area of cognitive development to look at in this respect, as all of these three cognitive domains are involved. Children have to inhibit distracting features from other non-target objects and their own knowledge about the intended object when picking a referential expression; they have to take into account the perspective of the addressee to choose the right referential term and they have to have sufficient linguistic skills (both lexical and syntactic) in order to be able to describe the intended object unambiguously. Referential communication can thus be considered to be at the interface of ToM, language and EF and hence can shed light on the interrelationships between these cognitive domains.

Previous work on the relationship between EF, ToM, language and referential communication is relatively scarce. A study that looks at ToM in relation to referential communication is Resches & Pereira (2007). They presented 74 three- to five-year-olds with a referential communication task in which one child with knowledge of the whereabouts of a desirable object had to explain its location to another child who did not know where the desirable object was hidden. This study found that children who passed standard ToM tasks showed a better understanding of their role as informants than the children who did not pass the ToM tasks: ToM passers responded more adequately to the ignorant child's needs for information and expressed the referents more precisely than the children who failed the ToM tasks. The authors conclude that this suggests that ToM is an important factor in the development of referential communication. It should be noted, however, that this study did not include an assessment of the subjects' linguistic or EF capacities. Whether performance on the ToM task was a better predictor of performance on the referential communication task than the child's linguistic or EF abilities can thus not be ascertained.

Astington (2003) considers the role of both language and ToM in the development of referential communication, although she does not look at EF. In her study on three- to five-year-olds, Astington finds positive significant relations between performance on a standard referential communication task and ToM scores, even when linguistic ability is controlled for. James (2001, cited in Astington, 2003), however, did not find any relationship between ToM and referential communication as assessed by a standard referential communication task, once language was controlled for. James did find a significant correlation between ToM and referential communication in an adapted referential communication task, however, in which children could win stickers if they described them correctly. Some studies thus do find a significant correlation between ToM and referential communication, even when language is controlled for, whereas others do not.

A study that looked at the relationship between EF and referential communication is Nilsen & Graham (2009). They tested 4,5- to 5,5-year-old children's inhibition capacities as well as their verbal ability and referential communication skills. Once the children's verbal ability (that is, their score on a standardised receptive vocabulary test) was taken into account, the inhibition measure was not significantly correlated with referential communication. This study did find a relationship between children's inhibition capacities and their ability to interpret speaker requests using referential terms, however. In these comprehension tasks, children were presented with a slightly different array of objects than their conversational partners. For instance, children could see a big duck and a little duck (as well as various other objects), but the conversational partner could only see a big duck (as well as the other non-duck objects). Crucially, the child was aware of the fact that even though she could see two ducks her partner could only see one duck. If the conversational partner thus uttered the request "pick up the duck", she could only be referring to the big duck, as this was the only duck she had in her array[1]. For this version of the task then, Nilsen & Graham did find a significant correlation between children's ability to inhibit their own knowledge (i.e. that there is also another duck available) and focus only on the referent that the conversational partner must have intended. Whereas this study thus did not find a relationship between EF and referential communication in production, they did find a significant relationship between EF and referential communication in comprehension.

Given the different findings in these studies, it is not clear exactly what the contributions of EF, language and ToM are to referential communication. This study aims to clarify this question by giving three- and young four-year-old children a battery of tests that assesses all four domains. In an attempt to demonstrate successful referential communication in a younger age group, children were given a form of the standard referential communication task that was less taxing for the child's ToM, EF and linguistic abilities. This assessment should not only be interesting from the point of view of children's development of referential communication, but it should also shed light on the debate regarding the interrelationships between ToM, language and EF. If ToM development depends on language, then it would be expected that language is the best predictor of referential communication. After all, if language drives ToM (and hence can explain a large part of the variance in ToM performance), then language should also be the better predictor of referential communication, as referential communication involves both ToM and language. Conversely, if ToM drives language, then ToM should come out as the better predictor of referential communication. The same type of claim can be made regarding the relationship between ToM and EF and EF and language.

[1] See Nadig & Sedivy (2002) for a study with a similar design that demonstrates that 5 and 6 year old children take into account the fact that their perspective is different to that of the conversational partner when they are required to produce descriptions of intended objects.

2. Method[2]

2.1 Subjects

Thirty-eight Dutch-speaking children[3] (19 boys and 19 girls) between ages 2;11 (years; months) and 4;3 (*M*= 3;9) participated in the study. The children were recruited from a child-care centre and three primary schools in Rotterdam (The Netherlands). Most of the children came from lower middle class or middle class families.

2.2 Procedure

Children were tested individually in a separate room in the school building. For all sessions, two adults were present: the author (acting as experimenter) and an assistant. The data presented in this paper represent a subset of a larger dataset from an unpublished study looking at the relationship between EF, ToM and language development. Each child was tested on three occasions separated by at least a day and at most a week between each session. Each session lasted approximately 30 minutes; total testing time was thus around 1.5 hours per child. Testing time for the tests presented here was approximately one hour. Each child received one of twelve possible testing orders, so that test order effects were minimised. Children received stickers in return for their participation.

2.3 Assessing Theory of Mind

In assessing children's ToM abilities, children were given three different versions of the so-called "false belief" task. Although children's understanding of other people's mental states is broader than only their understanding of false beliefs, the false belief task is generally considered to be the litmus test of ToM. If children can pass the false belief task, they are demonstrating a relatively sophisticated understanding of other people's mental states. In this sense, then, performance on the false belief task can be taken as a good indicator of children's understanding of mental states more generally.

The three different types of ToM tasks that were presented to the children were two appearance-reality tasks (Flavell, Flavell & Green, 1983; Gopnik & Astington, 1988), two false belief location change tasks (Wimmer & Perner, 1983) and two false belief unexpected contents tasks (Perner et al., 1987). In the appearance-reality tasks, children were introduced to a puppet and told that he was too tired to play a game with them at the moment, but that he would return

[2] For additional notes on the methodology of this paper and the reasons behind the choice of the particular tests, see appendix 1

[3] Some of the children had been exposed to a language other than Dutch as well at home. As it has been suggested that bilingual children may have better EF than monolingual children, especially regarding their inhibition skills (cf. Bialystok & Viswanathan, 2009), this is potentially relevant information. However, in this test sample, the EF capacities of the bilingual children did not differ from those of the monolingual children, so this variable was not considered further.

later. After the puppet had disappeared, the child was shown a candle that looked like a cake and asked what it was. Once the child had volunteered the expected answer (a cake), she was shown the true identity of the object. The child was then asked two test questions: the self-question, which required the child to report her own previous false belief regarding the true nature of the cake/candle and the other-question, which probed the child's understanding of the puppet's false belief. To ensure children's understanding of the dual nature of the object, after the test questions they were asked two control questions: the reality-question (what is this really?) and the appearance-question (what does this look like?). In a separate session, the children were shown a pencil sharpener that looked like a car and asked the same questions.

In the false belief location change tasks, children were told a story in which a figure, Laura, places a marble in a basket. Another figure, Paul, then moves the marble from the basket to a box in Laura's absence. On Laura's return, the child is required to predict where Laura will look for her marble and explain why she will look there. To ensure children's understanding of the key events in the story, they were asked two control questions. These questions were asked after the test questions and related to the first location of the marble (Where was the marble first?) and the final location of the marble (Where is the marble really?). In a separate session, children were presented with another version of this task in which Paul puts his marble in a blue box and Laura moves it to a red box in Paul's absence.

For the false belief unexpected contents tasks, children were shown the puppet and told that he was too tired to play a game at the moment. The children were then shown one of two familiar containers (a pencil box in one session and an egg box in the other) and asked what was in the container. Once the child had given the expected answer, they were shown the true contents of the box (a piece of string and a toy car, respectively). The box was then closed again and the child was asked three test questions: a self-question, an other-question and an explanation-question (in which the child had to explain her answer to the other-question). A control question (what is really in the box?) was included to ensure children had remembered the relevant aspects of the story.

2.4 Assessing Language

In order to get a broad picture of the children's linguistic ability, two different standardised general language tasks were given that assessed vocabulary and syntax. The Dutch version of the Peabody Picture Vocabulary Test III (PPVT) created by Schlichting (2005) was used as a measure of children's receptive vocabulary. This is a standardised test that involves the child listening to a word and pointing to one picture out of an array of four that goes with that word.

Comprehension of syntax was tested by giving children an abbreviated version of the Reynell test for language comprehension (Van Eldik, Schlichting, lutje Spelberg, van der Meulen & van der Meulen, 1995). The Reynell test is a standardised test, suitable for children from 1;3 to 6;3 years old. All test items involved the child manipulating certain objects out of an array of multiple objects, following a verbal instruction by the experimenter. Given the long duration of the whole test (approximately 45 minutes per child), only parts 8, 9 and 11 of the test were conducted (consisting of 34 items in total) as these were deemed to give the best assessment of the child's language abilities at the sentential level (the PPVT test already provided information regarding children's abilities at the lexical level). These parts of the Reynell test do not have specific names, but the manual states that part 8 assesses "non-standard couplings of two objects through a preposition and the understanding of passive forms", part 9 assesses children's "recognition of properties of objects and understanding of number, question words and prepositions" and part 11 tests children's understanding of "two or more concepts (e.g. question words, colour, superlative forms, pronouns, prepositions and double negatives) in a concrete situation". The test items thus included a range of syntactic constructions consisting of, for example, passive constructions (e.g. the dog is bitten by the rabbit), prepositions (e.g. put a small pig next to the black pig), negation (e.g. which button is not in the cup?) and the diminutive form (e.g. show me the smallest button).

2.5 Assessing Executive Function

As the inhibition component of EF was deemed to be the most relevant for referential communication, three different tasks that assessed this EF component were presented to the children: a dimensional change card sort task (DCCS), a false sign location change task and a false sign contents change task. The DCCS (Frye et al., 1995) is a classical task assessing EF. In this task, a set of 20 cards (10 x 10 cm) was used. Two of these cards were the targets cards: one target card had a picture of two green cars on it; the other depicted one yellow car. The remaining 18 cards were test cards, 9 of which depicted one green car; the other 9 cards had two yellow cars on them. Each target card was affixed to a box with a slit through which the test cards could be posted.

The DCCS consisted of two different phases: the preswitch phase and the postswitch phase. In the preswitch phase, the experimenter told the child that they would play the colour game in which all the yellow cards had to be put in the box with the yellow target card and all the green cards should go in the box with the green target card. The child received help on sorting the first two cards and was provided with feedback if she attempted to put the card in the wrong box. The child was then asked to sort seven cards on her own with the experimenter labelling the relevant dimension of the card for each card ("here's a yellow one"). In the post-switch phase, the child was introduced to another game: the number game. The experimenter explained that all the cards with two cars (coloured yellow) on them now had to be put in the box with the two-car target card (depicting two green cars) and all the cards with one car (coloured green) on them should go in the box with the one-car target card (depicting a yellow coloured car). The experimenter labelled the first two cards that the child sorted in the post-switch phase; the remaining 7 test cards had to be sorted by the child without feedback or labelling. The order of the games (the colour and the number game) was counterbalanced across children.

In the false sign location change task (Sabbagh et al., 2006), children were introduced to two figures, Paul and Laura, and shown two identical toy houses and an arrow mounted on a stand. The experimenter explained that Paul could play in either of the two houses and showed that the arrow could be moved to point to each of the two houses. It was then explained to the child that as Paul was not visible from the outside when he was playing in one of the houses, he would indicate his whereabouts using the arrow. To make sure that the children understood the nature of the arrow, they were given two warm-up trials. In these trials, the experimenter moved the arrow to point to one of the houses and asked the child "if the arrow points like this, where is Paul?". If the child answered incorrectly, she was given feedback. Once the child demonstrated understanding of the arrow, the experimenter continued with a story in which Paul and Laura wanted to play together, but couldn't decide in which house they would play. Laura then leaves the scene and Paul moves the arrow to point to one of the houses and goes in. After a while, Paul goes to the other house, but, crucially, he does not move the arrow to point to the new house (the child is alerted to this explicitly). The child is then asked the test question "where does the arrow say Paul is playing?". In order to ensure that the child had remembered the key events in the story, the child was also asked the control question "where is Paul really playing?"

In the false sign contents change task (an adaptation of Sabbagh et al. 2006), the child is introduced to the figure Paul and his three pets: a dog, a rabbit and a cat. The child is told that Paul has a box in which his pets can rest when they are tired and that he has cards with pictures of his pets on them. As you cannot see the pets from the outside when the box is closed, the children are told that Paul displays the relevant card next to the box when one of his pets is in it. In a warm-up trial, Paul puts his dog in the box and displays the dog card next to the box. Paul and the remaining two animals then leave and the child is asked "what does the card say is in the box?". If the child answered incorrectly, she was given feedback. Paul, the cat and the rabbit then return and Paul puts the cat in the box and displays the cat picture next to it. Again, Paul and the remaining pets leave. After a while, the rabbit returns on its own, jumps in the box and removes the cat. Importantly, the cat card remains next to the box. The child is then asked the test question: "what does the picture say is in the box?". To ensure that the child had remembered the main events in the story, the child was also asked the control question "what's really in the box?"

2.6 Assessing Production of Referring Expressions

A modified version of the standard referential communication task was used to assess children's production of referring expressions. In this task, the child was asked to describe a picture in such a way that another person, with no visual access to the picture, could find the same picture. Sixteen different pictures, each depicting one character (a man, a woman, a boy or a girl) engaged in a certain action (e.g. riding a horse, combing their hair) were used in this task. The experimenter explained that the assistant would show the child a picture and that she would have to describe the picture in such a way that the experimenter would be able to find the same picture from a big book of pictures. It was stressed that as the experimenter would be behind an opaque screen when the pictures were shown to the child, it was really necessary that she describe the picture accurately. The child was told explicitly that she would have to describe two things for the experimenter to be able to pick the right picture: which character was in the picture and which action he or she was engaged in. This was demonstrated using a picture of a man jumping over a wall. The children were shown that the experimenter had four different pictures, each depicting one of the four characters jumping over a wall. It was thus made clear that only mentioning the action the character was engaged in would not be enough information for a choice to be made. Another four pictures of each of the characters riding a horse demonstrated that it was also not enough to mention only the character, as the characters would be engaged in different actions depending on the picture that was chosen. This explanation thus obviated the need for the child to discern by herself what the relevant aspects of the picture would be and how her knowledge state would differ from that of the addressee during the experiment.

To ensure that the children were in principle capable of describing each of the characters and the action they were engaged in, the experimenter and the child looked through all the pictures prior to the experiment. While looking through the pictures, the child was required to give a verbal description of the character and the action carried out by the character. If children did not know how to describe a particular action or character, the experimenter helped them. Again, this represents a simplification in respect to the standard form of the referential communication task in that word finding difficulties in describing the pictures were tackled prior to the experiment. This meant that failure at the referential communication task was unlikely to be due to lexical gaps, but would stem from deeper problems in providing the addressee with the necessary information.

In comparison with standard referential communication tasks, this task was thus simpler, so that it would be more doable for the younger age range that was tested in this sample. The EF demands were lessened by telling the child beforehand what the relevant dimensions of the pictures were and by showing the child one picture at a time instead of requiring them to describe one picture from an array of pictures (thereby decreasing the need for the child to inhibit irrelevant features from other pictures than the target picture). ToM demands were decreased by making it clear to the child in advance what information the listener required in order to pick the same picture. Importantly, this simplification did not mean that the child could ignore the listener's perspective: she still had to take into account the fact that she was describing a picture to someone who did not have visual access to the picture. It was only the additional task, which information exactly was needed by the listener, that the child was helped with. The linguistic load of this task was lessened by making sure that the children did have the requisite lexical items necessary for describing each of the characters and the actions they were engaged in. This was important, because if referential communication fails simply because the child has certain gaps in her lexical knowledge, this does not mean that the child is incapable of referential communication as such. The children thus were not trained to perform well on the test, rather, it was made sure that they knew the relevant words and understood the task set-up. Because of this level of instruction beforehand, performance on the referential communication task is easier to interpret: if children perform successfully, evidently, they are capable of referential communication in this simpler task format; if children perform unsuccessfully, then that indicates problems with referential communication as such, not with lexical gaps or misunderstanding of the task.

2.7 Scoring

Theory of Mind

Each appearance-reality test yielded two points: one for the self-question and one for the other-question. Children were only awarded points for the test questions if they answered both control questions correctly. Each false belief location change task also yielded a maximum of two points: one point for the prediction question and one for the explanation question. For the explanation question, answers were scored as correct if they referred to the original location of the object or the character's belief regarding the location of the object. Again, the child was only awarded the points if she correctly answered both of the control questions. Children could receive a maximum of three points for the false belief unexpected contents task: one for the self-belief question, one for the other-belief question and one for the explanation question. Answers to the explanation question were scored correct if they referred to the box' misleading appearance or the character's mistaken belief regarding the contents of the box. Children only received the points if they answered the control question correctly. Across all ToM tests, children could thus receive a maximum of 14 points[4].

Language

The PPVT vocabulary test is a standardised test of the child's receptive vocabulary and hence comes with a set scoring metric. The age of the child and the raw score as determined by the number of items the child got right are taken into account resulting in a quotient score. A score of 100 represents an exactly average receptive vocabulary for a child of that age (in years and months). The Reynell test is also a standardised test of the child's receptive language skills, but as only parts of the whole task were presented to the child, the scoring metric could not be used. Instead, the total number of correct items out of the

[4] Other studies that test ToM often only have one or two false belief questions, so this can be considered to be a relatively broad assessment of false belief understanding.

three parts of the test was taken as the child's score (34 being the maximum possible score).

Executive Function
For the DCCS, the child received a score depending on the number of cards she sorted correctly in the post-switch phase. Children could score a maximum of seven points for this task. In both the false sign location change task and the false sign contents change task, children could receive a maximum of one point for answering the test question correctly. Children were only awarded the points if they answered the control questions correctly.

Production of Referring Expressions
The child received one point for each correct picture description, yielding a possible maximum of eight points. An answer was considered correct if it referred to the character using a lexical noun and a verb relating to the action. The exact nature of the noun used to describe the character was not important; as long as it referred to an older male for the man, an older female for the woman, a younger male for the boy and a younger female for the girl. In describing the man, for instance, nouns like man, mister, daddy and granddad were thus all accepted. The exact nature of the verb was also not important, as long as it plausibly described the action. In describing jumping over a wall, phrases like *jumping*, *walking over a wall* and *climbing over a wall* were all considered acceptable. If the child described only the character or only the action or used a pronoun to describe the character (there were two male and two female characters, so a pronoun did not pick out a unique referent), the child did not receive any points.

3. Results

3.1 Descriptive Statistics
Table 1 shows the means, standard deviations and ranges of the various tasks and the subjects' ages.

In order to create one total ToM score, the scores on the individual ToM tasks were summed. In order to derive a total language score, z-scores of the individual tests were taken and summed to create one language z-score (as the range of the PPVT task is much larger than that of the Reynell task, simple addition would result in inflation of the importance of the child's PPVT score in the language score). A similar procedure was followed for the EF scores: z-scores were taken for the three individual measures and these were summed to create one measure (again, the range of the DCCS is larger than that of the other two tasks, so the importance of this measure would be inflated if the scores were summed). Further analyses involving EF and language were conducted on these combined scores.

Table 1 Means, standard deviations and ranges of age and all tests in the test battery

Measure	Subtest	Mean	SD	Range
Age (months) (years;months)	N/A	45 (3;9)	5.7	35-51 (2;11-4;3)
ToM	Appearance-reality	0.7	1.3	0-4
	False belief location change	1.1	1.4	0-4
	False belief unexpected contents	1.2	1.7	0-6
	ToM sum score	3	3.7	0-14
General language	PPVT	96.9	16.6	57-126
	Reynell	15.2	7.3	3-29
EF	DCCS	4.9	2.5	0-7
	False sign location change	0.4	0.5	0-1
	False sign contents change	0.3	0.5	0-1
Producing referring expressions	Referential communication	5.1	2.9	0-8

*Note***.** Maximum scores: appearance-reality and false belief location change = 4; false belief unexpected contents = 6; no PPVT maximum; Reynell = 34; DCCS = 7; false sign location change and false sign contents change = 1; referential communication = 8

3.2 Performance on Control Items

The scoring guidelines proved to be a rather strict measure of ToM capacity, as a considerable number of children passed at least one of the test questions, but failed to answer all control questions correctly. To be precise, for the appearance-reality task, 28 children correctly answered at least one of the test questions while failing at least one of the control questions; this number was 12 for the false belief unexpected contents task and 4 for the false belief location change task. These children were all scored as failing the test question. The guidelines led to a similarly strict selection for the false sign EF tasks. Again, children had to answer the control questions correctly in order to be awarded any points on the test questions. In the false sign location change task, 3 children answered the test question correctly, but failed the control question. For the false sign contents change task, this number was 11. All of these children were scored as failing the test question. While this scoring policy might be strict, it does ensure understanding of ToM and false signs in the children who scored points in these domains.

3.3 Correlations and Regression Analyses

The correlations between ToM, language, EF and referential communication are shown in Table 2. As can be seen from the table, the correlations between ToM,

Table 2 Correlations between ToM, language, EF and referential communication

	ToM	General language	EF
General language	.67*		
EF	.53*	.46*	
Referential communication	.43*	.21	.18

*Note***.** *p<.01, two-tailed

language and EF are significant and relatively high. It should be noted, however, that only ToM is significantly correlated with referential communication.

In order to assess the relative contributions of ToM, language and EF to referential communication, hierarchical regression analyses were conducted with referential communication as the dependent variable and ToM, language and EF as predictors. The results of these analyses can be found in Table 3.

Table 3 Hierarchical regression analyses for EF, ToM and language predicting referential communication

	B	SE B	β	R²	ΔR²
Model 1					
EF	0.26	0.24	.18	.03	.03
Model 2					
EF	0.14	0.27	.10	.05	.02
Language	0.27	0.29	.17		
Model 3					
EF	-0.08	0.27	-.06	.20	.15*
Language	-0.20	0.33	-.13		
ToM	0.44	0.18	.55*		

*Note***.** *p≤.05

As can be seen in Table 3, the final model in the regression analysis, model 3, describes 20% of the variance in referential communication (R^2_{adj} = 12,9%) with an overall significant relationship ($F_{3,34}$ = 2.83; p=.05). Model 3 also shows that only the child's ToM capacity is a significant positive predictor of referential communication (t_{34} = 2.50; p = .02). Referential communication increases by 0.44 points for every point increase in ToM score. The other predictors in the model, EF and language, do not significantly predict referential communication (t_{34} = -0.31, p = .76 and t_{34} = -0.60, p = .55 respectively). Thus, controlling for EF and language, only ToM significantly predicts performance on the referential communication task. Furthermore, adding ToM to the model containing EF and language as predictors enhances the percentage of explained variance of the model significantly by 15%.

4. Discussion

This study investigated the relationship between EF, ToM, language and referential communication in Dutch-speaking preschool children. The aim was to consider the referential communication abilities of these young children using a simplified form of the standard referential communication task and to determine the contributions of EF, ToM and language to children's ability to appropriately produce referring expressions. Furthermore, this study intended to shed light on the nature of the relationship between ToM, EF and language. Referential communication was deemed an interesting area to investigate in this respect, as it is a cognitive domain on the interface of EF, ToM and language. Referential communication requires the child to inhibit her own knowledge about the referent when picking a referential expression; she has to take into account the perspective of the addressee to choose the right referential term and she has to have sufficient linguistic skills (both lexical and syntactic) in order to be able to describe the intended object appropriately.

In contrast to previous literature that suggested that children generally experience difficulty in referential communication until they are about six years old (cf. Deutsch & Pechmann, 1982; Glucksberg, Krauss & Weisberg, 1966; Krauss & Glucksberg, 1969), it was found that preschool children were capable of producing appropriate referential expressions in this simplified form of the standard referential communication task. Although these children did not perform at ceiling yet (their mean score was 5,1 out of a possible 8), most children were capable of producing referential expressions that were appropriate in the given context on at least some of the trials.

Simplification of the referential communication task consisted of decreasing the demands placed on the ToM, language and EF capacities of the child. ToM demands were decreased by making it clear to the child beforehand what information the listener would require. Importantly, the child thus still had to take the listener's perspective into account (the child could not simply use referential expressions that were in line with her own view of the picture), but she did not have the extra task of discerning the precise nature of the information the listener needed. Presenting the child with only one target picture at a time reduced demands on the child's EF, as irrelevant features from other pictures did not have to be directly inhibited. However, children did still need to inhibit the use of referential expressions that would be in line with their own view of the picture. The task thus still demanded some level of inhibitory control. In order to alleviate the linguistic demands of the task, children were helped if they were unable to describe a character or an action before the test trials began. Although children thus still had to draw on their verbal ability to describe the picture appropriately, unsuccessful performance due to lexical gaps was reduced in this way. In this simplified version of the standard referential communication task children under the age of six were thus capable of successful referential communication in experimental situations. It should be noted, however, that even with this scaffolding, children were not yet at ceiling in their performance on this task. Being capable of successful referential communication is thus clearly still developing at this age, even if it is tapped into using a simplified task set-up.

Regarding the relationship between EF, ToM, language and referential communication, the child's performance on ToM tasks was found to be the best predictor of referential communication. This finding is in line with prior research suggesting interesting links between ToM development and referential communication (cf. Astington, 2003; Resches & Pereira, 2007). This effect was found in a language population not previously considered in this type of research: Dutch-speaking preschoolers. The effect of ToM on referential communication was quite strong, remaining even when general language ability (as assessed by a standardised vocabulary test and parts of a standardised language comprehension test) and the inhibitory component of EF were controlled for. On the other hand, neither EF nor linguistic ability were significant predictors of referential communication. This finding suggests, then, that it is understanding of other people's mental states that is of primary importance in children's capacity to use referring expressions appropriately.

These findings are interesting in that they suggest that it is not so much a child's linguistic or EF ability that contributes to her capacity to deal with real life conversational situations in which a child has to inform a less knowledgeable individual using an appropriate referential expression, but her ability to understand another person's mental states. This then poses a challenge to accounts that hold that the child's ability to understand others' mental states and to predict their behaviour on that basis is dependent on linguistic or EF development. After all, this study shows that understanding of mental states is a better predictor of referential communication than language or EF. In fact, in this data set, neither language nor EF significantly predicted referential communication at all. If the child's linguistic or EF development was the key determinant of a child's capacity to understand anything about mental states, one would expect to see language and EF to be the better predictor of referential communication. After all, if language and/or EF drive the understanding of mental states then language and/or EF should drive referential communication (involving language, ToM and EF) as well.

It should be noted, however, that, given the correlational nature of this study the findings presented here cannot falsify the view that EF or language drives ToM, as the causal direction between ToM, language, EF and referential communication cannot be determined on the basis of this evidence. It is possible that the development of referential communication drives the development of ToM, instead of ToM bootstrapping the development of referential communication, as is assumed here. Longitudinal data, which is in the process of being collected, or data from intervention studies is necessary in order to make stronger claims regarding the direction of causality between ToM, language, EF and referential communication. This cautionary note notwithstanding, there does seem to be a developmental connection between ToM and the production of appropriate referential expressions that was not found between referential communication and language and EF (as ToM was a significant predictor of referential communication, but language and EF were not). ToM and referential communication thus seem to share underlying connections that this data set does not show to be present between referential communication and language and EF.

Chapter 2

Children's understanding of epistemic modality: Contributions from theory of mind and linguistic development

Abstract

This study assessed the contributions of Theory of Mind (ToM) and linguistic development to children's understanding of epistemic modal terms. 110 Dutch-speaking children (M=4;6 years) were given a test battery assessing their ToM development, lexical and syntactic aspects of linguistic ability and their understanding of the epistemic modal auxiliaries *moeten* 'must' and *kunnen* 'might' and the modal adverbs *zeker* 'definitely' and *misschien* 'maybe'. The results showed that ToM was, but the language measures were not, a significant predictor of performance on the epistemic modality tests. These results go against linguistic determinism accounts that claim that ToM development is dependent on language, suggesting instead an influential role of ToM in the acquisition of epistemic modal terms.

Key words

Theory of Mind; Language acquisition; Epistemic modality; Linguistic determinism

1. Introduction

A particular milk carton contains a coin. Show someone else the carton and ask them what's in it. What will they say? Milk! But this is not so obvious for young children. Appreciating other people's beliefs is hard for them, especially if those beliefs are different from their own. The understanding of others' beliefs as separate entities develops in most children somewhere between their third and fifth year, marking the child's dawning ability to assess another person's knowledge state in a more adult-like way. The standard test used to discover whether the child has this understanding is the so-called 'false belief task' (cf. Perner, Leekam & Wimmer, 1987; Wimmer & Perner, 1983). In its original version, the child is told a story in which the protagonist, Maxi, puts some chocolate in a blue cupboard. In Maxi's absence, mother moves the chocolate from the blue cupboard to a green cupboard. On Maxi's return, the child is asked the false belief question: "Where will Maxi look for his chocolate?" The child is thus required to predict the behaviour of a story character given the latter's false belief about the location of the object. If a child can ignore her own knowledge about the world and focus on another person's belief, even if that belief is incorrect given the current state of the world, she is showing an advanced understanding of what goes on in other people's minds. In short, she is said to have a Theory of Mind (ToM).

False belief understanding is not the only component of ToM, however. The term ToM is used very broadly to refer to a whole range of aspects of social cognition: from joint attention, to appreciating others' desires and emotions, to understanding false beliefs. However, passing the false belief task is generally considered the hallmark of true possession of ToM, as it demonstrates not only an advanced understanding of others' minds, but also of how behaviour is affected by beliefs. Throughout this paper then, the term ToM is used in this more specific sense to refer to the stage at which the child shows understanding of false beliefs.

1.1 Theory of Mind and Language: Relative Contributions

The development of ToM is a major milestone in the child's cognitive development and, as such, has attracted much attention of researchers interested in child development. One particular point of debate regards the role that the acquisition of language plays in the child's ToM development. That there is some kind of relationship between ToM and linguistic development is generally accepted, as many studies find high correlations between false belief tests and measures of general language ability (Jenkins & Astington, 1996; Ruffman, Slade, Rowlandson, Rumsey & Garnham, 2003). The precise nature of the relationship is, however, considerably less clear (Astington & Baird, 2005; Milligan, Astington & Dack, 2007). Is ToM pivotal in the development of language? Or is linguistic development a prerequisite for the development of ToM? Some researchers claim that language is fundamental in ToM development, stating that only once the child's general language abilities are sufficient, is she able to represent other people's mental states properly (cf. Astington & Jenkins, 1999). On this view, which will be referred to as the linguistic determinism view, language provides the scaffolding that allows the child to make sense of the different layers of representation that are necessary for understanding others' beliefs as distinct from one's own. The question is, however, exactly which aspects of language might provide the building blocks for the child's development of ToM. Both semantic and syntactic aspects of language are possible candidates: semantics provides the child with labels for unobservable entities like mental states (e.g. mental state verbs like *know* and *believe*). In accordance with this idea, Moore, Bryant and Furrow (1989) note a relationship between children's comprehension of the mental state verbs *know*, *think* and *guess* and their performance on false belief tests. Ziatas, Durkin & Pratt (1998) obtained similar findings for both typically and atypically developing populations.

Syntax, on the other hand, provides the child with a format for representing ideas that differ from reality. This aspect of syntax may be of key importance in developing an understanding of false beliefs, as the hallmark of understanding false beliefs is the ability to separate what you know about reality and what someone else believes to be the case. De Villiers and colleagues (de Villiers, 2005, 2007; de Villiers & Pyers, 2002) claim that there is one particular syntactic construction that is a prerequisite for false belief understanding: the sentential complementation construction. Mental state verbs (*think*, *believe*) and communication verbs like *say* occur with sentential complements (see 1 and 2 for examples).

1) Maxi thinks that the chocolate is in the blue cupboard
2) Mary says that she is eating her peas

The interesting thing about these constructions is that the sentential complement ("the chocolate is in the blue cupboard" in 1 and "she is eating her peas" in 2 can be false (i.e. the chocolate is in the green cupboard and Mary is not eating her peas), but the whole sentence can still be true. As long as Maxi thinks that the chocolate is in the blue cupboard, sentence 1 is true irrespective of the true location of the chocolate. In more formal terms, this means that the truth conditions of the subordinate sentence and the matrix sentence may differ in the case of sentential complementation constructions.

Understanding of the syntactic and truth conditional aspects of sentential complementation constructions may then, according to de Villiers and her colleagues, allow the child to bootstrap her way into false belief understanding. In order to make this possible, the child first has to notice that communication verbs like *say* can take false complements. There should be overt evidence for this in the input the child receives: the child hears an utterance like "John says that the keys are in the drawer" in a situation in which the keys are not in the drawer, but the child has heard John say that the keys are in the drawer. These kinds of situations could allow the child to infer that the complement ("the keys are in the drawer") does not have to be true even if the whole sentence is true. The child then has to realise that mental state verbs like *believe* and *think* are similar in their surface syntactic form to communication verbs like *say*. The child then has to extend this analogy to assume that not only are the surface syntactic forms of communication and mental state verbs similar, they are also similar in that both allow the embedded complement to be false while retaining the overall truth of the sentence.

The idea is thus that the child develops an understanding of false beliefs by realising that *say* and *think* are syntactically similar, hearing the verb *say* occur with a false complement and generalising this feature of *say* (i.e. that it can occur with a false complement) to the verb *think*. In this way, the understanding of sentential complementation constructions forces the child to contemplate the nature of mental states and to appreciate the fact that it is possible to have 'false' mental states just like it is possible to say things that are not true. Acquiring sentential complementation constructions thus provides the child with a format for representing false beliefs and hence is assumed to be necessary for the child to develop a ToM. In line with this idea, a training study by Lohmann & Tomasello (2003) demonstrates that training children on sentential complementation constructions also enhances their performance on false belief tasks (but see Cheung, Hsuan-Chih, Creed, Ng, Wang & Mo, 2004 and Perner, Sprung, Zauner and Haider, 2003 for alternative points of view regarding the role of sentential complementation in false belief understanding).

In contrast to the view in which (particular aspects of) language acquisition are necessary for the development of ToM, other studies have found that ToM development influences the acquisition of language. Slade & Ruffman (2005), for example, show in a longitudinal study that whereas earlier linguistic development can be shown to predict later ToM development, the reverse relationship also holds. This bi-directional relationship only became apparent, however, once the ranges of scores in the language and false belief tasks were equated. In general, language measures consist of a considerably larger number of items and ranges of possible scores than tests for false belief understanding (which tend to consist of only a few items). Slade & Ruffman (2005) showed that once the language scores were equated with the ToM scores (i.e. an equal number of items from the language and ToM measures was used), ToM exerts an influence on linguistic development as well, with earlier ToM development predicting later linguistic development. Similarly, Milligan et al. (2007) also found evidence for a bi-directional relationship in their meta-analysis of the relation between language ability and false belief understanding.

Furthermore, aspects of broad ToM that develop prior to false belief understanding have also been shown to be of key importance in the development of language. Children's understanding of intention, for example, assists them in understanding which object an adult is referring to, which, in turn, aids them in vocabulary learning (cf. Baldwin, 1993; Baldwin & Moses, 2001; Bloom, 2000, 2002). In these studies then, instead of language influencing ToM development, there is evidence that (broad) ToM development is influencing linguistic development.

Given this diversity of points of view and experimental findings, it is thus not clear how exactly the development of the two cognitive domains, language and ToM, is related. Is language a prime contributor to, or even a prerequisite for, the development of ToM? Or is ToM development fundamental to the acquisition of language? Framed in this general way, these questions are very hard to answer, however. After all, it does not seem likely that all of language must be in place before any of ToM develops or that language can only develop once the most sophisticated aspects of ToM have been acquired. For this issue to be addressed then, it is necessary to make the questions more specific: Which aspects of language are major contributors to the development of which aspects of ToM? Or, vice versa, which aspects of ToM are fundamental in the development of which parts of language? Aside from de Villiers' specific claim (i.e. that sentential complementation is a prerequisite for the development of false belief understanding), much of prior research has not clearly defined which aspects of the two cognitive domains are being related, making it hard to draw any robust generalisations regarding the interrelationships between language and ToM.

1.2 Epistemic Modality: At the ToM-Language Interface

The purpose of the present study is to consider the issues regarding the relationship between ToM and language more closely by looking at the development of those areas of cognition that are on the interface of ToM and general language. The child's developing understanding of epistemic modality is a prime area of cognitive development to look at in this respect as both language acquisition and an understanding of mental states are involved in this domain. In general terms, epistemic modality concerns a speaker's evaluation of the likelihood that a certain state of affairs is true or false (cf. Nuyts, 2001). In other words, epistemic modal terms, like *definitely* and *possibly*, convey how certain a speaker is of a proposition. Epistemic modality is thus related to linguistic ability in that the modal terms have to be acquired as lexical items, but also to ToM as it requires an understanding of the nature of others' beliefs (be they true or false, certain or uncertain) to truly appreciate the intended meaning. Specifically, the areas of epistemic modality considered here are the epistemic modal auxiliaries *moeten* 'must' and *kunnen* 'might' and the epistemic modal adverbs *zeker* 'definitely' and *misschien* 'maybe'[1].

[1] Note that these modal auxiliaries can also be used deontically (i.e. to convey obligation or permission, as in *young people must offer their seats to the elderly*), but the focus of this paper is on children's understanding of their epistemic use.

Epistemic modal auxiliaries and adverbs such as the italicised words in examples 3, 4, 5 and 6 relate to how strongly the speaker is committed to the truth of a proposition. In other words: what degree of belief the speaker has in her utterance (cf. Papafragou, 1998).

3) The keys *must* be in the drawer

4) The keys *might* be in the drawer

5) The horse is *definitely* in the barn

6) *Maybe* the horse is in the barn

In 3 and 5, use of the modal auxiliary *must* or the modal adverb *definitely* indicates that the speaker is very certain of the underlying proposition and hence strongly believes that the keys are in the drawer and the horse is in the barn. Use of *might* in example 4 and *maybe* in example 6, on the other hand, indicates a considerably less strong belief in the truth of the underlying proposition.

By far the most of the studies that have looked at the development of epistemic modality have concentrated on the acquisition of modal auxiliaries. Bliss (1988), for instance, reports that modal auxiliaries first occur in children's natural discourse when they are about two years old. It is unlikely, however, that these first occurrences really demonstrate understanding of the strength of speaker belief that is implied by the use of these terms. Generally, children use the modal terms to imply ability ('I *can* see you') or intention (I'*ll* show how to do it'). In Bliss' sample of two- to five-year-old children, epistemic uses of modal auxiliaries occurred only very rarely in spontaneous speech. Hirst & Weil (1982) provide early experimental evidence regarding the acquisition of epistemic modal auxiliaries. Three- to six-year-old children were told to find a hidden peanut by listening to the advice of two puppets that used the modal terms *must*, *may* and *should* contrastively ('the peanut must be under the cup' vs. 'the peanut may be under the box'). Hirst & Weil found that only the oldest children (starting at 5;6) could make strength distinctions between the modals, a result that was replicated in a more recent study by Noveck, Ho & Sera (1996). Byrnes & Duff (1989) found a different result, however, in their study of modal auxiliaries. They considered children's ability to differentiate the strength conveyed by *has to be* vs. *might be* (It has to be under the red cup vs. It might be under the blue cup) and the difference between the negated terms *can't be* vs. *might not be*. Results of this study showed that children improved significantly between the ages of three and four, with ceiling performance at five years old. Moore, Pure & Furrow (1990) represent a midway between these two findings in their study of the English modal auxiliaries *must*, *might* and *could*. This study found significant improvement between the ages of three and four as well, but even the oldest group in their study (consisting of six-year-olds) did not demonstrate ceiling performance yet.

It is thus not entirely clear at what age English-speaking children start to be able to distinguish the differences in speaker certainty as conveyed by epistemic modal auxiliaries. From the available data, it seems that somewhere between four and six years old children can appreciate differences in relative force. To what extent this result can be generalised to languages other than English is not clear, however. At least one study on a language other than English, Bascelli & Barbieri's (2002) study on the Italian modal auxiliaries *dovere* 'must' and *potere* 'may', finds considerably later understanding of the differences between the modals. Only at six years old do the Italian children tested in this study demonstrate some understanding of the contrasts between these auxiliaries, whilst the full system isn't mastered until they are eight years old. Additional studies on the development of epistemic modal terms in languages other than English are thus called for to see to what extent the acquisition of these terms is similar across languages.

A study that looks at modal adverbs as well as modal auxiliaries is Moore et al. (1990). This study investigated whether three- to six-year-olds could understand the differences in speaker certainty between *must*, *might* and *could* as well as their performance on the distinction between the modal adverbs *probably*, *possibly* and *maybe*. Similar to the findings for the modal auxiliaries, three-year-olds were not capable of differentiating between any of the modal adverb contrasts, but the older age groups were capable of finding the hidden object on the basis of the modal terms (this study used a design similar to the one in Hirst & Weil, 1982 described above). Aside from broadening the scope of investigation (studying modal adverbs as well as auxiliaries), the Moore et al. (1990) study also investigated whether the development of ToM and the acquisition of these modal terms were related. In order to assess ToM, children were presented with various different types of tasks assessing their understanding of false beliefs. The results of this study demonstrated that the children's performance on the modal terms tasks was strongly related to their performance on the ToM tasks. This finding suggests that there is not just a link between ToM development and the acquisition of language in a general sense, as argued above, but that a specific part of ToM development, the understanding of false beliefs, can be linked to a specific area of language, namely epistemic modality.

Epistemic modality is not the only area of language that has been linked to ToM development, however. Papafragou (2001a), Papafragou & Li (2001) and Ifantidou (2005), for instance, all argue that children's acquisition of evidential markers (the linguistic encoding of information source, like the hearsay marker *allegedly* in English) is constrained by the development of ToM, in particular their understanding of the source of beliefs and speaker certainty. Moore et al. (1989) make a similar claim regarding the understanding of the mental state verbs *know*, *think* and *guess*. Although this study does not explicitly test the children's performance on standard ToM tasks, the authors note that the timing of coming to understand the difference between the mental state terms used here and children's passing of standard false belief tasks is very similar and hence points to an interesting relationship between the development of the two domains. Ziatas et al. (1998) extend this finding by demonstrating that autistic children (who are known to have problems in ToM development) are impaired in their development of the mental state terms *know*, *think* and *guess*.

1.3 Aims of the Study

The primary aim of the current study is to shed light on the relationship between the development of ToM and language in Dutch-speaking four-year-olds by considering a part of cognition on the interface of ToM and language: epistemic modality. Which is the better predictor of the development of epistemic modal terms: The child's understanding of false beliefs or the child's general linguistic capacities? In other words, what contributes more to the child's epistemic modality development: Being able to understand the minds of others or verbal ability?

This study adds to existing research by narrowing the scope of the general ToM-language debate. Instead of asking whether there is a relationship between language and ToM in general, specific aspects of ToM and language are considered. ToM is operationalised as false belief understanding, as this is considered to mark the beginning of a more adult-like understanding of others. General language consists of receptive vocabulary, syntax and sentential complementation and epistemic modality comprises an understanding of modal auxiliaries and modal adverbs. The specific question at the heart of the study is then: which is the better predictor of epistemic modality, false belief understanding or general language?

In line with the above research suggesting that ToM is at least highly correlated with and potentially an important catalyst of the development of other mental aspects of language like mental state verbs and evidential markers, the assumption underlying this study is that false belief understanding will prove to be the better predictor of epistemic modality. General language is assumed to be of less importance in the child's performance on the epistemic modality tasks. The development of epistemic modality is thus taken to be dependent on ToM development, relying on an understanding of others' minds, instead of being dependent on (particular aspects of) a child's verbal capacity. This prediction is in contrast with what the linguistic determinism view would predict regarding the relationship of language and ToM in the development of epistemic modality. As the linguistic determinism view claims that the development of (particular aspects of) language is the driving force in the child coming to understand mental states, it stands to reason that language would then also predict the development of areas of cognition that involve *both* language and the understanding of others' mental states (i.e. epistemic modality in this case).

A secondary aim of the study is to consider the development of epistemic modality in a language other than English. To what extent are Dutch four-year-olds capable of differentiating the modal terms considered here? Will they pattern more like the English children, who have been shown to demonstrate at least some understanding of modal terms by the age of four, or will they be more similar to the Italian children studied by Bascelli & Barbieri (2002), who do not differentiate between the modal terms *potere* 'must' and *dovere* 'may' until they are at least six years old?

The rationale for choosing Dutch-speaking four-year-olds for this study was thus two-fold. In the first place, Dutch is a language for which the understanding of epistemic modality has not been studied experimentally before. Considering the performance of Dutch children thus adds to our understanding of how the development of epistemic modality may vary depending on which language is studied. Secondly, this study included four-year-olds, because it was expected that this age group would show interesting variation in all three domains under investigation. Four-year-olds show some understanding of other people's false beliefs, but most children do not yet show ceiling-performance if a broad range of different false belief tasks is employed. Similarly, if the studies on English children's understanding of epistemic modals are considered, at age four, children can be expected to demonstrate some understanding of epistemic modals, although most will not yet show ceiling-performance. The same goes for the language measures: understanding of sentential complementation is supposed to appear around the same time as false belief understanding and the general syntax and vocabulary measures are set-up in such a way that ceiling-performance is unlikely. Lack of ceiling-performance in all three domains is necessary in this case, as the primary aim of the study is to determine whether ToM or general language predicts the larger part of the variance in epistemic modal understanding. If the large majority of the subjects had already fully acquired the aspects of ToM, general language and epistemic modality considered here, there would not be much variation to predict. Given the available evidence then, four-year-old Dutch children are thus an interesting group to investigate.

2. Method[2]

2.1 Participants

110 Dutch-speaking children (49 boys and 61 girls) between ages 4;0 and 4;11 (*M*= 4;6) participated in the study. The children were recruited from three primary schools in Rotterdam and one primary school in Rosmalen (both are cities in The Netherlands). Most of the children came from lower middle class or middle class families.

2.2 Procedure

Children were tested individually in a separate room in the school building. For all sessions, two adults were present: an experimenter and an assistant. The data

[2] For additional notes on the methodology of this paper and the reasons behind the choice of the particular tests, see appendix 1.

presented in this paper represent a subset of a larger dataset from an unpublished study looking at the relationship between ToM and language development. Each child was tested on three occasions separated by at least a day and at most a week between each session. Each session lasted approximately 30 minutes; total testing time was thus around 1.5 hours per child. Testing time for the tests presented here was approximately one hour. Each child received one of twelve possible testing orders, so that test order effects were minimised. Children received stickers in return for their participation.

2.3 Assessing Theory of Mind

Three different types of false belief tasks were presented to the children: two appearance-reality tasks (Flavell, Flavell & Green, 1983; Gopnik & Astington, 1988), two location change tasks (Wimmer & Perner, 1983) and two unexpected contents tasks (Perner et al., 1987). In the appearance-reality tasks, children were first introduced to a puppet, Ernie. They were then told that Ernie would like to play a game with them, but that he was too tired to do so at the moment and would return later for a different game. The puppet was then placed out of the child's sight under the table. After the puppet had disappeared, the child was shown a deceptive object (e.g. a candle that looked like a cake) and asked what it was. Once the child had volunteered the expected answer (a cake), she was shown the true identity of the object. The child was then asked two false belief questions: the self-question (when you first saw this, before we looked at it closely and you touched it, I asked you what it was. What did you say[3]?) and the other-question (Ernie was sleeping when I showed you this. He has never seen it before and never touched it. What will Ernie say this is if we ask him?). In order to make sure that children truly understood the nature of the object, after the test questions they were asked two control questions: the reality-question (what is this really?) and the appearance-question (what does this look like?). In a separate session, the children were shown another deceptive object and asked the same questions as described above. If children did not answer the questions initially, they were given a forced choice of the two possible answers.

In one of the two location change tasks, children were told a story in which a figure, Laura, places a marble in a basket. Another figure, Paul, then moves the marble from the basket to a box in Laura's absence. On Laura's return, the child is asked the prediction false belief question (where will Laura look first for her marble?) and the explanation false belief question (why will Laura look there first?). Two control questions were also included to ensure that the child had understood the story and remembered the key events. These questions were

[3] Note the absence of mental state verbs throughout the false belief questions (in most false belief tests, this question would be phrased as "What did you think this was when you first saw it?" or something similar). Mental state verbs were not used in the test questions here as children of this age may not fully understand the meaning of these terms yet and thus fail the ToM question on that basis. Furthermore, other mental state terms (epistemic modal auxiliaries) are considered to be the dependent variable in this study; using mental state verbs in the test question for one of the independent variables may thus blur the results.

asked after the false belief questions and related to the first location of the marble (Where was the marble first?) and the final location of the marble (Where is the marble really?). In a separate session, children were presented with the other version of this task, which involved Paul putting his marble in a blue box and Laura moving it to a red box in Paul's absence. For all prediction and control questions, children were asked to choose between the two possible options, if they did not answer the questions initially.

For the unexpected contents tasks, children were again first shown the puppet Ernie and told that he would like to play a game with them, but was too tired at the moment. The children were then shown a familiar container (e.g. a pencil box) and asked what was in the container. Once the child had given the expected answer, she was shown the true contents of the box (a piece of string). The box was then closed again and the child was asked three false belief questions: a self-question (When you first saw this box, before I opened it up and we looked inside, I asked you what was in it. What did you say?), an other-question (Ernie was sleeping when I showed you this. He has never seen this box before and never looked inside. What will Ernie say is in this box if we ask him?) and an explanation-question (Why will Ernie say that?). A control question (What is really in the box?) was included to ensure children had remembered the relevant aspects of the story. In a separate session, the children were shown another familiar container and asked the same questions as described above. For the self, other and control questions, children were asked to choose between the two possible options, if they did not answer the questions initially.

2.4 Assessing General Language

Three different general language tasks were given, testing children's receptive vocabulary, comprehension of syntax in general and sentential complements in particular. The receptive vocabulary test was the Dutch version of the Peabody Picture Vocabulary Test III (PPVT) created by Schlichting (2005). This is a standardised test of Dutch receptive vocabulary, which is suitable for both adults and children aged 2;3 and older. The test involves the participant listening to a word and pointing to one picture out of an array of four that goes with that word.

General comprehension of syntax was tested by giving children an abbreviated version of the Reynell test for language comprehension (Van Eldik, Schlichting, lutje Spelberg, van der Meulen & van der Meulen, 1995). The Reynell test is a standardised test, suitable for children from 1;3 to 6;3 years old. All test items involved the child manipulating certain objects out of an array of multiple objects, following a verbal instruction by the experimenter. Given the act-out nature of the test, all of the test items could be answered non-verbally, although verbal answers were possible (and indeed volunteered by the children) for some items. Given the long duration of the whole test (approximately 45 minutes per child), only parts 8, 9 and 11 of the test were conducted, consisting of 34 items in total. These parts were chosen as they best tested the child's understanding of syntax at the sentential level. Test items included understanding of passive constructions (e.g. the dog is bitten by the rabbit), prepositions (e.g. put a small pig next to the black pig), negation (e.g. which button is not in the cup?) and the diminutive form (e.g. show me the smallest button).

In order to test the child's understanding of sentential complementation, a special test was devised. It has been argued (Ruffman et al., 2003) that standard tests of sentential complementation rely on false belief understanding. In a typical sentential complementation task, children are told stories in which the protagonist is described as making a mistake, telling a lie or having a false belief. An example of such a story is the following (de Villiers & Pyers, 2002):

7) He thought he found his ring, but it was really a bottle cap. What did he think?

De Villiers and colleagues claim that false belief understanding is not necessary to answer the question correctly, as the child only has to repeat the thought verbatim. However, the problem with this test is that the story does not make much sense if you have no concept of false beliefs already in place. As Ruffman et al. (2003) point out, without false belief understanding the child has no basis for reconstructing what was said and hence may find it hard to remember a mistaken proposition. An incorrect answer to the question (i.e. "that he found a bottle cap") may be due to the false belief test failer resorting to answering the question in line with their current level of understanding and hence reasoning in terms of what they know to be true.

In an attempt to disentangle sentential complementation from false belief understanding, an alternative test was devised. The task involved the child listening to six stories accompanied by pictures together with a puppet, Ernie. The stories always involved two protagonists, Jan and Karin, talking about three objects. The two actors and the three objects were depicted in the accompanying picture. One of the characters would always say something about one of the objects; the other character would then say something about the remaining two objects. Once the story was over, Ernie the puppet would ask the child about one of the character's utterances. An example can be found in 8:

8) [child sees a picture of Jan and Karin in a living room sitting next to a teddy bear, a doll and a book]
It's Karin's birthday and Karin is showing Jan the presents she got. Jan says that Karin got a teddy bear for her birthday. Karin then says that she also got a doll and a book.
Ernie: That went a bit fast. They both said something, but what did JAN say Karin got?

Correctly responding "a teddy bear" instead of "a teddy bear, a doll and a book" or other possible answers shows true understanding of the sentential complementation construction: the question regarding the relevant sentence (Jan says that Karin got a teddy bear for her birthday) is properly interpreted as relating to the content of the embedded clause and not as a general question for clarification regarding the presents that Karin received for her birthday. Importantly, none of the utterances in the story are false. All three of the objects are Karin's birthday presents; the protagonists just choose to comment on a subset of them. The child thus does not have to take into account false beliefs or lies; she only has to remember what objects the protagonists talked about.

To make sure that the children could deal with the memory load imposed by the story, four control stories were added. These stories had the same memory load as the test stories but they did not contain sentential complementation constructions (see 9 for an example):

9) [child sees a picture of Jan and Karin standing next to a crab, a starfish and a shell]
Jan and Karin are at the beach. They're looking for things they can take home with them. Karin found a starfish. And Jan found a crab and a shell.
Ernie: Wait a minute. They both found something, but what did KARIN find?

2.5 Assessing Epistemic Modality

In order to test understanding of the two areas of epistemic modality assessed here, a test design very similar to the one used in many of the previous studies mentioned above was employed. In this design, children were told that they would play a game in which they could win stickers. Children were shown two boxes, a red one and a blue one, and told that the experimenter would hide a sticker in one of them. Children were then introduced to a rabbit puppet and a lion puppet and told that they would help them in finding the sticker. If the children wanted to win stickers, they were told, they would have to listen very closely to the advice that the two puppets would give. In their advice, the puppets used the different epistemic modal terms contrastively. The epistemic modal auxiliaries and adverbs were each presented in separate sessions. In the modal auxiliary task, *moet* 'must' and *kan* 'may' were used contrastively (see examples 10 and 11) and in the modal adverbs task, *zeker* 'definitely' and *misschien* 'maybe' were used contrastively (see 12 and 13). In order to be successful on this task, children thus had to choose the box denoted by the modal term that conveyed greater speaker certainty over the term that conveyed lesser speaker certainty. Although successful performance on this task may not be enough to claim that children have complete understanding of the linguistic encoding of speaker certainty, if they are able to consistently choose the stronger term over the weaker term, this does imply that they have at least some appreciation of the differences in speaker certainty as conveyed by these Dutch epistemic modal terms.

10)

De	sticker	moet	in	de	rode	doos	liggen
The	sticker	must	in	the	red	box	lie

The sticker must be in the red box

11)

De	sticker	kan	in	de	blauwe	doos	liggen
The	sticker	might	in	the	blue	box	lie

The sticker might be in the blue box

12)

De	sticker	ligt	zeker	in	de	rode	doos
The	sticker	lies	definitely	in	the	red	box

The sticker is definitely in the red box

13)

De	sticker	ligt	misschien	in	de	blauwe	doos
The	sticker	lies	maybe	in	the	blue	box

Maybe the sticker is in the blue box

In both the modal auxiliary and the modal adverb task, children received four trials. Children were not allowed to look inside the boxes; after the last trial they received a number of stickers irrespective of their performance on the task. Prior to the test trials, two practice trials were included in which one puppet stated simply where the sticker was (*de sticker ligt in de rode doos*, the sticker is in the red box) and the other puppet stated where the sticker was not (*de sticker ligt niet in de blauwe doos*, the sticker is not in the blue box). In the practice trials, both puppets thus demonstrated that they could help the child find the sticker by telling her in plain terms where the sticker was located (in the first practice trial, the rabbit puppet gave the affirmative statement; in the second trial, the lion gave the affirmative statement). Furthermore, care was taken that the intonation and voice used for the two puppets was the same across items and trials; there were thus no paralinguistic cues on which the subjects could base their choice. The child received a sticker for each of the practice trials and was promised more stickers if she played the game and paid attention.

2.6 Scoring

Theory of Mind

Each appearance-reality test yielded two points: one for the self-question and one for the other-question. Children were only awarded points for the test questions if they answered both control questions (the appearance question and the reality question) correctly. Each false belief location change task also yielded a maximum of two points: one point for the prediction question and one for the explanation question. For the explanation question, answers were scored as correct if they referred to the original location of the object or the character’s belief regarding the location of the object. Again, the child was only awarded the points if she correctly answered both of the control questions (the first location and the final location questions). Children could receive a maximum of three points for the unexpected contents task: one for the self-belief question, one for the other-belief question and one for the explanation question. Answers to the explanation question were scored correct if they referred to the box' misleading appearance or the character's mistaken belief regarding the contents of the box. Children only received the points if they answered the control question (the true contents question) correctly. Across all ToM tests, children could thus receive a maximum of 14 points, which, in comparison to other studies, is a relatively broad range. High scores on the ToM measure thus demonstrate children's capacity to predict and explain false beliefs across three types of tasks each presented in two different scenarios.

Note that in this scoring method, children do not receive a higher score for a correct explanation than for a correct prediction, although it could be argued that children who can explain false beliefs have developed ToM to a higher level than those who can only predict them (in the current scoring framework, a child who is capable of predicting and explaining a false belief on one of the tasks, but incapable of giving a correct answer on either of the questions in another task would receive the same amount of points as a child who gives correct predictions but incorrect or incomplete explanations on both tasks). The rationale behind this scoring method is two-fold: in the first place, by assigning a higher score to explanations over predictions, the linguistic aspects of the ToM task would receive greater prominence in the scoring (as the explanation question requires more of the child's linguistic abilities than the prediction question). As the contributions of language and ToM are considered separately, this would not be desirable. Secondly, if a child is capable of giving a correct prediction and explanation on one task, but incapable of doing so in a second version of this task, can we really say that this child has a higher level of ToM understanding than a child who can give correct predictions on both tasks, but not a correct explanation? It seems that both children are lacking full understanding of false beliefs and this is reflected in their similar scores (and, of course, children who consistently give correct predictions and explanations receive a higher score than children who consistently give correct predictions but incorrect explanations). Higher scores on the ToM measure thus reflect more complete false belief understanding than lower scores.

General Language

The PPVT vocabulary test is a standardised test of the child's receptive vocabulary and hence comes with a standardised scoring metric. The age of the child and the raw score as determined by the number of items the child got right are taken into account resulting in a quotient score. A score of 100 represents an exactly average receptive vocabulary for a child of that age (in years and months). The Reynell test is also a standardised test of the child's receptive language skills, but as only parts of the whole task were presented to the child, the standardised scoring metric could not be used. Instead, the total number of correct items out of the three parts of the test was taken as the child's score (34 being the maximum possible score). For the sentential complementation task, the child's score was the number of test items, out of six, that she got right. The points were only awarded if the child answered at least three out of the four control questions correctly.

Epistemic Modality

Both the modal auxiliary and the modal adverb tasks consisted of four trials. For the modal auxiliary task, the child received a point each time she preferred *moet* 'must' over *kan* 'might', allowing a total of four points for this task. Four points in total could also be gained for the modal adverb task if the children preferred the modal adverb *zeker* 'definitely' over *misschien* 'maybe'.

3. Results

3.1 Descriptive Statistics

Table 1 shows the means, standard deviations and ranges of the various tasks and the participants' ages.

Table 1 Means, standard deviations and ranges of age and all tests in the test battery

Measure	Subtest	Mean	SD	Range
Age in months (years;months)	N/A	54 (4;6)	3.23	48-59 (4;0-4;11)
ToM	Appearance-reality	1.52	1.46	0-4
	False belief location change	2.32	1.61	0-4
	False belief unexpected contents	2.39	2.17	0-6
	ToM sum score	6.23	4.29	0-14
General language	PPVT – standardised	102.07	15.65	57-143
	PPVT – raw score	65.63	13.51	26-98
	Reynell	21.34	6.58	3-32
	Sentential complementation	1.95	2.32	0-6
Epistemic modality	Modal adverbs	2.79	1.06	0-4
	Modal auxiliaries	2.45	1.06	0-4
	Epistemic modality sum score	5.25	1.66	1-8

Note. Maximum scores: appearance-reality and false belief location change = 4; false belief unexpected contents = 6; ToM sum = 14; no PPVT maximum; Reynell = 34; sentential complementation = 6; modal adverbs and modal auxiliaries = 4; epistemic modality sum = 8

In order to create a total ToM score, the scores for the individual ToM tasks were summed. Scores for the modal adverbs and the modal auxiliaries were also summed to create one epistemic modality score. For the vocabulary measure both the raw scores and the standardised scores are reported in table 1. The standardised scores demonstrate that the subjects' mean score was slightly above average (average is a score of 100). In order to consider the effect of age only once in the analyses, the raw scores are used instead of the standard scores in further analyses (age is already taken into account in determining the standardised score and as age is considered as a separate variable in the following analyses, age would thus be doubly represented in the vocabulary score if the standardised score is used instead of the raw score). To determine a general language score, a simple sum score could not be taken, as the different sub-tests in this domain each had very different test designs and different ranges. As the range of scores for the PPVT task was vastly greater than for the Reynell and the sentential complementation task (see Table 1), summing the scores of the three tasks would result in an inflation of the importance of the PPVT task. In order to assign equal weight to the three tests, a one-factor solution was computed using principal component analyses. The three subcomponents loaded well onto the one-factor solution with loadings of .71 or higher.

3.2 Performance on Control Items

The scoring guidelines proved to be a rather strict measure of ToM capacity, as a considerable number of children answered at least one of the test questions correctly, but failed on at least one of the control questions. To be precise, for the appearance-reality task, 50 children answered at least one of the test questions correctly while failing at least one of the control questions. This number was 25 for the false belief unexpected contents task and 4 for the false belief location change task. These children were all scored as failing the test question. Given the relatively large number of children failing the control questions, it seems that the controls for the appearance-reality task and the false belief unexpected contents task proved to be quite hard. The control question for the false belief location change task, on the other hand, was problematic only for a very small number of children.

This result may seem somewhat strange as all three tasks are supposed to tap the same underlying construct (understanding of false beliefs). However, in order to make sure that the children really understood the false beliefs instead of just correctly guessing between the two available answer options, stricter controls had to be used for the appearance-reality and unexpected contents task than for the location change task. To make sure that children understood the location change task, it was enough to probe their memory of key events in the story (were was the ball first and finally), but this was not possible for the other two tasks. To demonstrate understanding of the nature of the false belief in these tasks unequivocally, children had to show that they understood that the object under inspection could seem to be or to contain one thing whilst actually being or containing something else. If the child does not have this understanding of the dual nature of the object, then their (correct) answers to the false belief questions are not very insightful. After all, if the child conceptualises the test object only as being a cake (in the case of the cake/candle) or as containing pencils (in the case of the pencil box), then their answers to the false belief questions would be correct, but not based on proper understanding of false beliefs.

The scoring guidelines also proved to be a strict measure of sentential complementation understanding. In this task, children had to answer at least 3 out of the 4 control questions correctly in order to be awarded any points on the test questions. 50 children answered at least one test question correctly, but failed on at least 2 out of the 4 control questions. This finding for the control questions demonstrates that, aside from assessing sentential complements, the task also demanded something of the children's working memory capacity. However, as was the case for the ToM measures, without these strict controls, seemingly correct answers on the sentential complementation test trials would not necessarily be meaningful. The test set-up dictated that only the first mentioned object (out of the three objects) was correct. If children used a strategy in which they simply always gave the first mentioned object as an answer, they would thus consistently give correct answers even though they did not necessarily understand the nature of the sentential complementation construction. Adding the requirement that children had to answer at least three of the four control questions correctly made sure that children who were using this kind of strategy to answer the questions would not receive points for sentential complementation understanding. Of course, this means that for both the ToM and the sentential complementation tasks some children will not have received any points even though they may in reality have some understanding of false beliefs or sentential complementation constructions. Nonetheless, this strict scoring criterion does ensure that those children who receive points on these measures definitely do understand sentential complements and false beliefs. If better understanding of sentential complementation or false beliefs thus does relate to better understanding of epistemic modality, this should become apparent even with this strict scoring policy.

3.3 Epistemic Modality Performance

In order to address the question whether four-year-old Dutch children would be able to differentiate between the various epistemic modal terms tested here, first the performance on the modal auxiliaries and adverbs was analysed independently of the contributions of general language and ToM. The maximum score for the epistemic modals test was 8. As children had to choose between two boxes, a score of 4 was expected if they were responding on the basis of chance. Although the children's performance was not at ceiling yet (their mean score was 5,25), a one-sample t-test demonstrated that their performance was significantly better than would be predicted by chance (t_{109}=7.87; p<.000). The children's performance on the epistemic modals task can be further analysed by considering the modal adverbs and auxiliaries separately. For the two tasks, the maximum score was 4; a score of 2 per task is thus expected if children are responding on the basis of chance. One-sample t-tests demonstrated that children were performing significantly above chance for both areas of epistemic modality (t_{109}=4.48; p<.000 for the modal auxiliaries and t_{109}=7.84; p<.000 for the modal adverbs). Although the children's performance was thus not at ceiling (mean scores of 2.45 for the modal auxiliaries and 2.79 for the modal adverbs), their above-chance performance indicates at least some understanding of the differences in speaker certainty conveyed by these terms.

At least some understanding of the differences in speaker certainty as conveyed by epistemic modal terms is thus present in this group of Dutch four-year-olds. But to what extent is this understanding related to their ToM and general verbal ability? Table 2 demonstrates that, as expected, ToM and general language are highly and significantly positively correlated. Epistemic modality is significantly correlated with both ToM and general language, but the effect is slightly larger for ToM than for general language. Although both ToM and general language are significantly correlated with age, understanding of epistemic modality is not (it should be noted, however, that all the children in the sample were four years old, so the sample was relatively homogeneous in that sense).

Table 2 Correlations between age, ToM, general language and epistemic modality

	Age	ToM	General language
ToM	.36*		
General language	.43*	.71*	
Epistemic modality	.17	.42*	.37*

Note. *p<.000, two-tailed

In order to assess the relative contributions of ToM and general language to epistemic modality, hierarchical regression analyses were conducted with epistemic modality as the dependent variable and ToM and general language as predictors. Although all the children that were tested were the same age (four years old), it is possible that there would be performance differences between younger and older four-year-olds. In order to control for this possible effect, age was thus also added as a predictor variable. The results of these analyses can be found in Table 3. It should be noted that as the data are correlational in nature, it would not be very informative to consider only the relationship between ToM and general language in a regression analysis, as the results would be the same if ToM is taken as the independent variable and general language as the dependent variable as when ToM would be taken as the dependent variable and general language as the independent variable. If, however, ToM and general language are taken as predictors of epistemic modality (which is the research question at the heart of this study), it can be determined what percentage of the variance in epistemic modality performance is explained by general language and ToM.

As can be seen in Table 3, model 1 describes only 3% of the variance in epistemic modality (R^2_{adj} = 1,9%; $F_{1,108}$ = 3.13; p=.08). Considered in a group of four-year-olds, age thus does not significantly predict performance on the epistemic modality tasks (t_{108} = 1.77; p = .08). In contrast to the non-significant result for age as a predictor variable, model 2 shows that the addition of general language to the model significantly enhances the percentage of explained variance by 11%. This model describes 13,9% of the variance (R^2_{adj} = 12,3%)

Table 3 Hierarchical regression analyses for age, ToM and general language predicting epistemic modality

	B	SE B	β	R²	ΔR²
Model 1					
Age	0.09	0.05	.17	.03	.03
Model 2					
Age	0.01	0.05	.01	.14	.11**
General language	0.61	0.17	.37**		
Model 3					
Age	-0.01	0.05	-.01	.19	.05*
General language	0.27	0.21	.16		
ToM	0.12	0.05	.30*		

Note. *p≤.05; **p ≤.001

with an overall significant relationship ($F_{2,107}$ = 8.61; p<.000). Furthermore, general language proved to be a significant predictor of epistemic modality (t_{107} = 3.71; p<.000). However, the final model in the regression analysis, model 3, describes 18,5% of the variance in epistemic modality (R^2_{adj} = 16,2%) with an overall significant relationship ($F_{3,106}$ = 8.02; p<.000). The addition of ToM to model 2 enhances the percentage of explained variance by a significant 5%. Model 3 also demonstrates that not only is ToM a significant predictor of epistemic modality (t_{106} = 2.45; p=.02), but that once ToM is added to the model, general language is no longer a significant predictor (t_{106} = 1.27; p=.21). Thus, controlling for age and general language, only ToM significantly predicts epistemic modality.

General language, a combination of vocabulary, syntax and sentential complementation measures, thus does not seem to predict the child's performance on the epistemic modality tasks once ToM is taken into account. Perhaps though, the individual subcomponents in the general language measure do predict epistemic modal understanding. After all, as stated in the introduction, various claims have been made regarding the role of separate areas of language in the development of ToM. Maybe then, one or more of the subcomponents does play a significant role in the understanding of epistemic modality.

Table 4 demonstrates the correlations between the individual language measures, ToM and epistemic modality (as age did not turn out to be a significant predictor of epistemic modality in the previous analysis, it is not considered in this analysis). Again, all correlations are positive, significant and represent a medium to large effect. Out of the three language measures, the Reynell test is the most highly correlated with epistemic modality. However, the highest correlation is again between ToM and epistemic modality.

Table 4 Correlations between ToM, PPVT, Reynell, sentential complementation and epistemic modality

	ToM	PPVT	Reynell	Sentential complementation
PPVT	.59**			
Reynell	.67**	.65**		
Sentential complementation	.44**	.42**	.41**	
Epistemic modality	.42**	.32**	.39**	.21*

Note. * p<.05; **p<.01, two-tailed

In order to investigate the effect of the individual language measures on epistemic modality more closely, another hierarchical regression analysis was conducted. This time the three language subcomponents, vocabulary, general syntax and sentential complementation, were used as separate predictors with ToM as the fourth predictor variable and epistemic modal understanding as the dependent variable. The results of this analysis can be found in Table 5.

Table 5 Hierarchical regression analyses for PPVT, Reynell, sentential complementation and ToM predicting epistemic modality understanding

	B	SE B	β	R²	ΔR²
Model 1					
PPVT	0.01	0.01	.10	.16	.16***
Reynell	0.08	0.03	.31**		
Sentential complementation	0.03	0.07	.04		
Model 2					
PPVT	0.00	0.01	.04	.20	.03*
Reynell	0.05	0.03	.19		
Sentential complementation	0.00	0.07	.00		
ToM	.10	0.05	.27*		

Note. *p≤.05; ** p≤.01; ***p≤.001

Model 1 in Table 5 demonstrates that the initial model is significant ($F_{3,106}$ = 6.85; p<.000) and describes 16,2% of the variance in epistemic modal understanding (R^2_{adj} = 13,9%). If the individual language components are considered without the influence of ToM taken into account, only the child's understanding of general syntax (as assessed by the Reynell test) predicts epistemic modal understanding. Out of the three subcomponents of the language measure then, it seems that only general syntax predicts understanding of epistemic modals. This picture changes, however, once ToM is added to the model. Model 2 describes 19,6% of the variance in epistemic modality (R^2_{adj} = 16,6%) with an overall significant relationship ($F_{4,105}$ = 6.41; p<.000). More importantly, model 2 also shows that once ToM is added to the model, none of the individual language subcomponents are significant predictors of epistemic modal understanding anymore. Only the child's ToM capacity is a significant positive predictor of epistemic modality (t_{107} = 2.36; p = .02). The other predictors in the model, PPVT, Reynell and sentential complementation, do not significantly predict epistemic modality understanding (t_{105} = 0.32, p = .75 for PPVT; t_{105} = 1.45, p = .15 for Reynell and t_{105} = -0.00, p = 1.00 for sentential complementation). Thus, controlling for each of the individual language measures, only ToM significantly predicts epistemic modality. Furthermore, adding ToM as a predictor variable to the initial model containing the individual language measures enhances the percentage of explained variance of the model significantly by 3%.

4. Discussion

This study investigated the relationship between ToM, general language and epistemic modality in four-year-old Dutch-speaking children. The primary aim of this research was to add to the lively debate in the literature regarding the contributions of ToM to language development and language to ToM development. Instead of trying to relate general aspects of ToM to general aspects of language, this study looked at the issue from a different angle, considering the relative contributions of false belief understanding and general verbal ability (a combination of vocabulary and syntax measures) to the child's performance on a task assessing epistemic modal understanding. Epistemic modality was deemed an interesting area to investigate, as it is a cognitive domain on the interface of ToM and language. It is linguistic in that the modal terms have to be acquired as lexical items, but epistemic modality also relates to ToM in that it requires an appreciation of the nature of others' belief states to fully appreciate the intended meaning. Although various different aspects of epistemic modality could be considered, this research focussed on the child's capacities to understand the Dutch modal auxiliaries *moeten* 'must' and *kunnen* 'might' and the modal adverbs *zeker* 'definitely' and *misschien* 'maybe'.

A secondary aim of this study was to consider the development of epistemic modality in a language other than English. As the age at which children first demonstrate understanding of modal terms is quite different depending on which study and which language is consulted (anywhere between four to six years old for English and not before six years old for Italian), adding data from another language can help in determining to what extent various languages differ in this respect. Although the four-year-olds in this study had not completely mastered the differences between the modal auxiliaries and adverbs considered here, they did at least show above chance performance for both areas of epistemic modality. In contrast with Italian, but in line with the studies on English, Dutch children thus at least have some understanding of the modal system at four years old. Future research on older age groups can demonstrate at which age Dutch children fully master the modal system; research on younger children can demonstrate whether Dutch children younger than four are also capable of discriminating between the modal terms used here.

Regarding the primary aim of this study, the relationship between ToM, general language and the development of epistemic modality, this study found the child's false belief understanding to be the best predictor of epistemic modality. Evidently then, children's understanding of false beliefs is a better predictor of their understanding of these linguistic expressions of speaker certainty than their general verbal ability. This result is thus in line with prior research suggesting interesting links between ToM development and the development of language relating to the understanding of others' minds (cf. Moore et al., 1990; Papafragou & Li, 2001; Slade & Ruffman, 2005; Ziatas et al., 1998) This effect was found in a language population not previously considered in this type of research: Dutch-speaking four-year-olds.

Furthermore, the effect was found even when various different aspects of the child's general language were controlled for. Somewhat surprisingly, none of the individual language measures, nor the language total score significantly predicted epistemic modality performance once ToM was added to the model. Even without ToM in the model only one of the individual language measures, the general syntax test, significantly predicted performance on the epistemic modality task. General vocabulary and sentential complementation understanding did not predict epistemic modal development. If any aspect of language is relevant for epistemic modality development, then, it seems that general syntax is the most important. The epistemic modal system is a relatively complex part of language to learn (as evidenced by the finding that, for English at least, children do not master these constructions fully until they are at least six years old) and presumably is only acquired once more basic aspects of syntax are in place. Understanding of sentential complementation constructions apparently does not fall into this category though, as understanding of sentential complements did not explain variance in the understanding of epistemic modals. Whereas a general level of syntax may thus be necessary in order to build up understanding of the epistemic modal system, understanding of sentential complements seems to be a separate achievement. The finding that general vocabulary also does not predict epistemic modal understanding demonstrates that the acquisition of epistemic modals does not rely only on children's general vocabulary learning skills; a basic level of syntax and an understanding of the nature of beliefs are also necessary.

These findings thus suggest that it is not so much a child's linguistic ability that contributes to the acquisition of epistemic modal auxiliaries, but her ability to understand another person's mental states. Given how the addition of ToM to the model eclipses the role of language in predicting the variance in epistemic modal understanding, these results can be seen as posing a challenge to linguistic determinism accounts of ToM development. The main claim made by these accounts is that the development of ToM is dependent on (particular aspects of) language. However, if this is indeed the way that cognitive development in these domains works, then surely one would also claim that language that involves an understanding of others' mental states, i.e. epistemic modal terms, should also rely on either general linguistic development or the particular aspects of language (e.g. sentential complementation) that are supposed to be the catalyst of ToM development. After all, if language bootstraps ToM development, then surely language also bootstraps ToM-related language. The results of this study go against this idea, however, as this study shows that ToM is a better predictor of epistemic modal terms than general language as a total score or any of the individual subcomponents. Neither general vocabulary nor understanding of sentential complementation constructions was of any significance in explaining variance in epistemic modal understanding. Only general syntax was shown to play a role in epistemic modal understanding, and even that disappeared once the child's ToM capacity was taken into account in the model. As this study demonstrates that the child's understanding of the differences in speaker certainty as encoded by epistemic modal terms can be predicted better by her understanding of others' mental states than by various aspects of her verbal ability, the findings here thus run counter to the idea that the child's understanding of mental states is dependent on linguistic development.

It should be noted, however, that given that the data is correlational in nature, the findings presented here cannot falsify the linguistic determinism view of cognition, as the causal direction between ToM, general language and epistemic modality cannot be determined on the basis of this evidence. It is possible that the development of epistemic modality drives the development of false belief understanding, instead of false belief understanding bootstrapping the development of epistemic modality. Longitudinal data, which is in the process of being collected, or data from intervention studies is necessary in order to make a more forceful claim regarding the direction of causality between ToM, general language and epistemic modality. This cautionary note notwithstanding, there does seem to be a connection between ToM and epistemic modality that was not found between epistemic modality and general language (as ToM is, but general language is not, a significant predictor of epistemic modality). ToM and epistemic modality thus share underlying connections that are not present between epistemic modality and general language. Whereas general language thus does not seem to play much of a role in the understanding of epistemic modal terms, the role of ToM in the understanding of epistemic modals merits further investigation.

Chapter 3

Modal auxiliaries in typically developing and autistic children: A theory of mind account*

Abstract

This study considers the role of Theory of Mind in the acquisition of epistemic modal auxiliaries (EMA) in both typically developing (TD) and autistic children. A ToM deficit (commonly found in autistic children) was hypothesised to lead to problems in EMA understanding. Results showed no significant difference in EMA understanding between the TD and the autistic children. However, once participants were divided into a group of ToM passers and ToM failers, results showed that ToM passers performed significantly better than ToM failers on EMA understanding. These findings suggest that ToM is crucial in understanding epistemic modal auxiliaries.

Key words

Epistemic modal auxiliaries; Autism; Theory of Mind; Language acquisition

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* A slightly modified version of this paper has been submitted in co-authorship with Annette Watzema

1. Introduction

For most typically developing children the task of learning words in their native language does not seem to be particularly challenging, even though, on the face of it, the magnitude of the task is daunting. If we assume that an average English-speaking adult knows around 60.000 words and that children start to learn words around their first birthday, this means that the child has to learn an average of around 10 new words a day every day until they reach adulthood. This is no small feat, but it is accomplished by all typically developing children, even if their social environments are not conducive to word learning (cf. Bloom, 2000, 2002).

Exactly how children are capable of this stunning accomplishment is not entirely clear, but many researchers agree that children's understanding of other people's intentions is a fundamental part of the word learning process (Baldwin, 1993; Baldwin & Moses, 2001; de Villiers, 2007; Happé & Loth, 2002). Children are capable of appreciating the significance of a speaker's gaze direction, pointing behaviours and intention to refer to a particular object or action and linking them to the particular sounds the speaker produces. Various studies demonstrate just how sensitive young children are to speakers' intentions in acquiring new words for things. Tomasello and Barton (1994), for example, considered novel word learning in two-year-old children and found that they did not apply a simple 'map a novel word onto the first novel object you see' strategy, but that they relied on social-pragmatic cues to map the novel word onto the intended novel object. This finding was replicated with even younger children, 18-month-olds, in Tomasello, Strosberg & Akhtar (1996).

Understanding of a speaker's intentions is thus a major asset for typically developing children in the word learning process: without the natural tendency to take into account the speaker's gaze direction, her pointing behaviours and intentions, the child would have a hard time in acquiring her first words. Of course, children's understanding of other people's intentions and mental states develops considerably after they have learnt their first few words. A defining moment in the child's cognitive development is the acquisition of a 'Theory of Mind' (ToM). A child is generally said to have a ToM, when she is capable of appreciating so-called 'false beliefs' as assessed by standard ToM tasks (Perner, Leekam & Wimmer, 1987; Wimmer & Perner, 1983). In these tasks, the child is told a story in which a protagonist puts an object in a particular location and then leaves the scene. Another character then removes the object from its original location and places it somewhere else. The protagonist then returns to the scene and the child is asked where the protagonist will look for the object. This question forces the child to predict the behaviour of a story character given the latter's false belief about the location of the object. If a child can ignore her own knowledge about the world and focus on the other person's belief, even if that belief is incorrect given the current state of the world, she is showing an advanced understanding of what goes on in other people's minds and is said to have a ToM.

This paper considers how the development of this more advanced understanding of others' mental states, the development of ToM, relates to a particular aspect of the word learning process: the acquisition of those words that rely on an understanding of the speaker's mental state for their interpretation. As the studies cited above demonstrate, a basic understanding of a speaker's intention is fundamental in learning even the simplest words, but what about words that actually refer to the speaker's mental state? Mental state verbs like *know* and *guess*, modal adverbs like *possibly* and *maybe*, modal auxiliaries like *must* and *might* and evidentials like *allegedly* and *apparently* all would seem to depend on a relatively advanced appreciation of mental states in order to fully comprehend their meaning. How does the development of ToM relate to the acquisition of these 'mental' areas of language? Is there a relationship between these two domains? And, if so, what is the nature of this relationship? Does understanding other people's mental states provide the basis for the development of mental language? Or does the acquisition of mental language force the child to think more deeply about the nature of mental states? In other words: does mental language drive ToM development or vice versa?

1.1 Theory of Mind and (Mental) Language: Related Development?

The relationship between ToM and language in a general sense has been the topic of much debate in the last few decades. A common finding in the literature is that performance on ToM tasks and tests of general language ability is highly correlated (Jenkins & Astington, 1996; Ruffman, Slade, Rowlandson, Rumsey & Garnham, 2003), but whether there is a causal link between the two domains and, if so, what the direction of that link is, is less clear (Astington & Baird, 2005; Milligan, Astington & Dack, 2007). Is ToM pivotal in the development of language? Or is linguistic development a prerequisite for the development of ToM? Some researchers claim that language is fundamental in ToM development, stating that only once the child's language abilities are sufficient, is she able to represent other people's mental states properly (cf. Astington & Jenkins, 1999). On this linguistic determinism view, language provides the scaffolding that allows the child to make sense of the different layers of representation that are necessary for understanding others' beliefs as distinct from one's own. Exactly which aspects of language would provide the basis for the development of mental state understanding is the subject of considerable debate. Both semantic and syntactic aspects of language are possible candidates: semantics provides the child with labels for unobservable entities like mental states, but syntax provides the child with a format for representing ideas that differ from reality. Potentially though, these points of view are not mutually exclusive; syntax and semantics may work in tandem to scaffold ToM development.

In contrast to the linguistic determinism view, other researchers have provided evidence for the alternative direction of influence: that ToM development drives the acquisition of language. On this view, only once the child has the conceptual understanding required to appreciate what it means to think or know something or to be more or less certain about something, will she be capable of acquiring the words and syntactic formats related to these concepts. In their longitudinal study, Slade & Ruffman (2005), for example, provide evidence for this view, showing that whereas earlier linguistic development can be shown to predict later ToM development, the reverse relationship also holds. Similarly, Milligan et al. (2007) also find evidence for a bi-directional relationship in their meta-analysis of the relation between language ability and ToM.

Given this diversity of points of view and experimental findings, it is thus not clear how exactly the development of the two cognitive domains, language and ToM, are related. In order to clarify this issue, it may be more enlightening to consider the relationship of ToM to more circumscribed areas of language. A particularly interesting issue in this respect is how ToM development relates to those areas of language that rely on an understanding of the speaker's mental state for their interpretation: mental language. The acquisition of mental language is part of the language acquisition process in that it involves the acquisition of words (*know*, *must*, *probably* etc.) and the particular syntactic frames in which these words occur, like the sentential complementation structure necessary for belief verbs: "I think the keys are in the drawer" (cf. de Villiers & Pyers, 2002). The acquisition of mental language also relates to ToM, however, in that it requires an appreciation of others' mental states to fully understand the intended meaning. Mental language is thus at the interface of ToM and language and hence is an interesting domain to look at in order to gain insight into the relationship between ToM and language at a more general level.

A number of studies have indeed taken this tack and looked more specifically at the relationship between the development of ToM and the acquisition of mental areas of language. Moore, Pure & Furrow (1990), for example, looked at three- to six year-olds' understanding of the modal auxiliaries *must*, *might* and *could* and the modal adverbs *probably*, *possibly* and *maybe* in relation to their ability to pass ToM tasks. In order to assess the children's understanding of modal auxiliaries and adverbs, they presented the child with two containers, one red and one blue. In one of the containers, the experimenter had hidden a piece of candy; the child's task was to determine in which of the two containers it had been put. Two puppets aided the child in this task by providing contrastive statements using modal auxiliaries or adverbs that differed in the level of speaker certainty they conveyed. One puppet would thus say, for instance, 'it must be in the red box' and the other puppet would say 'it might be in the blue box'. In this case, then, the child should pick the red box, as the modal auxiliary *must* conveys greater speaker certainty than the modal auxiliary *might*. In order to test the children's ToM, they were presented with various different types of tasks assessing the children's understanding of false beliefs. The results of this study demonstrated that the children's performance on the modal terms tasks was strongly related to their performance on the ToM tasks. This finding suggests that there is not just a link between ToM development and the acquisition of language in a general sense, but that a specific part of ToM development, the understanding of false beliefs, can be linked to a specific area of language, namely those areas of language that relate to the understanding of mental states.

Similar findings have been reported for areas of mental language other than the modal auxiliaries and adverbs considered in the Moore et al. (1990) study. Papafragou (2001a), Papafragou & Li (2001) and Ifantidou (2005), for instance all argue that children's acquisition of evidential markers (the linguistic encoding of information source, like the hearsay marker *allegedly* in English) is constrained by the development of ToM, in particular their understanding of the source of beliefs and speaker certainty. Moore, Bryant & Furrow (1989) make a similar claim regarding the understanding of the mental state verbs *know*, *think* and *guess*. Although this study does not explicitly test the children's performance on standard ToM tasks, the authors note that the timing of coming to understand the difference between the mental state terms used here and children's passing of standard false belief tasks is very similar and hence points to an interesting relationship between the development of the two domains.

1.2 Mental Language when ToM is Impaired: The Case of Autism

The initial work by Moore et al. (1989) described above was extended in a particularly interesting way in Ziatas, Durkin & Pratt (1998). Employing a design very similar to Moore et al. (1989) and (1990), Ziatas et al. (1998) considered the development of the mental state verbs *know*, *think* and *guess*. Their subjects' task was two-fold. Initially, the child was required to find a hidden piece of candy by preferring a puppet's statement with the mental state verb *know* ('I know it's in the red box') over a statement containing *think* or *guess* ('I think/guess it's in the blue box') and by preferring a statement with *think* over a statement with *guess*. After this mental state verb comprehension task, the children went on to perform a mental state verb production task. In this task, the child was required to play the roles of the puppets herself, using the mental state verbs contrastively and thereby allowing the experimenter to be able to find a piece of candy for her. Aside from these two tasks, subjects were also given ToM tasks. As expected, Ziatas et al. (1998) found a strong relationship between the children's ToM capacity and their performance on the mental state verb tasks. The novel aspect of this study, however, was the fact that it included various clinical groups as well as typically developing children. Of particular interest in this case is the group of autistic children that was included.

Autism is a developmental disorder that is characterised primarily by social and communicative impairments as well as repetitive and stereotyped patterns of behaviour and interests (cf. Kazak, Collis & Lewis, 1997; Lord, Cook, Leventhal & Amaral, 2000). It is generally assumed that many autistic children are specifically impaired in their ability to appreciate the mental states of others (cf. Baron-Cohen, Leslie & Frith, 1985; Frith, 2003; Leslie & Thaiss, 1992; Yirmiya, Erel, Shaked & Solomonica-Levi, 1998). They typically fail to take into account the speaker's focus of attention when she utters a novel word, leading to problems in lexical acquisition (Baron-Cohen, Baldwin & Crowson, 1997) and, when they are older, they also tend to fail standard ToM tasks. Given this particular deficit, it is thus an interesting question to consider how this group fares in their understanding of mental language. A clear finding of the Ziatas et al. (1998) study was that the autistic group performed significantly worse on the tasks assessing mental verb understanding and production than the typically developing children. It thus seems likely that an appreciation of the differences in speaker certainty conveyed by the mental state verbs used in the study requires the child to be able to infer the 'mind behind the speech'. If that understanding is impaired, areas of language relating to that understanding are similarly impaired. This finding is consistent with the results reported by Tager-Flusberg (1992) demonstrating that autistic children use significantly less cognitive mental state language in comparison to language-matched children with Down syndrome and with Kazak et al.'s (1997) finding that autistic children were impaired in their ability to understand the mental state terms *know* and *guess*.

In contrast to these studies testing autistic individuals' mental language skills, De Roeck & Nuyts (1994, cited in Papafragou, 2002) found that four high-functioning Dutch-speaking autistic adults displayed typical use of three markers of epistemic modality in their spontaneous speech. The particular markers the researchers looked at in their corpus of spontaneous speech produced by these individuals were the adjective/adverb *waarschijnlijk* meaning probable or probably, the mental state verb *denken* (think) and the modal auxiliary *kunnen* (can/may). This finding thus suggests that at least for certain autistic adults, it may not be impossible to acquire some level of understanding of mental language. However, as performance on standard ToM tasks is not reported for these four autistic adults, it is not entirely clear to what extent they really lack the capacity to understand false beliefs (cf. Papafragou, 2002). It has been noted in the literature that high-functioning autistic individuals can learn to pass standard tests of false belief understanding at some point in development, although they are rarely capable of doing so when they are four or five years old, the age at which most typically developing children would be able to pass this kind of task (cf. Frith & Happé, 1994; Happé, 1993). Given the fact that the individuals tested in this study were adults and high-functioning autistic adults at that, it is possible that the participants in the De Roeck & Nuyts study fall into this category of autistic individuals.

1.3 ToM and the Acquisition of Epistemic Modal Auxiliaries

The aim of the current study is to extend the previous findings regarding the development of mental language in general and in autistic individuals in particular and thereby to shed further light on the nature of the relationship between ToM and language. In order to accomplish this aim, autistic and typically developing children were presented with various tasks assessing not only their ToM and general language skills, but also their understanding of a particular domain of mental language: epistemic modal auxiliaries (EMA).

Epistemic modal auxiliaries such as the italicised words in examples 1 and 2 relate to how strongly the speaker is committed to the truth of a proposition. In other words: what degree of belief the speaker has in her utterance (cf. Papafragou, 1998).

1) The keys *must* be in the drawer

2) It *may* be raining

In 1, use of the modal auxiliary *must* indicates that the speaker is very certain of the location of the keys and hence strongly believes they are in the drawer; use of *may*, on the other hand, indicates a considerably less strong belief in the truth of the statement.

Various studies have looked at the acquisition of modal auxiliaries in young children. Bliss (1988) reports that modal auxiliaries first occur in children's natural discourse when they are about 2 years old. It is, however, unlikely that these first occurrences really demonstrate understanding of the strength of speaker belief that is implied by the use of these terms. Generally, children used the modal terms to imply ability ('I *can* see you') or intention (I'*ll* show how to do it'). In Bliss' sample of two- to five-year-old children, epistemic uses of modal auxiliaries were used only very rarely in spontaneous speech. Hirst & Weil (1982) provided early experimental evidence regarding the acquisition of EMA. Three- to six-year-old children were told to find a hidden peanut by listening to the advice of two puppets that used the modal terms *must*, *may* and *should* contrastively ('the peanut must be under the cup' vs. 'the peanut may be under the box'). Hirst & Weil found that only the oldest children (starting at 5;6) could make strength distinctions between the modals, a result that was replicated in a more recent study by Noveck, Ho & Sera (1996). Byrnes & Duff (1989) found a different result, however, in their study of modal auxiliaries. They considered children's ability to differentiate the strength conveyed by *has to be* vs. *might be* (It has to be under the red cup vs. It might be under the blue cup) and the difference between the negated terms *can't be* vs. *might not be*. Results of this study showed that children improved significantly between the ages of three and four, with ceiling performance at five years old. Moore et al. (1990), described above, represents a midway between these two findings in their study of English modal auxiliary understanding. This study found significant improvement between the ages of three and four as well, but even the oldest group in their study (consisting of six-year-olds) did not demonstrate ceiling performance yet.

It is thus not entirely clear at what age English-speaking children start to be able to distinguish the differences in speaker certainty as conveyed by epistemic modal auxiliaries. From the available data, it seems that somewhere between four and six years old children can appreciate differences in relative force. To what extent this result can be generalised to languages other than English is not clear, however. At least one study on a language other than English, Bascelli & Barbieri's (2002) study on the Italian modal auxiliaries *dovere* (must) and *potere* (may), finds considerably later understanding of the differences between the modals. Only at six years old do the Italian children tested in this study start to acquire the contrasts between these auxiliaries, with the full system not being acquired until they are eight years old.

Many questions thus remain regarding the acquisition of mental language in general and epistemic modal auxiliaries in particular. When do children understand the differences in speaker certainty conveyed by these terms? To what extent does this depend on the particular language the child is acquiring? And what is the role of the child's general language ability and ToM capacity in the development of this domain of mental language? By considering the acquisition of EMA in Dutch autistic and typically developing children and comparing it to their general language and ToM abilities, this study aims to address these questions and thus extend previous studies in various ways. The age of the autistic subjects (6;11 in comparison to Ziatas et al.'s 8;3 and De Roeck & Nuyts' adults), the domain of mental language they were tested on (EMA) and the language of testing (Dutch) are all novel elements in the study of ToM and mental language development which should add to the existing body of knowledge and help in illuminating the outstanding questions mentioned above.

In line with previous work suggesting that ToM plays an important role in the development of language in general and mental language in particular, the assumption underlying this study is that impairment in ToM, as demonstrated in many autistic individuals, will coincide with impairment in the understanding of EMA. Only if the child is capable of understanding the mental state concepts underlying EMA, will she be able to acquire a mature understanding of them. Only children who pass ToM tasks are thus predicted to understand EMA. In contrast to what linguistic determinism views would predict, this study hypothesises that children will generally not demonstrate understanding of EMA whilst failing ToM tasks. Furthermore, it is hypothesised that general language ability will not significantly affect the understanding of EMA once ToM abilities are taken into account. The fundamental driving force behind the acquisition of mental language is taken to be ToM and not general language abilities.

2. Method[1]

2.1 Participants

Nineteen Dutch-speaking typically developing (TD) children (11 girls and 8 boys) between ages 6;0 and 7;0 (*M*=6;5 years) and ten Dutch-speaking autistic children (2 girls and 8 boys) between ages 5;1 and 8;4 (*M*=6;11 years) participated in this study. All the children in the autistic group had been clinically diagnosed with a disorder in the autistic spectrum (as assessed by medical specialists in the Netherlands using DSM-IV criteria) and were attending either special schools or special programmes within regular schools catered to autistic children. The autistic sample was recruited from four different schools in various places in The Netherlands (Schagen, Den Helder and Heerhugowaard); the control children all came from one regular primary school in Rotterdam in The Netherlands. The teachers of the control group children reported that none of them had any identified disorders or impairments, nor was there any suspicion of possible disorders.

2.2 Procedure

Children were tested individually in a separate room in the school building. For the control children, two adults were present throughout the session: the first author (acting as experimenter) and an assistant. The data from the control children was a subset of a larger dataset in an unpublished study looking at the relationship between ToM and language development. These children received three different testing sessions, each lasting approximately half an hour. Total testing time for the control group children was thus 1.5 hours, of which approximately 30 minutes relates to the data presented in this paper. The autistic children received only one session of approximately 30 minutes in which the data reported on here was gathered. For practical reasons, it was not possible to have two adults present for the autistic group, so only one experimenter, the second author, did the testing for the autistic children. All children received stickers in return for their participation.

2.3 Assessing Epistemic Modal Auxiliaries

In order to test understanding of EMA, a test design very similar to the one used in Moore et al. (1989) and Ziatas et al. (1998) described above was employed. In this task, children were told that they would play a game in which they could win stickers. Children were shown two boxes, a red one and a blue one, and told that the experimenter would hide a sticker in one of them. Children were then introduced to a rabbit puppet and a lion puppet and told that they would help them in finding the sticker. If the children wanted to win stickers, they were told, they would have to listen very closely to the advice that the two puppets would give. In their advice, the puppets used the Dutch epistemic modal auxiliaries *moeten* (must), *zullen* (should) and *kunnen* (might) contrastively. To find the sticker, children thus had to prefer the box referred to by the EMA

[1] For additional notes on the methodology of this paper and the reasons behind the choice of the particular tests, see appendix 1.

moeten over the one referred to by either *zullen* or *kunnen* and the box referred to with *zullen* over the one with *kunnen*[2] (see 3, 4 and 5 for examples).

3) De sticker moet in de rode doos liggen
The sticker must in the red box lie
The sticker must be in the red box

4) De sticker zal in de blauwe doos liggen
The sticker should in the blue box lie
The sticker should be in the blue box

5) De sticker kan in de rode doos liggen
The sticker may in the red box lie
The sticker may be in the red box

Children received six trials in which each contrastive pair was used twice. Children were not allowed to look inside the boxes; at the end of the six trials they received a number of stickers irrespective of their performance on the task. Prior to the test trials, two practice trials were included in which one puppet stated simply where the sticker was (*de sticker ligt in de rode doos*, the sticker is in the red box) and the other puppet stated where the sticker was not (*de sticker ligt niet in de blauwe doos*, the sticker is not in the blue box). The child received a sticker for each of the practice trials (two stickers in total) and the child was promised more stickers if she played the game and paid attention. For each time the child preferred *moeten* (must) over *zullen* (should) and *kunnen* (might) and *zullen* (should) over *kunnen* (might), she received a point. A total of six points was thus possible.

2.4 Assessing Theory of Mind

Two different types of false belief tasks were presented to the children: one false belief location change task (Wimmer & Perner, 1983) and one false belief unexpected contents task (Perner et al., 1987). In the location change task, children were told a story in which a figure, Laura, places a marble in a blue box. Another figure, Paul, then moves the marble from the blue box to a red box in Laura's absence. On Laura's return, the child is asked to predict Laura's searching behaviour with the prediction false belief question 'where will Laura look first for her marble?'; the child is then asked to explain her answer with the explanation false belief question 'why will Laura look there first?'. Two control questions were also included to ensure that the child had understood the story and remembered the key events. These questions were asked after the false

[2] A pilot version of this task completed by 14 Dutch-speaking adults demonstrated that they performed at ceiling on this task with a 96,8% accuracy rate. The difference in speaker certainty conveyed by the three modal terms used here is thus robust for adult speakers of Dutch.

belief questions and related to the first location of the marble (Where was the marble first?) and the final location of the marble (Where is the marble really?). For the prediction and control questions, children were asked to choose between the two possible options, if they did not answer the questions initially. A maximum of two points could be scored on this task: one point for the prediction question and one for the explanation question. For the explanation question, answers were scored as correct if they referred to the original location of the object or the character's belief regarding the location of the object. Children were only awarded the points if they answered both of the control questions correctly (the first location and the final location questions).

For the unexpected contents task, children were introduced to a familiar puppet, Ernie, and told that he would like to play a game with them, but that he was too tired at the moment. The children were then shown a familiar container (an egg box) and asked what was in the container. Once the child had given the expected answer, they were shown the true contents of the box (a toy car). The box was then closed again and the child was asked three false belief questions: a self-question (when you first saw this box, before I opened it up and we looked inside, I asked you what was in it. What did you say?), an other-question (Ernie was sleeping when I showed you this. He has never seen this box before and never looked inside. What will Ernie say is in this box if we ask him?) and an explanation-question (Why will Ernie say that?). A control question (what is really in the box?) was included to ensure children had remembered the relevant aspects of the story. For the self, other and control questions, children were asked to choose between the two possible options, if they did not answer the questions initially. Children could receive a maximum of three points for the unexpected contents task: one for the self-belief question, one for the other-belief question and one for the explanation question. Answers to the explanation question were scored correct if they referred to the box' misleading appearance or the character's mistaken belief regarding the contents of the box. Children only received the points if they answered the control question (the true contents question) correctly.

2.5 Assessing General Language Ability

Two different general language tasks were given, testing children's receptive vocabulary and their comprehension of syntax. The receptive vocabulary test was the Dutch version of the Peabody Picture Vocabulary Test III (PPVT) created by Schlichting (2005). This is a standardised test of Dutch receptive vocabulary, which is suitable for both adults and children aged 2;3 and older. The test involves the participant listening to a word and pointing to one picture that goes with that word out of four possible choices. As the PPVT vocabulary test is a standardised test of receptive vocabulary, it comes with a scoring metric. The age of the child and the raw score as determined by the number of items the child answered correctly are taken into account and result in a quotient score. A score of 100 represents an exactly average receptive vocabulary for a child of that age (in years and months).

Comprehension of syntax was tested by giving children an abbreviated version of the Reynell test for language comprehension (Van Eldik, Schlichting, lutje Spelberg, van der Meulen & van der Meulen, 1995). This Reynell test is a Dutch adaptation of a standardised test assessing the child's language comprehension. All test items involved the child manipulating certain objects out of an array of multiple objects following a verbal instruction by the experimenter. Given the act-out nature of the test, all of the test items could be answered non-verbally, although verbal answers were possible (and indeed volunteered by the children) for some items. Given the long duration of the whole test (approximately 45 minutes per child), only parts 8, 9 and 11 of the test were conducted, consisting of 34 items in total. These parts were chosen as they best tested the child's understanding of syntax. Test items included understanding of passive constructions (e.g. the dog is bitten by the rabbit), prepositions (e.g. put a small pig next to the black pig), negation (e.g. which button is not in the cup?) and the diminutive form (e.g. show me the smallest button). Given the standardised nature of the Reynell test, a scoring metric was available. As only parts of the whole task were presented to the child, this metric could not be used, however. Instead, the total number of correct items out of the three parts of the test was taken as the child's score (34 being the maximum possible score).

3. Results

In order to create one total ToM score, the scores on both of the individual ToM tasks were summed. In order to derive a total general language score, z-scores of the two individual tests were taken and summed to create one general language z-score (as the range of the PPVT task is much larger than that of the Reynell task, simple addition would result in inflation of the importance of the child's PPVT score in the general language score). Further analyses involving ToM and general language were conducted on these combined scores.

Table 1 shows the descriptive statistics specified for the TD and the autistic group separately. As no previous studies have considered the development of EMA in Dutch children before, first the performance of only the typically developing children was analysed. The maximum score for the EMA test was 6. As children had to choose between two boxes, a score of 3 was expected if they were responding on the basis of chance. Although the TD children were not at ceiling yet (their mean score was 4), a one-sample t-test demonstrated that their performance was significantly better than would be predicted by chance (t_{18}=3.08; p=.006). A similar analysis was conducted on only the data from the autistic children in order to determine whether they were performing significantly better than chance as well. Again, a one-sample t-test demonstrated that their mean score (3,7) was indeed better than chance (t_9=3.28; p=.01).

The performance of both the autistic and the TD group on the EMA task was thus better than chance. It is still possible, however, that these groups differed from each other in their EMA performance and potentially also on other relevant

Table 1 Means, standard deviations and ranges of age and all tasks for the autistic and TD group

		TD (N=19)			Autistic (N=10)		
		Mean	SD	Range	Mean	SD	Range
Age in months (years;months)		77 (6;5)	3.85	72 -84 (6;0)-(7;0)	83 (6;11)	11.63	61-100 (5;1)-(8;4)
ToM	False belief location change	2	0	2	1.4	0.84	0-2
	False belief unexpected contents	2.58	0.77	1-3	1	1.16	0-3
	ToM total score	4.58	0.77	3-5	2.4	1.71	0-5
General language	PPVT	94.21	13.44	68-120	100.8	15.59	75-120
	Reynell	24.47	2.67	19-28	26.3	5.54	14-33
	General Language total score	-0.32	1.44	-3.04-2.13	0.61	2.44	-4.28-3,67
Mental language	EMA	4	1.41	2-6	3.7	0.68	3-5

Note. Maximum scores: false belief location change = 2; false belief unexpected contents = 3; ToM total score = 5; no PPVT maximum; Reynell = 34; EMA=6

variables. To test this possibility, an independent t-test was conducted testing whether the TD and autistic children differed in age, ToM, general language ability and their understanding of EMA. As expected, the autistic children were significantly worse in their performance on the ToM tasks than the TD children (t_{27}=4.76; p=.003). They did not differ significantly in age or in general language ability, however (t_{27}=-1.88; p=.18 and t_{27}=-1.29; p=.21 respectively). Although the mean score of the autistic group was lower on the EMA test (3,7 for the autistic children vs. 4 for the TD children), the autistic children did not differ significantly from the TD group in their understanding of EMA (t_{27}=0.63; p=.45). In this sample then, it seems that the autistic children are not impaired in this domain of mental language ability as compared to TD children.

While this result is initially surprising, an explanation may lie in the ToM performance of the children in the TD and autistic groups. As the ranges for the ToM total score demonstrate, it is not the case that all TD children passed all the ToM tasks and all the autistic children failed them. In fact, five out of 19 TD children did not answer all ToM questions correctly and one out of the ten autistic children did pass all ToM tasks. Given the hypothesis that a child's ToM ability is the determining factor in her EMA performance, a second analysis compared the performance of ToM 'passers' (i.e. the 15 children, 14 TD and 1 autistic, who scored five out of five on the ToM total score) and ToM 'failers' (i.e. the 14 children, 5 TD and 9 autistic who scored less than five on the ToM total score). The descriptive statistics of these two groups are presented in Table 2.

Table 2 Means, standard deviations and ranges of age and all tasks for the ToM passers and failers

		ToM passers (N=15)			ToM failers (N=14)		
		Mean	SD	Range	Mean	SD	Range
Age in months (years;months)		79 (6;7)	4.24	73 -86 (6;1)-(7;2)	80 (6;8)	10.46	61-100 (5;1)-(8;4)
ToM	False belief location change	2	0	2	1.57	0.76	0-2
	False belief unexpected contents	3	0	3	1	0.88	0-2
	ToM total score	5	0	5	2.57	1.4	0-4
General language	PPVT	96.47	12.13	73-120	96.5	16.79	68-120
	Reynell	25.07	3.22	19-31	25.14	4.66	14-33
	General language total score	-0.01	1.46	-2.69-2.13	0.01	2.27	-4.28-3.67
Mental language	EMA	4.53	1.13	3-6	3.21	0.89	2-5

Note. Maximum scores: false belief location change = 2; false belief unexpected contents = 3; ToM total score = 5; no PPVT maximum; Reynell = 34; EMA=6

As a first analysis, the performance of these groups was considered individually using one-sample t-tests. The ToM passers with their mean EMA score of 4.53 were performing significantly above chance (t_{14}=5.28; p<.000). The ToM failers, with a mean score of 3.21, on the other hand, did not perform any better than would be expected on the basis of chance (t_{13}=.90; p=.39).

To further determine the differences between the ToM passers and failers, an independent t-test compared the two groups on age, general language and EMA ability. Results of this analysis demonstrated that whereas these two groups did not differ in age or general language ability (t_{27}=0.26; p=.80 and t_{27}=0.03; p=.98 respectively), there was a significant difference between the two groups in their performance on the EMA task (t_{27}=-3.48; p=.002). As the descriptive statistics in Table 2 show, the ToM failers scored on average 1.32 points lower on the EMA task than the ToM passers. Correlations between passing or failing ToM

(ToMpf), EMA and general language ability also demonstrate the link between ToM and EMA. As can be seen in Table 3, only ToM and EMA are highly and significantly correlated; correlations between EMA and general language, on the other hand, are not significant.

Table 3 Correlations between ToMpf, EMA and General language

	EMA	ToMpf
ToMpf	.56**	
General language	.14	-.01

Note. **p<.01, two-tailed

This finding thus demonstrates that ToM passers outperform ToM failers in their understanding of EMA and thereby suggests that having a fully developed ToM is important in acquiring EMA. However, the reverse may also be possible, namely that understanding EMA is important for developing full ToM (instead of mental state understanding driving the understanding of words relating to mental states, the acquisition of words relating to mental states may affect mental state understanding itself). In order to consider this possibility, the performance on ToM tasks of EMA 'passers' and EMA 'failers' was compared. If children scored higher than chance (that is, more than three points) on the EMA task, they were considered EMA passers; children scoring less than four points (i.e. at chance or below chance), were considered EMA failers. This criterion meant that ten typically developing and six autistic children could be considered EMA passers (N=16) and nine typically developing and four autistic children could be considered EMA failers (N=13). The descriptive statistics of these two groups are presented in Table 4.

An independent t-test comparing the performance of the EMA passers and the EMA failers demonstrated that these two groups did not differ significantly in their performance on the ToM tasks (t_{27}=-0.90; p=.38). Whether children are capable of passing or failing the EMA test thus does not seem to have an impact on their ToM performance. Again, the age and general language performance of these two groups also has to be compared to make sure that differences in these two factors were not responsible for the lack of difference in ToM performance. However, independent t-tests showed that this was not the case; the two groups did not differ either in age or in general language ability (t_{27}=-0.24; p=.81 and t_{27}=-0.54; p=.59 respectively). It should be noted, though, that in some sense the scoring criterion for passing ToM is stricter than for passing EMA. For ToM passers, all the ToM test questions had to be answered correctly, whereas EMA passers had to score at an above chance level[3]. However, if the criterion for EMA passers is made as strict as the criterion for ToM passers (that is, only children who score 6 out of 6 on the EMA task are considered EMA passers),

[3] Given the fact that both ToM tests had an explanation question as well as a prediction question, there was no clear criterion for what would constitute chance performance in the ToM tests. Using a chance criterion for the ToM test outcome thus was not an option.

Table 4 Means, standard deviations and ranges of age and all tasks for the EMA passers and failers

		EMA passers (N=16)			EMA failers (N=13)		
		Mean	SD	Range	Mean	SD	Range
Age in months (years;months)		80 (6;8)	8.59	61 - 100 (5;1)-(8;4)	79 (6;87)	6.88	72-95 (6;0)-(7;11)
ToM	False belief location change	1.69	0.70	0-2	1.92	0.28	1-2
	False belief unexpected contents	2.38	1.09	0-3	1.62	1.19	0-3
	ToM total score	4.06	1.73	0-5	3.54	1.33	1-5
General Language	PPVT	98.38	14.42	73-120	94.15	14.37	68-120
	Reynell	25.25	4.33	14-31	24.92	3.48	19-33
	General Language total score	0.17	1.96	-4.28-2.95	-0.21	1.78	-3.04-3.67
Mental Language	EMA	4.81	0.75	4-6	2.77	0.44	2-3

then only three children (all in the typically developing group) would be considered EMA passers. If the ToM ability of these children is compared to the ToM ability of the remaining 26 children, then they do perform better on the ToM task. However, as the number of subjects per group is so uneven in this case, caution should be taken in interpreting this finding.

Another interesting result is found when the individual patterns of performance on the ToM and EMA tasks are considered (see Table 5). Generally, children either passed both tasks (11 children) or failed both tasks (9 children). However, four children were not yet able to pass the EMA task even though they did demonstrate ToM and five children displayed the opposite pattern (failing ToM whilst passing EMA). Only five children thus demonstrated an unexpected pattern (being able to pass the EMA task even though they failed on the ToM tasks); all but one of these children scored one point above chance (4 points), the other child scored 5 out of 6 points.

Table 5 Patterns of performance for ToM compared to EMA

	EMA	
	Passing (>3/6 correct)	Failing (≤3/6 correct)
Passing ToM	11	4
Failing ToM	5	9

4. Discussion

This study investigated the relationship between ToM, general language and the understanding of epistemic modal auxiliaries in Dutch typically developing and autistic children. The aim of this research was to extend the previous findings regarding the development of mental language in general and in autistic individuals in particular and thereby to shed light on the nature of the relationship between ToM and language. In particular, the focus of this study was to determine the role of a child's ToM in the acquisition of epistemic modal auxiliaries. However, as this was the first study to consider the understanding of epistemic modal auxiliaries experimentally in Dutch-speaking children, this study can also address the question to what extent the acquisition of Dutch EMA is comparable to the acquisition of EMA in the other languages that have been studied in previous literature.

The results for the TD children demonstrate that six-year-old Dutch-speaking children are significantly better than chance in their capacity to prefer a stronger modal statement over a weaker one. The difference in speaker certainty between the Dutch epistemic modal auxiliaries *moeten* (must), *zullen* (should) and *kunnen* (might) is thus understood to some extent at least at six years old. The TD children did not perform at ceiling yet, however, (a mean score of 4 out of a possible 6), indicating that the development of this understanding is still in progress. In this respect then, the results are more in line with Bascelli & Barbieri's (2002) finding regarding Italian children's understanding of the Italian epistemic modal system than with the findings for the English epistemic modal system as reported by Byrnes and Duff (1989). Where Byrnes and Duff report full development for the five-year-old children they tested, Italian children do not start to understand the differences in speaker certainty as conveyed by Italian epistemic modal auxiliaries until they are about six years old. Although children younger than six years old were not assessed in this study, the six-year-olds tested here were not at ceiling yet, in contrast to the fully developed modal system found for five-year-olds in the Byrnes and Duff study. As other studies assessing the English modal system (Hirst & Weil, 1982; Moore et al., 1990; Noveck et al., 1996) still find development in the oldest groups they tested (five- and six-year-olds), it seems likely that whereas some understanding of epistemic modal auxiliaries may already be present at younger ages, at least for the languages under considerations here (Italian, English and Dutch), the system is not fully acquired yet until children are at least six years old.

Looking then at the performance of the autistic group, a surprising result was found. Not only were the autistic children performing better than chance on the EMA task, indicating at least some understanding of the Dutch modal auxiliary system, they also did not differ significantly from the TD children. T-tests showed no significant difference between the TD and autistic group regarding EMA, general language ability and age. The only significant difference between these two groups was their performance on the ToM tasks. As ToM was predicted to play an important role in the acquisition of EMA, this finding seems to go against the idea that children require ToM in order to acquire mental language. On closer inspection of the data, however, it became clear that one child in the autistic group was in fact capable of passing all the ToM tasks and that five children in the TD group were not. The initial assumption, that the autistic children would fail the ToM tasks and the TD children would pass them, thus proved to be false. If the children were divided according to whether they passed or failed ToM tasks, the results were different. In looking at the performance on the EMA task for both groups separately, results showed that the ToM passers were performing above chance, hence indicating that they had an understanding of the Dutch EMA system. The performance of the ToM failers, on the other hand, did not differ significantly from chance, demonstrating their lack of understanding of the differences in speaker certainty as conveyed by epistemic modal auxiliaries. Further analyses confirmed that the difference between these two groups really did lie in their understanding of EMA: the ToM passers and failers did not differ in age or general language ability. The importance of ToM in EMA understanding was corroborated by the finding that although ToM passers outperformed ToM failers on the EMA task, EMA passers did not outperform EMA failers on the ToM task. Passing or failing ToM tasks thus does seem to have an effect on children’s ability to succeed on the EMA task, however, passing or failing the EMA task does not seem to be related to children’s performance on ToM tasks. This asymmetrical finding thus suggests that ToM plays an important role in the development of EMA, whereas the converse relationship does not hold.

These findings are particularly interesting in that they suggest that ToM is the key factor in developing an understanding of at least the area of mental language considered here. The particular clinical diagnosis given to a child seems to be less relevant than their ability to pass ToM tasks: if a child is capable of figuring out other people’s mental states, then she seems to be able to acquire EMA. Conversely, a child that does not yet demonstrate full understanding of other people’s mental states also seems to have trouble in understanding the different levels of speaker certainty as conveyed by epistemic modal auxiliaries. However, the opposite claim, that children who understand EMA will display better performance on ToM tasks than those who do not understand EMA was not borne out by the data. This claim also receives support from the patterns of performance in passing and failing the ToM and EMA task: if children pass ToM tasks, they generally pass the EMA task and if they fail ToM tasks they generally fail the EMA task as well. Nine children did not fit this pattern, however. Of these nine children, four children passed the ToM tasks, but failed the EMA tasks. These children presumably have the requisite mental state understanding to acquire EMA, but they may not yet have mapped this understanding onto the particular lexical items that go with EMA. Importantly, this performance does not go against the idea that ToM is a prerequisite for EMA understanding. It does demonstrate, however, that factors other than ToM are also involved in children's understanding of EMA. Out of the 29 children then, only five demonstrated a pattern of performance that is in contrast to the idea that ToM is a prerequisite for EMA understanding. These five children were able to pass the EMA task whilst failing the ToM tasks.

Generally then, the findings seem to be in line with previous research demonstrating an important role for ToM in the development of mental language (Ifantidou, 2005; Moore et al., 1990; Papafragou, 2001a; Papafragou & Li, 2001). The findings are somewhat in contrast, however, to Ziatas et al. (1998)'s finding for the development of mental state verbs in autistic children. Their study demonstrated that the autistic children were impaired in their understanding of these verbs in comparison to typically developing control children, whereas the current study did not find impaired performance for the autistic group as a whole. As both the sample size (12 autistic children in Ziatas et al. and 10 in the current study) and the number of autistic children passing ToM tasks (2 out of 12 in Ziatas et al. and 1 out of 10 in this study) were similar, it is not entirely clear why this difference appeared. However, Ziatas et al. employed one ToM task in which the child only had to predict looking behaviour. In the current study, the children received two ToM tasks in which children both had to predict behaviour and explain it as well. The ToM measure used in this study may thus have been more strict in that only children who were capable of both predicting and explaining another's behaviour in two different scenario's were counted as passing the ToM task. The two autistic children that passed the ToM task used in Ziatas et al. may thus not have passed the relatively more elaborate ToM tasks used in this test. In that case, all of the autistic children would count as failing the ToM task, hence making them not only a group of autistic children, but also a group of 'ToM failers'. This factor then may explain the difference in performance.

The finding that ToM passers do and ToM failers do not understand epistemic modal auxiliaries suggests that ToM plays an important role in the acquisition of mental language. This finding combined with the fact that this result was obtained in two groups that did not differ in general verbal ability, provides evidence against the linguistic determinism view of (mental) language acquisition. According to this view (cf. Astington & Baird, 2005; Astington & Jenkins, 1999; de Villiers & Pyers, 2002), language is an important driving force in children's ability to understand other people's mental states (i.e. in their development of ToM). Along these lines then, a child's general language ability should be strongly related to (if not the main force behind) the child's ability to acquire areas of language that relate to mental state understanding. After all, if language allows children to comprehend other people's mental states, it should also allow children to comprehend language about other people's mental states. This is not what was found in the current study, however. Aside from the fact that differences in EMA performance coincided with similar levels of general language ability, in the current study general language ability and EMA were not even significantly correlated. The current findings thus go against the idea that children's understanding of mental language is driven by their general language abilities and support the view that ToM is an important factor in at least the mental areas of language development.

General language may thus not be an important factor influencing EMA development, but these data are not definitive with respect to the direction of the link between EMA understanding and ToM development. Most of the data are in line with the idea that ToM has to be in place for the EMA task to passed: 24 out of 29 children demonstrate a pattern of performance that is in line with the idea that ToM has to be in place prior to EMA understanding. That is, once children pass ToM tasks they predominantly pass the EMA task; if children fail ToM tasks they generally fail the EMA task. However, the data here do not entirely rule out the possibility that EMA understanding is in place prior to the full development of ToM. In this sample, five children were capable of passing the EMA task even though they did not succeed on all aspects of the ToM tasks. Furthermore, if a similarly strict criterion was used for determining whether or not a child could be considered an EMA passer as was used for passing ToM, then EMA passers could be seen to outperform EMA failers on the ToM task. However, the force of this finding is mitigated by the fact that only three children could then be considered EMA passers; the differences in group size were thus too extreme to allow reliable conclusions to be drawn from this finding. Although the data thus more strongly support the necessity of ToM in EMA development, they do suggest that at least some children can pass the EMA task in the absence of full understanding of other people's mental states. Longitudinal data, which is in the process of being collected, or data from intervention studies is necessary in order to determine the direction of causality between EMA and ToM more precisely.

Generally though, the findings from this study support the view that ToM plays an important role in the child's acquisition of language. An understanding of what goes on in the minds of other people appears to be involved from day one in the language acquisition process: from learning her first words by appreciating others' intentions, pointing behaviour and gaze direction, to being able to understand the differences in speaker certainty as conveyed by the epistemic modal system, ToM helps the child in accomplishing the daunting task of acquiring a language.

Chapter 4

Developing communicative competence: The acquisition of mental state terms and indirect requests

Abstract

This longitudinal study involving Dutch four- and five-year-olds charts the development of indirect requests (IR) and mental state terms (MST) and the role that Theory of Mind (ToM) and various aspects of linguistic ability (vocabulary, sentential complementation, general syntax and spatial language) play in their development. The results demonstrate that basic understanding of IR and MST is present in four-year-olds, but that full understanding is not reached even at five years old. Furthermore, it was found that only earlier general syntax is a significant predictor of later IR understanding and only earlier spatial language for later MST understanding. These findings suggest that whereas IR understanding relies primarily on general linguistic skills, more specific aspects of language may bootstrap MST understanding.

Keywords

Theory of Mind; Language acquisition; Indirect requests; Mental state terms

1. Introduction

"I don't know how to open it!", young Nina says as she looks pleadingly at her mother. Nina has been given a new toy, but the plastic box in which it is encased is proving to be hard for her to open. Her mother's reaction was as you might expect: recognising the girl's plight, she takes the box and opens it for her. Business as usual for any parent. However, at least two aspects of this short interchange merit further consideration. In the first place, notice that Nina did not actually ask her mother to open the box for her, she merely stated that she did not have the requisite know-how to be able to do so herself. Nonetheless, this indirect form of requesting behaviour had the desired effect: the box was opened for her. But was Nina aware of the fact that she was making an indirect request or had she simply learnt that if she claims not to be able to do something, other people tend to do it for her? In the second place, we can wonder to what extent Nina was in fact just stating that she did not have the requisite know-how to open the box herself. In using the term *know*, was she really alluding to the lack of an underlying knowledge state that would enable her to open the box, or was she simply using an alternative form for "I can't open it"?

The development of these two areas of communicative competence, understanding of indirect requests and mental state terms, are the focus of this paper. According to the literature, from as young as two years old, children use mental state verbs like *know* and *think* in their speech (Booth, Hall, Robison & Yeong Kim, 1997; Shatz, Wellman & Silber, 1983). A similar finding is obtained for the production of indirect requests: prior research demonstrates what would seem to be indirect requests (e.g. "I hungry", cf. Ervin-Tripp, 1976) again from about two years old. However, as in the "I don't know how to open it" case described above, true understanding of indirect requests and mental state terms cannot necessarily be inferred from their occurrence in children's speech. Indeed, it is perfectly possible that the child uttering the "I hungry" example has simply learnt that she stands a better chance of getting her needs met if she verbalises them (without necessarily understanding fully the requestive nature of her utterance). Whether or not children really understand the mental state terms they produce at this early age can also be questioned, as careful examination of these occurrences demonstrates that they tend to be conversational in nature (e.g. know what?) instead of being used in their epistemic meaning (i.e. referring to an underlying knowledge state). In order to assess children's appreciation of the requestive function underlying indirect requests and the meaning of mental state vocabulary, an assessment of children's understanding of these areas of language is thus potentially more informative than only looking at their occurrence in children's speech.

But what can an investigation of children's understanding of indirect requests and mental state terms tell us? Both of these aspects of communicative competence are interesting, as they each give an insight into children's understanding of mental states and their linguistic encoding at different levels. Whereas understanding of mental state terms tells us something about children's appreciation of the linguistic encoding of mental states at the lexical level, understanding of indirect requests demonstrates children's ability to take into account the speaker's underlying intention at the discourse level. In this sense then, these two areas of communicative competence can be considered "mental language". They are at the interface of language and mental state understanding, requiring both linguistic skills and an appreciation of the "mind behind the speech" for their development. As both language and an appreciation of mental states are core aspects of cognitive development, without which a child is severely impaired in her ability to take part in social interaction, research looking at this domain of cognition at which they intersect should lead to interesting insights regarding the child's cognitive development.

1.1 The Development of Mental State Terms and Indirect Requests

So what is known about these two domains of mental language, mental state terms and indirect requests? Various studies have looked at children's understanding of terms that relate to mental states. Although if defined broadly one could consider things like desire terms (e.g. *want*, *need*), perception terms (e.g. *see*, *look*) and emotion terms (e.g. *happy*, *sad*) to be mental state terms, the focus of this paper is specifically on children's understanding of epistemic mental terms (i.e. those terms that require an appreciation of an underlying knowledge state), as these mark a more advanced understanding of mental states. In particular, this study considers the development of epistemic mental verbs (*know*, *think* and *guess*) and epistemic modality (i.e. the epistemic modal auxiliaries *must* and *might* and the epistemic modal adverbs *definitely* and *maybe*).

As stated above, naturalistic observations of these mental state terms demonstrate very early use in production (by two years of age, cf. Shatz et al., 1983 for production data on mental state verbs and Bliss, 1988 for production data on epistemic modals). However, not until the third or fourth year of life do children tend to use these terms in a way that suggests that they have some understanding of the differences in speaker certainty that these terms convey (cf. Pascual, Aguado, Sotillo & Masdeu, 2008). Given the potential problems in inferring true understanding from production data, various studies have considered children's understanding of mental state terms experimentally. Hirst & Weil (1982), for example, provided early experimental data on the acquisition of epistemic modal auxiliaries. Three- to six-year-old children were told to find a hidden peanut by listening to the advice of two puppets that used the modal terms *must*, *may* and *should* contrastively ('the peanut must be under the cup' vs. 'the peanut may be under the box'). Hirst & Weil found that only the oldest children (starting at 5;6) could make strength distinctions between the modals, a result that was replicated in a more recent study by Noveck, Ho & Sera (1996). Byrnes & Duff (1989) found a different result, however, in their study of modal auxiliaries. They considered children's ability to differentiate the strength conveyed by *has to be* vs. *might be* ('It has to be under the red cup' vs. 'It might be under the blue cup') and the difference between the negated terms *can't be* vs. *might not be*. Results of this study showed that children improved significantly between the ages of three and four, with ceiling performance at five years old. Moore, Pure & Furrow (1990) represent a midway between these two findings in their study of the English modal auxiliaries *must*, *might* and *could*. This study found significant improvement between the ages of three and four as well, but even the oldest group in their study (consisting of six-year-olds) did not demonstrate ceiling performance yet.

Modal auxiliary understanding is thus relatively well studied, although the findings, for English at least, do differ to some extent. There are studies that look at the development of modal adverbs and mental state verbs experimentally as well, however. Aside from looking at modal auxiliaries, Moore et al. (1990) also consider children's understanding of the differences in speaker certainty as conveyed by the modal adverbs *probably*, *possibly* and *maybe*. Similar to the findings for the modal auxiliaries, three-year-olds were not capable of differentiating between any of the modal adverb contrasts, but the older age groups were capable of finding the hidden object on the basis of the modal adverbs. Moore and his colleagues have also conducted various studies on children's understanding of the mental state verbs *know*, *think* and *guess*. Moore & Davidge (1989), for example, demonstrated that by four to five years of age, children understood that *know* expressed greater speaker certainty than *think*. Similarly, Moore, Bryant & Furrow (1989) showed that four-year-olds are capable of appreciating the fact that *know* expresses greater speaker certainty than *think* or *guess*; by five years old their performance on these contrasts is at ceiling. However, the distinction between *think* and *guess* was not understood even by eight-year-olds, the oldest group considered in this study. Overall then, it seems that for English modal auxiliaries, modal adverbs and mental state verbs, children start to understand the differences in speaker certainty as expressed by these terms at about four years old. How this understanding develops over time is not yet clear, however, as the cross-sectional studies discussed above have different outcomes and longitudinal studies employing a similar empirical design have not yet been conducted.

Another question that remains after consulting the existing studies on these mental state terms is to what extent the findings for English generalise to other languages. Children acquiring English may start to appreciate the linguistic encoding of differences in speaker certainty by four years old, but children acquiring other languages may show a different developmental path. Indeed, one of the few studies to consider the understanding of these terms using an experimental design similar to the one employed in the above studies on English-speaking children, Bascelli & Barbieri's (2002) study on the Italian modal auxiliaries *dovere* (must) and *potere* (may), finds considerably later understanding of the differences between the modals. Only at six years old do the Italian children tested in this study demonstrate some understanding of the contrasts between these auxiliaries, whilst the full system isn't mastered until they are eight years old. Studies on the development of epistemic modal terms and mental state verbs in languages other than English are thus called for to see to what extent the acquisition of these terms is similar across languages.

Less research has been conducted assessing children's understanding of indirect requests than their understanding of mental state terms. In contrast to direct requests (see 1 for an example), indirect requests refer to a type of request that is not in the imperative form. Indirect requests can differ in how explicit they are. In 2, an example of a relatively explicit indirect request is given. Note that although on the face of it, the utterance in 2 could be interpreted as an information request regarding the child's ability to come and eat dinner, this question is of course intended by the speaker as a request for the child to stop playing with her toys and come to the dinner table. The indirect request in 2 is more explicit than the one in 3, however, as the indirect request in 2 does in fact have the imperative form embedded in it (i.e. come and eat dinner). The indirect request in 3, also referred to as 'hint' (cf. Ervin-Tripp, 1976), represents the most complicated type of indirect request as the listener is given no explicit cue as to the act that the speaker expects her to carry out. In the case of 3, then, mother is thus not giving a descriptive statement regarding the time of day, rather, she intends the child to stop playing with her toys and come to the dinner table. Only if the child understands the mother's intention can she thus comply with the underlying request.

1) [mother to child playing with toys] Come and eat dinner!
2) [mother to child playing with toys] Can you come and eat dinner?
3) [mother to child playing with toys] It's dinner time

Although children as young as two years old have been documented to use what would seem to be indirect requests, true understanding of indirect requests has not been found until children are at least three years old with development continuing until at least eight years old (cf. Bernicot, Laval & Chaminaud, 2007; Bernicot & Legros, 1987; Elrod, 1987; Leonard, Wilcox, Fulmer & Davis, 1978; Spekman & Roth, 1985). As was the case with previous research considering mental state term understanding, the understanding of indirect requests has mainly been considered for English-speaking children (although Bernicot and colleagues work with French-speaking children) and only using cross-sectional designs. The development of indirect request understanding in different languages and in the same child over time thus remains understudied.

1.2 Mental State Terms and Indirect Requests: The Role of Theory of Mind and Language

Aside from looking at children's developing understanding of indirect requests and mental state vocabulary, this study also considers which factors the development of these areas of mental language depends on. In the understanding of indirect requests and mental state terms two aspects of cognition would seem to play a role: the child's linguistic ability and her understanding of other people's mental states. Both the understanding of indirect requests and mental state vocabulary require a certain level of linguistic ability: children need to learn the mental state terms as lexical items and for indirect requests children need to appreciate the intricacies of discourse structure and they have to be able to parse the syntactic constructions that the indirect requests are framed in. At the same time, though, it would seem that for understanding of these domains of communicative competence to arise, children also have to have the relevant conceptual underpinning in place to understand the nature of mental states. If this understanding is not in place, the meaning of mental state terms and the intention behind the indirect request should remain oblique to the child. If an understanding of the "mind behind the speech" is indeed necessary for understanding of indirect requests and mental state terms, it is to be expected that performance on tests assessing children's understanding of other people's mental states would be predictive of their understanding of indirect requests and mental state terms. In other words, not only should children's linguistic skills be related to their understanding of mental state terms and indirect requests, children's understanding of other people's mental states, their Theory of Mind (ToM) development, should also play an important role.

The development of ToM is standardly assessed by the so-called "false belief test" (cf. Perner, Leekam & Wimmer, 1987; Wimmer & Perner, 1983) and requires the child to appreciate that others may have beliefs that differ from their own, even if the child's own belief is in line with the true state of affairs. In the original version of the false belief task, the protagonist, Maxi, puts some chocolate in a blue cupboard that is then moved, in Maxi's absence, by his mother to a green cupboard. On Maxi's return, the child is asked the false belief question: "Where will Maxi look for his chocolate?" The child is thus required to predict the behaviour of a story character given the latter's false belief about the location of the object. If the child is capable of answering this question correctly, she is demonstrating an ability to appreciate the fact that others can have beliefs that may differ from her own belief (even though the child's own belief may be the correct belief given the current state of the world) and thus a relatively more adult-like understanding of other people's minds. Children's ability to pass ToM tests, which generally arises when they are between four and five years old, is thus potentially an important predictor of their understanding of mental state terms and indirect requests.

In line with this idea, previous work on mental state term understanding has found a correlation between ToM development and epistemic mental state term understanding (cf. Moore et al., 1990 for the relationship between ToM and modal terms and Ziatas, Durkin & Pratt, 1998 for the relationship between ToM and mental state verbs in autistic individuals). Regarding ToM and indirect request understanding, not much work has been done that explicitly considers this relationship, but findings from research with autistic individuals (who are known to have ToM deficiencies; cf. Baron-Cohen, Leslie & Frith, 1985) suggest that they have severe impairments in their pragmatic inference abilities (understanding of indirect requests being a prime domain of cognition in which pragmatic inferences are required) which are presumed to be caused, in part at least, by their deficient ToM development (cf. Loukusa & Moilanen, 2009 for a review). Aside from this finding in atypically developing individuals, the timing of children's more adult-like production and comprehension of indirect requests (i.e. around four years old) also coincides with children's more adult-like understanding of other people's mental states as assessed by standard ToM tasks.

Although it may seem like a given that ToM will play a role in the development of indirect request and mental state term understanding (as an understanding of mental states plays such a crucial role in both of these aspects of mental language), there is reason to question this assumption. It is true that there are various researchers that claim that the development of ToM plays a fundamental role in children's linguistic development (Bloom, 2001; Papafragou, 2001a; Tomasello, 2000), but many other researchers claim that it is a child's linguistic development that influences her understanding of other people's mental states (cf. Astington & Baird, 2005 and Milligan, Astington & Dack, 2007 for a review of studies considering the nature of the causal relationship between language and ToM). Astington & Jenkins (1999), for example, state that only once the child's general language abilities are sufficient, is she able to represent other people's mental states properly. On this view, it is language that provides the scaffolding that allows the child to make sense of the different layers of representation that are necessary for understanding others' beliefs as distinct from one's own. Instead of ToM development providing children with the conceptual underpinnings to understand mental state terms and indirect requests then, potentially it is language that is giving children an insight into other people's mental states and, consequently, the child's linguistic skills that are the primary determinant of her understanding of mental state terms and indirect requests. Considering the role that a child's linguistic skills play in the development of mental state terms and indirect requests is thus also informative in light of this more general question regarding the nature of children's development of mental concepts.

Children's linguistic abilities may thus prove to be crucial in their ability to acquire mental state terms and indirect requests. However, although there are many researchers who claim that language is the fundamental driving force in children's dawning understanding of other people's mental states, they differ in which aspects of language they consider to be crucial. As described above, some researchers assume that the child has to have a certain general level of linguistic ability for her to be able to develop ToM. De Villiers and her colleagues (de Villiers, 2005, 2007; de Villiers & Pyers, 2002), on the other hand, suggest that one particular aspect of language is crucial in the child's understanding of mental states: the sentential complementation construction (see 4 and 5 for examples).

4) Maxi thinks that the chocolate is in the blue cupboard
5) Mary says that she is eating her peas

De Villiers notes that communication verbs like *say* and mental state terms like *think* and *guess* both occur in sentential complementation constructions. As the child presumably can get overt evidence in the input for the fact that the sentential complement in a sentence with a communication verb can be false (i.e. in 5, although Mary may say that she is eating her peas, she may not actually be doing so), this might prompt the child to realise that the sentential complement in utterances with a mental state verb may also be false (i.e. in 4, although Maxi might think that the chocolate is in the blue cupboard, this might not be the case). The idea is thus that the child develops an understanding of mental states (in particular an understanding of false beliefs) by realising that there is a syntactic similarity between *say* and *think*, hearing the verb *say* occur with a false complement and generalising this feature of *say* (i.e. that it can occur with a false complement) to the verb *think*. In this way, the understanding of sentential complementation constructions forces the child to contemplate the nature of mental states and to appreciate the fact that it is possible to have "false" mental states just like it is possible to say things that are not true. In line with this idea, a training study by Lohmann & Tomasello (2003) demonstrates that training children on sentential complementation constructions also enhances their performance on false belief tasks (but see Cheung, Hsuan-Chih, Creed, Ng, Wang & Mo, 2004 and Perner, Sprung, Zauner and Haider, 2003 for alternative points of view regarding the role of sentential complementation in false belief understanding).

Whether general characteristics of the child's language ability play a role in children's understanding of mental states or more specific aspects of language are the driving force, both versions of this idea suggest that the child's linguistic ability will play an important role in determining her capacity to understand mental state terms and indirect requests. Not only do the child's linguistic skills provide her with a symbolic system to decode references to mental states; at a more fundamental level, they also provide the child with a representational medium for understanding the mental states underlying these two aspects of mental language. Whether or not ToM and linguistic ability play a role in the development of mental state term and indirect request understanding and which of these factors is more important is thus an issue with much broader consequences for the current view of children's cognitive development than it may seem in the first instance.

1.3 Aims of the Study

In this paper then, two main questions are considered: how does Dutch children's understanding of indirect requests and mental state terms develop between four and five years old and what role does the child's linguistic ability and her understanding of other people's mental states play in the development of these two areas of communicative competence? Dutch children were chosen to participate as mental state term and indirect request understanding had not been considered in this language in previous research. Given the focus on English-speaking children in previous research in this domain, it is not clear whether the patterns found for English-speaking children also hold for children acquiring languages other than English. Assessing Dutch children's abilities in this domain thus allows this question to be addressed. At the first time of testing, four-year olds were chosen to participate in the study as many previous studies have demonstrated that at this age children begin to appreciate other people's mental states and they start to understand mental state terms and indirect requests in a more adult-like way. At this age then, children should start to show variation in their understanding of indirect requests and mental state terms, but this development was still expected to continue until at least the second time of testing (eight months later). By choosing four-year-olds it was thus expected that neither floor nor ceiling effects would be obtained for the mental language measures throughout the time of testing; a necessary requirement if the goal is to track their development and to consider the role of earlier ToM and linguistic ability in later mental language understanding. Given these considerations, four-year-old Dutch children thus are an interesting group to investigate.

2. Method[1]

2.1 Participants

101 Dutch-speaking children (47 boys and 54 girls) who were between the ages of 4;0 and 4;11 (*M*= 4;6) at the first time of testing participated in the study. The children were recruited from three primary schools in Rotterdam and one primary school in Rosmalen (both are cities in The Netherlands). Most of the children came from lower middle class or middle class families.

Between the first and the second time of testing, eight months later, an additional nine children could not be tested again. All of these children had moved to different towns in the intervening eight months and were thus dropped from the sample, thereby leaving 101 instead of 110 children for data analysis.

2.2 Procedure

Children were tested individually in a separate room in their school building. For all sessions, two adults were present: the author (acting as experimenter) and an assistant. Each child was tested on three occasions separated by at least a day and at most a week between each session. Each session lasted approximately 30 minutes; total testing time was thus around 1.5 hours per child. Each child received one of twelve possible testing orders, so that test order effects were minimised. Children received stickers in return for their participation. The second time of testing followed the same procedure as the first time of testing. Although all the tests conducted at the first time of testing were essentially the

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[1] For additional notes on the methodology of this paper and the reasons behind the choice of the particular tests, see appendix 1.

same as those at the second time of testing, two of the ToM sub-tests had to be modified to some extent (see the description of the various ToM tests below for more information).

2.3 Assessing Understanding of Indirect Requests

To assess understanding of indirect requests, the child was invited to listen to stories and look at accompanying pictures together with a puppet, Ernie. The stories all involved a mother uttering an indirect request to her daughter Karin or her son Jan. These indirect requests were always of the hint form; the child thus had to take into account the intention of the mother underlying the indirect request (i.e. the direct request) as well as the linguistic encoding of the indirect request in order to understand what was meant by the mother's utterance. Instead of asking the child directly what the indirect request meant, Ernie the puppet claimed that he didn't understand the story and asked the child to clarify the mother's utterance. An example can be found in 6:

6) Karin is standing in the hallway and wants to go outside. Next to her is a hat stand with her coat, her scarf and her gloves. Mummy sees Karin standing in the hallway and says: It's really cold outside, Karin.
Ernie: Why does mummy say that to Karin?

If the child did not respond to this question, the child was given the prompt "what will happen if mummy says that?". Seven different indirect request stories were given to the child.

Understanding of indirect requests was demonstrated if the child's response to the question referred to the mother's intended meaning (e.g. "Karin should put on her coat") or a consequence of the intended meaning (e.g. "she'll get ill if she doesn't put her coat on"). Answers of either type were given one point; all other answers were considered incorrect. Seven points in total could thus be received for the indirect requests test.

2.4 Assessing Mental State Term Understanding

The three different domains of mental state terms under consideration in this study, mental state verbs, modal auxiliaries and modal adverbs, were tested using a design very similar to the previous studies assessing children's understanding of mental state terms described above. Children were told that they would play a game in which they could win stickers that were hidden in one of two boxes (a blue box and a red box). In order to win the stickers, the child had to listen to advice given by two puppets, a rabbit and a lion, who gave hints about the location of the sticker by using the various mental state terms contrastively. Each type of mental state term was presented in a separate session. In the mental state verb task, the Dutch verbs *weten* (know), *denken* (think) and *raden* (guess) were used (see 7 for examples). Each contrast (i.e. know vs. think, know vs. guess and think vs. guess) was presented to the child three times for a total of nine trials. In the modal auxiliary task, *moet* (must) and *kan* (may) were used (see example 8) and in the modal adverbs task, *zeker* (definitely) and *misschien* (maybe) were used (see 9). The contrasts in both modal tasks were presented four times. In order to be successful on this task, children had to choose the box denoted by the mental state term that conveyed greater speaker certainty over the term that conveyed lesser speaker certainty.

7)

Ik	weet/denk/raad	dat	de	sticker	in	de	rode	doos ligt
I	know/think/guess	that	the	sticker	in	the	red	box lies

I know/think/guess the sticker is in the red box

8)

De	sticker	moet/kan	in	de	blauwe	doos	liggen
The	sticker	must/might	in	the	blue	box	lie

The sticker must/might be in the blue box

9)

De	sticker	ligt	zeker/misschien	in	de	rode	doos
The	sticker	lies	definitely/maybe	in	the	red	box

The sticker is definitely in the red box/
Maybe the sticker is in the red box

Children were not allowed to look inside the boxes; after the last trial they received a number of stickers irrespective of their performance on the task. Prior to the test trials, two practice trials were included in which one puppet stated simply where the sticker was (*de sticker ligt in de rode doos*, the sticker is in the red box) and the other puppet stated where the sticker was not (*de sticker ligt niet in de blauwe doos*, the sticker is not in the blue box). In the practice trials, both puppets thus demonstrated that they could help the child find the sticker by stating in plain terms where the sticker was located (in the first practice trial, the rabbit puppet gave the affirmative statement; in the second trial, the lion gave the affirmative statement). Furthermore, care was taken that the intonation and voice used for the two puppets was the same across items and trials; there were thus no paralinguistic cues on which the subjects could base their choice. The child received a sticker for each of the practice trials and was promised more stickers if she played the game and paid attention.

For the modal auxiliary task, the child received a point each time she preferred *moet* (must) over *kan* (might), allowing a total of four points for this task. Four points in total could also be gained for the modal adverb task if the children preferred the modal adverb *zeker* (definitely) over *misschien* (maybe). Nine points could be gained for the mental state verb task if the child consistently preferred *weten* (know) over *denken* (think) and *raden* (guess) and *denken* (think) over *raden* (guess). A total of 17 points could thus be scored by the child in the mental state term understanding task.

2.5 Assessing Theory of Mind

Three different types of false belief task were presented to the children: two appearance-reality tasks (Flavell, Flavell & Green, 1983; Gopnik & Astington, 1988), two location change tasks (Wimmer & Perner, 1983) and two unexpected contents tasks (Perner et al., 1987). In the appearance-reality tasks, children briefly talked to the puppet, Ernie, but then were told that he had to leave and would come back to play a game with them later. After the puppet had disappeared, the child was shown a deceptive object (e.g. a candle that looked like a cake) and asked what it was. Once the child had volunteered the expected answer (a cake), she was shown the true identity of the object. The child was then asked two false belief questions: the self-question (What did you say this was when you first saw it?) and the other-question (What will Ernie say this is if we ask him?). In order to make sure that children truly understood the nature of the object, after the test questions they were asked two control questions: the reality-question (what is this really?) and the appearance-question (what does this look like?). In a separate session at the first time of testing, the children were shown another deceptive object (a pencil sharpener that looked like a car) and asked the same questions as described above. If children did not answer the questions initially, they were given a forced choice of the two possible answers. At the second time of testing (eight months after the first time of testing), children had to be given different deceptive objects for the task to legitimately assess false belief understanding (otherwise children may simply remember the true nature of the object). The second time of testing involved a pen that looked like a car and a purse that looked like a glove, for the children that had initially seen the cake/candle and the pencil sharpener/car[2].

In the location change tasks, children witnessed one protagonist, Laura, place a marble in a basket, which a second protagonist, Paul, moved to a box in Laura's absence. On Laura's return, the child was asked the prediction false belief question (where will Laura look first for her marble?) and the explanation false belief question (why will Laura look there first?). Two control questions were also included to ensure that the child had understood the story and remembered the key events. These questions were asked after the false belief questions and related to the first location of the marble (Where was the marble first?) and the final location of the marble (Where is the marble really?). In the second version of this task, administered in a separate session, two different locations were used and Laura displaced the marble in Paul's absence. For all prediction and control questions, children were asked to choose between the two possible options, if they did not answer the questions initially.

In the unexpected contents tasks, children conversed briefly with puppet Ernie, but were told he had to leave. The children were then shown a familiar container

[2] The order of objects was counterbalanced across children. Half of the children thus received the cake/candle and the pencil sharpener/car as objects at the first time of testing and the pen/car and the purse/glove at the second time; the other half received these objects in the reverse order.

(e.g. a pencil box) and asked what was in the container. Once the child had given the expected answer, they were shown the true contents of the box (a piece of string). The box was then closed again and the child was asked three false belief questions: a self-question (What did you say was in this box when you first saw it?), an other-question (What will Ernie say is in this box if we ask him?) and an explanation-question (Why will Ernie say that?). A control question (What is really in the box?) was included to ensure children had remembered the relevant aspects of the story. In a separate session at the first time of testing, the children were shown an egg box that contained a toy car and asked the same questions as described above. Just as in the appearance-reality trials, the unexpected contents tasks at the second time of testing involved different familiar containers than the first time of testing (a milk carton containing a band-aid and a lunch box containing a lamb puppet)[3]. For the self, other and control questions, children were asked to choose between the two possible options, if they did not answer the questions initially.

Each appearance-reality test yielded two points: one for the self-question and one for the other-question. Children were only awarded points for the test questions if they answered both control questions (the appearance question and the reality question) correctly. Each false belief location change task also yielded a maximum of two points: one point for the prediction question and one for the explanation question. For the explanation question, answers were scored as correct if they referred to the original location of the object or the character's belief regarding the location of the object. Again, the child was only awarded the points if she correctly answered both of the control questions (the first location and the final location questions). Children could receive a maximum of three points for the unexpected contents task: one for the self-belief question, one for the other-belief question and one for the explanation question. Answers to the explanation question were scored correct if they referred to the box' misleading appearance or the character's mistaken belief regarding the contents of the box. Children only received the points if they answered the control question (the true contents question) correctly. Across all ToM tests, children could thus receive a maximum of 14 points, which, in comparison to other studies, is a relatively broad range. High scores on the ToM measure thus demonstrate children's capacity to predict and explain false beliefs across three types of tasks each presented in two different scenarios.

Note that in this scoring method, children do not receive a higher score for a correct explanation than for a correct prediction, although it could be argued that children who can explain false beliefs have developed ToM to a higher level than those who can only predict them (in the current scoring framework, a child who is capable of predicting and explaining a false belief on one of the tasks, but incapable of giving a correct answer on either of the questions in another task

[3] Again, the use of these items was counterbalanced across children with half being exposed to the pencil box and the egg box first and the milk carton and the lunch box second and the other half being exposed to these objects in the reverse order.

would receive the same amount of points as a child who gives correct predictions but incorrect or incomplete explanations on both tasks). The rationale behind this scoring method is two-fold: in the first place, by assigning a higher score to explanations over predictions, the linguistic aspects of the ToM task would receive greater prominence in the scoring (as the explanation question requires more of the child's linguistic abilities than the prediction question). As the contributions of language and ToM are considered separately, this would not be desirable. Secondly, if a child is capable of giving a correct prediction and explanation on one task, but incapable of doing so in a second version of this task, can we really say that this child has a higher level of ToM understanding than a child who can give correct predictions on both tasks, but not a correct explanation? It seems that both children are lacking full understanding of false beliefs and this is reflected in their similar scores (and, of course, children who consistently give correct predictions and explanations receive a higher score than children who consistently give correct predictions but incorrect explanations). Higher scores on the ToM measure thus reflect more complete false belief understanding than lower scores.

2.6 Assessing Linguistic Ability

Initially, the test battery was considered to consist of three different linguistic measures, testing children's receptive vocabulary, their understanding of sentential complements and their general language comprehension. The receptive vocabulary test was the Dutch version of the Peabody Picture Vocabulary Test III (PPVT) created by Schlichting (2005). This is a standardised test of receptive vocabulary, which is suitable for both adults and children aged 2;3 and older. The test involves the participant listening to a word and pointing to one picture out of an array of four that goes with that word. As the PPVT vocabulary test is a standardised test, it comes with a scoring metric. The age of the child and the raw score as determined by the number of items the child got right are taken into account, resulting in a quotient score. A score of 100 represents an exactly average receptive vocabulary for a child of that age (in years and months).

In order to test the child's understanding of sentential complementation, a special test was devised. It has been argued (cf. Ruffman, Slade, Rowlandson, Rumsey & Garnham, 2003) that standard tests of sentential complementation rely on false belief understanding. In a typical sentential complementation task, children are told stories in which the protagonist is described as making a mistake, telling a lie or having a false belief. An example of such a story is the following (de Villiers & Pyers, 2002):

10) He thought he found his ring, but it was really a bottle cap. What did he think?

De Villiers and colleagues claim that false belief understanding is not necessary to answer the question correctly, as the child only has to repeat the thought verbatim. However, the problem with this test is that the story does not make much sense if you have no concept of false beliefs already in place. As Ruffman et al. (2003) point out, without false belief understanding the child has no basis for reconstructing what was said and hence may find it hard to remember a mistaken proposition. An incorrect answer to the question (i.e. "that he found a bottle cap") may be due to the false belief test failer resorting to answering the question in line with their current level of understanding and hence reasoning in terms of what they know to be true.

In an attempt to disentangle sentential complementation from false belief understanding, an alternative test was devised. This novel task involved the child listening to six stories accompanied by pictures together with a puppet, Ernie. The stories always involved two protagonists, Jan and Karin, talking about three objects. The two actors and the three objects were depicted in the accompanying picture. One of the characters would always say something about one of the objects; the other character would then say something about the remaining two objects. Once the story was over, Ernie the puppet would ask the child about one of the character's utterances. An example can be found in 11:

11) [child sees a picture of Jan and Karin in a living room sitting next to a teddy bear, a doll and a book]
    It's Karin's birthday and Karin is showing Jan the presents she got. Jan says that Karin got a teddy bear for her birthday. Karin then says that she also got a doll and a book.
    Ernie: That went a bit fast. They both said something, but what did JAN say Karin got?

Correctly responding "a teddy bear" instead of "a teddy bear, a doll and a book" or other possible answers shows true understanding of the sentential complementation construction: the question regarding the relevant sentence (Jan says that Karin got a teddy bear for her birthday) is properly interpreted as relating to the content of the embedded clause and not as a general question for clarification regarding the presents that Karin received for her birthday. Importantly, none of the utterances in the story are false. All three of the objects are Karin's birthday presents; the protagonists just choose to comment on a subset of them. The child thus does not have to take into account false beliefs or lies; she only has to remember what objects the protagonists talked about.

To make sure that the children could deal with the memory load imposed by the story, four control stories were added. These stories had the same memory load as the test stories but they did not contain sentential complementation constructions (see 12 for an example):

12) [child sees a picture of Jan and Karin standing next to a crab, a starfish and a shell]
    Jan and Karin are at the beach. They're looking for things they can take home with them. Karin found a starfish. And Jan found a crab and a shell.
    Ernie: Wait a minute. They both found something, but what did KARIN find?

For the sentential complementation task, the child's score was the number of test items, out of six, that she got right. The points were only awarded if the child answered at least three out of the four control questions correctly.

General comprehension of syntax was tested by giving children an abbreviated version of the Reynell test for language comprehension (Van Eldik, Schlichting, lutje Spelberg, van der Meulen & van der Meulen, 1995). The Reynell test is a standardised test, suitable for children from 1;3 to 6;3 years old. All test items involved the child manipulating certain objects out of an array of multiple objects, following a verbal instruction by the experimenter. Given the act-out nature of the test, all of the test items could be answered non-verbally, although verbal answers were possible (and indeed volunteered by the children) for some items. Given the long duration of the whole test (approximately 45 minutes per child), only parts 8, 9 and 11 of the test were conducted, consisting of 34 items in total. These parts were chosen as they best tested four- and five-year-old children's understanding of language comprehension at the sentential level. No specific names are given to these parts, but the test manual states that part 8 assesses "non-standard couplings of two objects through a preposition and the understanding of passive forms", part 9 assess children's "recognition of properties of objects and assesses understanding of number, question words and prepositions" and part 11 tests children's "understanding of two or more concepts (e.g. question words, colour, superlative forms, pronouns, prepositions and double negatives) in a concrete situation".

Initially then, the child's performance on this task was taken as a measure of her general language comprehension ability. However, on closer examination of the assessment material, it became apparent that a considerable number of the test items involved children's understanding of spatial language, in particular their understanding of locative prepositions (e.g. *in*, *on*, *next to*). Across all three parts of the task, many items required the child to appreciate the relationship between two objects as expressed by a locative preposition. As locative prepositions encode perspective (the locative preposition denotes the nature of the spatial relationship between two objects from the perspective of the speaker) and perspective relates to children's developing ToM (which hinges on children's understanding of the notion that differing perspectives on events can lead to different beliefs regarding those events), the decision was made to not only consider the child's total score on the Reynell test in the further results, but also to look at whether the spatial items in the Reynell test were of greater importance in explaining the development of indirect requests and mental state terms than the non-spatial items. In dividing the Reynell items in parts 8, 9 and 11 into spatial and non-spatial items, spatial items were defined as items that contained locative prepositions and non-spatial items were those that did not contain a locative preposition. In this division of the Reynell test, items with negative elements in combination with locative prepositions (e.g. which pig is *not in* the field?) were discarded from analysis. The reason for this was that the negative element adds an extra level of processing difficulty to the item that comes on top of the computation required by the locative preposition making it unclear to what extent comprehension of the sentence is down to comprehension of the locative preposition or the negative element.

The child's performance on the Reynell test was thus considered in two ways: the score that the child received on all three parts of the test that were administered (34 being the maximum) was taken as a general measure of the child's language comprehension, but aside from that, the children's score on the spatial items (21 as the maximum) and the non-spatial items (9 as the maximum) was also considered in a separate analysis. Note that the remaining four items all contained locative prepositions in combination with a negative element and thus were discarded from analysis.

3. Results

3.1 Descriptive Statistics

Table 1 shows the means, standard deviations and ranges of the various tasks and the participants' ages at the first and second time of testing.

In the data analyses reported in the following sections, all the individual ToM tasks are summed in order to create a total ToM sum-score. For the vocabulary measure both the raw scores and the standardised scores are reported in table 1. The standardised scores demonstrate that on average the group of children assessed in this study had a slightly above average receptive vocabulary (average is a score of 100). In the further analyses, the raw scores are used, as otherwise the effect of age is considered twice in this variable (in order to determine the standard scores, the subject's age is already taken into account, if in further analyses age is entered as a separate variable, then the effect of age would thus be doubly accounted for in the model). Each of the mental state term domains is considered separately in the analyses that look at the development of mental state terms, but a sum score of the various mental state term domains was taken in the analyses that considered the role of ToM and language on mental state term development.

3.2 Performance on Control Items

At both time points, a relatively large number of children gave seemingly correct answers to the ToM questions, but failed on at least one of the control questions. At the first time of testing, 49 children gave the right answer to at

Table 1 Means, standard deviations and ranges of age and all the tests in the test battery at the first and second time point

		Time point 1			Time point 2		
Measure	Subtest	Mean	SD	Range	Mean	SD	Range
Age in months (years; months)	N/A	54 (4;6)	3.29	48-59 (4;0-4;11)	62 (5;2)	3.28	55-68 (4;7-5;8)
ToM	AR	1.58	1.47	0-4	2.44	1.56	0-4
	LC	2.41	1.61	0-4	3.14	1.33	0-4
	UC	2.47	2.24	0-6	3.44	2.40	0-6
	ToM sum score	6.46	4.34	0-14	9.01	4.27	0-14
General language	ppvt-s	102.6	15.97	57-143	104.77	16.1	70-144
	ppvt-r	66.18	13.78	26-98	76.12	13.31	48-115
	SC	2.01	2.36	0-6	3.05	2.46	0-6
	RO	21.52	6.61	3-32	24.13	4.19	12-33
	RS	11.68	4.65	0-20	13.46	2.84	6-20
	RNS	7.49	1.75	1-9	8.15	1.25	4-9
Mental language	MSV total	4.97	1.58	1-9	5.18	1.65	1-9
	k v. t	1.87	0.92	0-3	2.09	0.88	0-3
	k v. g	1.74	0.86	0-3	1.83	0.99	0-3
	t v. g	1.36	0.84	0-3	1.26	1.01	0-3
	MAux	2.50	1.07	0-4	2.85	1.20	0-4
	MAdv	2.84	1.02	1-4	3.12	0.94	0-4
	MST	10.31	2.40	5-16	11.15	2.69	6-17
	IR	4.14	2.05	0-7	5.64	1.83	0-7

Note. Maximum scores: appearance-reality (AR) and false belief location change (LC) = 4; false belief unexpected contents (UC) = 6; ToM sum = 14; no PPVT maximum (ppvts is PPVT standardised score; ppvtr is PPVT raw score); sentential complementation (SC)= 6; Reynell overall (RO) = 34; Reynell spatial (RS) = 21; Reynell non-spatial (RNS)= 9; mental state verbs total (MSV) = 9; know (k) v. think (t) , know (k) v. guess (g) and think (t) vs. know (k) = 3; modal auxiliaries (MAux) and modal adverbs (MAdv) = 4; mental state terms sum (MST) = 17; indirect requests (IR) = 7

least one of the appearance-reality false belief questions, but failed on at least one of the control questions; for the false belief unexpected contents task, 23 children failed on a control question while answering one or more of the test questions correctly. In comparison, the false belief location change control questions were easier, as only three children gave incorrect answers to one or more of the control questions whilst answering one or more of the false belief questions correctly. At the second point of testing, the control questions were easier for the children, although quite a number of them still failed control questions whilst passing test questions. For the appearance-reality task, this number was reduced to 27 children; for the false belief unexpected contents task, this number became 15 and the number of children who had problems with the control questions on the false belief location change task remained constant at three. At both time points, all of these children were scored as failing the test question.

This result may seem somewhat strange as all three tasks are supposed to tap the same underlying construct (understanding of false beliefs). However, in order to make sure that the children really understood the false beliefs instead of just correctly guessing between the two available answer options, stricter controls had to be used for the appearance-reality and unexpected contents task than for the location change task. To make sure that children understood the location change task, it was enough to probe their memory of key events in the story (where was the ball first and finally), but this was not possible for the other two tasks. To demonstrate understanding of the nature of the false belief in these tasks unequivocally, children had to show that they understood that the object under inspection could seem to be or to contain one thing whilst actually being or containing something else. If the child does not have this understanding of the dual nature of the object, then their (correct) answers to the false belief questions are not very insightful. After all, if the child conceptualises the test object only as being a cake (in the case of the cake/candle) or as containing pencils (in the case of the pencil box), then their answers to the false belief questions would be correct, but not based on proper understanding of false beliefs.

A similarly strict scoring criterion was imposed on the sentential complementation task. For children to score points on this task, they had to give the correct answer on at least three out of the four control questions. At the first time of testing, there were 46 children who did answer at least one of the test questions correctly, but who did not succeed in answering at least three control questions correctly. At the second time of testing, this number had decreased to 32. Again, all these children were scored as failing the test items. This finding demonstrates that, aside from assessing sentential complements, the task also demanded something of the children's working memory capacity. However, as was the case for the ToM measures, without these strict controls, seemingly correct answers on the sentential complementation test trials would not necessarily be meaningful. The test set-up dictated that only the first mentioned object (out of the three objects) was correct. If children used a strategy in which they simply always gave the first mentioned object as an answer, they would thus consistently give correct answers even though they did not necessarily understand the nature of the sentential complementation construction. Adding the requirement that children had to answer at least three of the four control questions correctly made sure that children who were using this kind of strategy to answer the questions would not receive points for sentential complementation understanding. Of course, this means that for both the ToM and the sentential complementation tasks some children will not have received any points even though they may in reality have some understanding of false beliefs or sentential complementation constructions. Nonetheless, this strict scoring criterion does ensure that those children who receive points on these measures definitely do understand sentential complements and false beliefs. If better understanding of sentential complementation or false beliefs thus does relate to better understanding of mental state terms and indirect requests, this should become apparent even with this strict scoring policy.

3.3 The Development of Indirect Requests and Mental State Terms

All individual language and ToM measures increased significantly between the first and the second time of testing (all paired-sample t-tests, p<.001). Regarding the dependent variables in this study, children's understanding of indirect requests and mental state terms, significant development was also observed across the two time points. Children's understanding of indirect requests increased significantly between the first and the second time of testing (p<.001), indicating their developing ability to make sense of indirect requests. Children's overall understanding of mental state terms also increased significantly across time points (p<.001). In order to consider the development of mental state terms more closely, the performance on the various mental state terms was considered separately. Paired-sample t-tests demonstrated that children's performance increased significantly for their understanding of modal auxiliaries (p<.001) and modal adverbs (p<.01). The mental state verbs showed a slightly different pattern, however. Although the sum score for the performance on the mental state verbs did not increase significantly over time (p=.11), children's understanding of the differences in speaker certainty as conveyed by *weten* (know) vs. *denken* (think) and *weten* (know) vs. *raden* (guess) did improve (p<.01 and p<.05 respectively). Children's understanding of the difference between *denken* (think) and *raden* (guess) did not improve significantly, however (p=.75).

In order to consider whether children were displaying above chance performance in their understanding of the various mental state terms, one-sample t-tests were run. Although overall performance on the mental state verb sum score may not have improved, one-sample t-tests did demonstrate that performance was above chance at both time points (p<.01 for time one and p<.001 for time two). A maximum score of 9 could be gained for this task with two possible answer options; above chance performance thus entails a score higher than 4,5. At both time points then, the children scored significantly higher than would be predicted by chance (with an average of 5 at time one and 5,2 at time two), indicating that they did have some understanding of the differences between the mental state verbs. Considering the three contrasts employed in the mental state verbs task separately, one-sample t-tests show that at both time points children were performing significantly above chance on the *weten* (know)-*denken* (think) contrast (p<.001 on both time points) and on the *weten* (know)-*raden* (guess) contrast (p<.01 for the first time point and p<.001 for the second time point; out of a maximum score of 3 for each contrast and a two-option forced-choice answer, above-chance performance was thus considered to be scores above 1,5). This was not the case for the *denken* (think)-*raden* (guess) contrast at either time point, however. At the first time point, children's scores did not differ from chance. However, at the second time point children's scores were significantly *below* chance. Although children thus displayed an understanding of the difference between *weten* (know) and *denken* (think) and *weten* (know) and *raden* (guess) already at the first time point (which had developed further by the second time point), children did not show any understanding of the difference between *denken* (think) and *raden* (guess) at either time point. On both the epistemic modal auxiliary and adverb task children displayed significantly above-chance performance (i.e. out of a maximum score of 4 children scored significantly higher than 2) with $p<.001$ at both time points.

At the first time point, children thus demonstrated some understanding of indirect requests, both areas of epistemic modal terms and the contrasts between the strongest mental state verb (*weten*) and the two weaker ones (*denken* and *raden*), which developed further in the course of the intervening eight months.

3.4 Correlations

For the sake of completeness, Table 2 presents all the bivariate Pearson correlations between age, ToM, the individual language measures and the child's understanding of indirect requests and mental state terms at both time points. If we consider the correlations between the variables, various things can be noted. In the first place, there are two correlations that are so high (.97 and .95) that they may indicate multicollinearity problems. These two correlations are between the spatial items subset of the Reynell test for language comprehension and the overall score of the Reynell test. As the spatial items represent a subset of the total Reynell items (about two-thirds of them), it is expected that the overall test and the spatial items measure very similar constructs. There is reason to believe, however, that the spatial items may be more relevant in explaining the findings described below, so the role of the spatial items will be returned to later in the paper. For the moment then, it can be said that the correlations within time points are positive and significant between all of the variables (between .21 and .70 with $p<.05$) except for the relationship between age and the two dependent variables (mental state term and indirect request understanding) and sentential complementation and the two dependent variables. Across time points, again, all correlations are positive and significant (between .22 and .74 with $p<.05$), except sentential complementation and the dependent variables and between the two dependent variables themselves. Generally then, the dependent variables do significantly and positively correlate with the independent variables both across and within time points.

Table 2 Bivariate correlations between ToM, language and mental language at both time points (N=101)

	Age	ToM1	PPVT1	SC1	RO1	RS1	RNS1	MST1	IR1	ToM2	PPVT2	SC2	RO2	RS2	RNS2	MST2
ToM1	.34***															
PPVT1	.38***	.61***														
SC1	.24*	.42***	.44***													
RO1	.38***	.67***	.70***	.40***												
RS1	.37***	.66***	.69***	.40***	.97***											
RNS1	.33***	.54***	.55***	.28**	.77***	.61***										
MST1	.11	.27**	.27**	.11	.34***	.31**	.32***									
IR1	.25**	.36***	.42***	.13	.45***	.37***	.54***	.24*								
ToM2	.26**	.65***	.58***	.23*	.63***	.62***	.48***	.34***	.25**							
PPVT2	.34***	.62***	.67***	.54***	.71***	.74***	.46***	.29**	.35***	.57***						
SC2	.21*	.38***	.41***	.53***	.52***	.51***	.39***	.14	.24*	.30**	.40***					
RO2	.29**	.57***	.65***	.35***	.78***	.76***	.61***	.34***	.44***	.59***	.68***	.42***				
RS2	.24*	.56***	.60***	.32***	.73***	.73***	.53***	.32***	.45***	.56***	.65***	.39***	.95***			
RNS2	.35***	.42***	.53***	.25**	.66***	.61***	.59***	.27**	.32***	.51***	.54***	.32***	.75***	.56***		
MST2	.23*	.33***	.29**	.24*	.42***	.42***	.28**	.32***	.22*	.30**	.42***	.30**	.32***	.24*	.40***	
IR2	.13	.38***	.40***	.14	.49***	.43***	.55***	.16	.38***	.36***	.25**	.15	.47***	.42***	.48***	.21*

Note. ToM, Theory of Mind; PPVT, Peabody Picture Vocabulary Test; SC, Sentential Complementation; RO, Reynell Overall; RS, Reynell Spatial; RNS, Reynell Non-Spatial; MST, Mental State Terms; IR, Indirect Requests

*p≤.05; **p≤.01; ***p≤.001

3.5 Regression Analyses

In order to consider the role of ToM and language in the development of mental state term and indirect request understanding, hierarchical regression analyses were conducted. Children's performance at a later age will depend partly on their age and their earlier performance on the tasks, so these two factors (age and earlier mental state term and indirect request understanding) were accounted for first in the models. In order to consider the contributions of ToM and language, the following two models added earlier ToM performance and earlier linguistic performance in the various domains to the initial model. Children's understanding of mental state terms and indirect requests was considered separately in these analyses.

3.6 Predicting Mental State Terms from ToM and Language

First, the role of ToM and language in the child's understanding of mental state terms was considered. Table 3 demonstrates the outcome of the hierarchical regression analyses assessing the contributions of ToM and language to mental state term understanding. The first model in the analysis shows that both age (t_{98} = 2.00; p = .05) and earlier mental state term understanding (t_{98} = 3.12; p = .002) significantly predict the child's later understanding of mental state terms. This first model describes 13,5% of the variance in mental state term understanding (R^2_{adj} = 11,8%) with an overall significant relationship ($F_{2,98}$ = 7.68; p=.001). The second model in the analysis considers whether earlier ToM is a significant predictor of later mental state term understanding controlling for age and earlier mental state term understanding. Table 3 shows that this is indeed the case: both earlier understanding of mental state terms and ToM predict later understanding of mental state terms (t_{97} = 2.53; p = .01 and t_{97} = 2.19; p = .03 respectively). This second model describes 17,6% of the variance (R^2_{adj} = 15,1%), thereby significantly improving the percentage of explained variance in the initial model by 4% (with an overall significant relationship, $F_{3,97}$ = 6.91; p<.000).

The third and final model considers whether any of the language measures contributes significantly to the child's understanding of mental state terms and whether the influence of ToM remains significant once the language measures are added to the model. This final model describes 22,2% of the variance (R^2_{adj} = 17,3%), again with an overall significant relationship ($F_{6,94}$ = 4.48; p<.000). The regression analysis demonstrates that aside from the child's earlier understanding of mental state terms (t_{94} = 2.06; p = .04) only one other predictor in the model significantly predicted later understanding of mental state terms: performance on the Reynell test for language comprehension (t_{94} = 2.04; p = .05). This model did not explain a significantly larger amount of the variance in later mental state term understanding than model 2, however (the extra 5% of explained variance was not a significant improvement). None of the other language measures proved to be a significant predictor of mental state term understanding once the other variables in the model were controlled for. The child's earlier understanding of sentential complementation constructions and her receptive vocabulary both thus did not significantly explain additional

Table 3 Predicting mental state term understanding at time 2 from ToM and language at time 1

	B	SE B	β	R²	ΔR²
Model 1					
Age	0.16	0.08	.19*	.14	.14***
MST 1	0.33	0.11	.30**		
Model 2					
Age	0.10	0.08	.12	.18	.04*
MST 1	0.27	0.11	.24**		
ToM 1	0.14	0.06	.22*		
Model 3					
Age	0.06	0.08	.07	.22	.05
MST 1	0.22	0.11	.20*		
ToM 1	0.03	0.08	.05		
SC 1	0.11	0.12	.09		
PPVT 1	-0.01	0.03	-.07		
Reynell 1	0.12	0.06	.30*		

Note. MST, Mental State Term; ToM, Theory of Mind; SC, Sentential Complementation; PPVT, Peabody Picture Vocabulary Test
*p≤.05; **p≤.01; ***p≤.001

variance in the child's understanding of mental state terms. The relationship between ToM and mental state term understanding also changed once the language measures were taken into account: where ToM was a significant predictor of mental state term understanding in model 2, this effect disappeared in model 3.

3.7 Predicting Indirect Requests from ToM and Language

After considering the role of ToM and language in the development of mental state term understanding, the following set of hierarchical regression analyses considered their role in the child's understanding of indirect requests. Again, later understanding of indirect requests was expected to depend on age and on earlier understanding of indirect requests, so these factors were introduced first in the model, after which the effects of ToM and the various language measures were considered. Table 4 shows the results of these analyses.

Against expectation, the first model demonstrated that although earlier understanding of indirect requests was a significant predictor of later understanding of mental states ($t_{98} = 3.81$; $p \leq .000$), age was not, once earlier understanding of indirect requests was controlled for. This first model described 14,3% of the variance in understanding indirect requests at time two (R^2_{adj} = 12,6%) with an overall significant relationship ($F_{2,98} = 8.19$; p=.001). The second model demonstrates that ToM does significantly predict later understanding of indirect requests even controlling for age and earlier understanding of indirect requests ($t_{97} = 2.97$; p = .004). Adding ToM to the model allowed the model to describe 21,5% of the variance (R^2_{adj} = 19%) with an overall significant

Table 4 Predicting indirect requests at time 2 from ToM and language at time 1

	B	SE B	β	R²	ΔR²
Model 1					
Age	0.02	0.05	.04	.14	.14***
IR 1	0.33	0.09	.37***		
Model 2					
Age	-0.02	0.05	-.04	.22	.07**
IR 1	0.25	0.09	.28**		
ToM 1	0.13	0.04	.30**		
Model 3					
Age	-0.06	0.05	-.10	.29	.08*
IR 1	0.16	0.09	.18		
ToM 1	0.04	0.05	.10		
SC 1	-0.07	0.08	-.08		
PPVT 1	0.01	0.02	.09		
Reynell 1	0.10	0.04	.36**		

Note. IR, Indirect Requests; ToM, Theory of Mind; SC, Sentential Complementation; PPVT, Peabody Picture Vocabulary Test
*p≤.05; **p≤.01; ***p≤.001

relationship ($F_{3,97} = 8.84$; p<.000). The additional 7% of explained variance was significant. The third and final model demonstrated that adding the language measures led the model to describe 29,2% of the variance ($R^2_{adj} = 24,7\%$) again with an overall significant relationship ($F_{6,94} = 6.46$; p<.000). The added 8% of explained variance was a significant improvement in comparison to the second model. In the final model, only the child's earlier performance on the Reynell test for language comprehension proved to be a significant predictor of her later understanding of indirect requests ($t_{94} = 2.59$; p = .01). None of the other predictors in the model significantly predicted the dependent variable.

3.8 The Reynell Test: A Closer Inspection

For both mental state term and indirect request understanding it was found that although ToM was a significant predictor in a model with age and earlier performance, this effect disappeared once the language measures were added to the model. Not all the language measures were relevant, however. It was only the child's earlier performance on the Reynell test for language comprehension that proved to be a significant predictor of the child's later understanding of mental state terms and indirect requests. As detailed in the method section, practical considerations dictated that only certain parts of the Reynell test were given, namely those that best assessed the four- and five-year-old child's understanding of language comprehension at the sentential level. On closer examination, however, it became apparent that about two thirds of the items in these sets involved an understanding of locative prepositions (e.g. *in*, *behind*, *next to*) that indicate the spatial relationship between two objects (e.g. "put one of the pigs *behind* the man"). As locative prepositions encode perspective (the locative preposition denotes the nature of the spatial relationship between two objects from the perspective of the speaker) and perspective relates to children's developing ToM (which hinges on children's understanding of the notion that differing perspectives on events can lead to different beliefs regarding those events), potentially then, it is this aspect of the Reynell test that was of primary importance in explaining the significance of the Reynell test as a predictor of mental state term and indirect request understanding. In the following analyses, the spatial and the non-spatial parts of the Reynell test were thus considered separately.

Table 5 demonstrates what effect this division has on the outcome regarding the child's understanding of mental state terms (as the first two models are the same as in table 4, only the final model is given) and table 6 shows the results for understanding of indirect requests.

For mental state term understanding then, the final model explains 22,9% (R^2_{adj} = 17,1%) of the variance with an overall significant relationship ($F_{7,93}$ = 3.95; p=.001). As can be seen in table 5, aside from earlier understanding of mental state terms (t_{93} = 2.18; p = .03), only the spatial subset of the Reynell test significantly predicted children's later understanding of mental state terms (t_{93} = 2.19; p = .03). None of the other measures in model 3 was a significant predictor. For the final model regarding the child's understanding of indirect requests, this finding was somewhat different. This model explains 34,2% of the variance (R^2_{adj} = 29,3%), again with an overall significant relationship ($F_{7,93}$ = 6.91; p<.000). In the final step of this model, however, it was only the non-spatial subset of the Reynell test that significantly predicted understanding of indirect requests (t_{93} = 3.32; p = .001). None of the other measures predicted performance significantly in this final model.

Both the development of mental state term and indirect request understanding is thus predicted by the child's earlier ToM performance, even if age and earlier performance on mental state terms and indirect requests are taken into account. Once the child's linguistic ability is added to the model, however, only the child's performance on the Reynell test for language comprehension proved to be a significant predictor. On closer examination, the spatial items of the Reynell test significantly predicted the child's understanding of mental state terms, whereas the non-spatial items were not a significant predictor in this instance. On the other hand, if the child's understanding of indirect requests is considered, the opposite finding appears as the non-spatial items of the Reynell test prove to be the only significant predictor of performance in this domain.

Table 5 Predicting mental state terms at time 2 from ToM, spatial and non-spatial language at time 1

	B	SE B	β	R²	ΔR²
Model 3					
Age	0.06	0.08	.08	.23	.05
MST 1	0.24	0.11	.21*		
ToM 1	0.03	0.08	.05		
SC 1	0.10	0.12	.09		
PPVT 1	-0.01	0.03	-.07		
Reynell spatial 1	0.18	0.08	.32*		
Reynell non-spatial 1	-0.03	0.19	-.02		

Note. MST, Mental State Term; ToM, Theory of Mind; SC, Sentential Complementation; PPVT, Peabody Picture Vocabulary Test
*p≤.05; **p≤.01; ***p≤.001

Table 6 Predicting indirect requests at time 2 from ToM, spatial and non-spatial language at time 1

	B	SE B	β	R²	ΔR²
Model 3					
Age	-0.06	0.05	-.11	.34	.13**
IR 1	0.09	0.09	.10		
ToM 1	0.03	0.05	.08		
SC 1	-0.06	0.08	-.08		
PPVT 1	0.01	0.02	.09		
Reynell spatial 1	0.04	0.05	.11		
Reynell non-spatial 1	0.41	0.12	.40***		

Note. IR, Indirect Requests; ToM, Theory of Mind; SC, Sentential Complementation; PPVT, Peabody Picture Vocabulary Test
*p≤.05; **p≤.01; ***p≤.001

4. Discussion

This paper considered the development of two areas of communicative competence, the understanding of indirect requests and mental state terms, in a longitudinal study of Dutch-speaking four- and five-year-old children. Two questions were at the heart of this paper: how does understanding of indirect requests and mental state terms develop between four and five years old and what role does the child's linguistic ability and her understanding of other people's mental states play in this development?

Regarding the first question, the results demonstrate that Dutch children do have some understanding of indirect requests and mental state terms by the age of four, but that this understanding increases significantly between four and five years old. Ceiling performance is not yet reached at this age, however, indicating that children continue to develop their understanding of these domains after five years old. The findings for the understanding of indirect requests are in line with the findings from English and French (Bernicot et al., 2007; Bernicot & Legros, 1987; Elrod, 1987; Leonard et al., 1978; Spekman & Roth, 1985) that state that children start to appreciate indirect requests by the age of three and continue their development until they are at least eight years old. Of course, this study only considered four and five year olds, so claims about Dutch children younger or older than these ages cannot be made. However, four-year-olds already demonstrated some understanding of a relatively opaque form of indirect requests, the hint, which developed across time within the same individual, but did not yet peak at five years old. At least for English, French and Dutch then, it seems that children undergo a significant improvement in their understanding of indirect requests between four and five years old.

Regarding Dutch children's understanding of mental state terms, the finding was that only the difference in speaker certainty as conveyed by the terms *denken* (think) vs. *raden* (guess) was not appreciated at any of the tested ages. Four-year-olds were at chance in their performance on this difference, which did not develop any further in the intervening eight months. These findings are very similar to the findings described by the cross-sectional studies on English-speaking children mentioned above (Byrnes & Duff, 1989; Hirst & Weil, 1982; Moore & Davidge, 1989; Moore et al., 1989, 1990; Noveck et al., 1996) which, although the findings do differ somewhat, broadly indicate some understanding of differences in speaker certainty at four years old with continuing development until at least five years old. Like the English children, Dutch children thus begin to appreciate the differences in speaker certainty as conveyed by various mental state verbs, modal auxiliaries and modal adverbs at least by four years old. This development then continues until at least five years old, by which point they understand that *weten* (know) expresses greater speaker certainty than *denken* (think) and *raden* (guess), that *moet* (must) expresses greater speaker certainty than *kan* (might) and that *zeker* (definitely) is more certain than *misschien* (maybe). Only the distinction between *denken* and *raden* remains problematic for Dutch children at these ages (which is line with Moore et al., 1989's finding that English children also have difficulties with the difference between *think* and *guess* until they are at least eight years old). Evidently then, it seems that four- and five-year-olds understand that the term *weten* (know) expresses high speaker certainty and that *denken* (think) and *raden* (guess) express some level of speaker uncertainty, but they are not yet capable of making the distinction between different levels of uncertainty.

However, this finding for mental state terms is in contrast with Bascelli & Barbieri's (2002) study on Italian modal auxiliaries that did not find any understanding of these terms until at least six years old. Potentially then, the particular language that the child is learning does have an effect on the age at which at least modal auxiliaries (the only area of mental state vocabulary tested in Bascelli & Barbieri, 2002) are learnt. However, given that the findings for English do seem to suggest that significant development occurs between four and five years old (with Byrnes & Duff, 1989, at the low end of this continuum with their finding that three-year-olds already understand modals and Hirst & Weil, 1982, at the high end with their finding that only 5,6-year-olds understand modals) and this study on Dutch confirms that, it is possible that more studies on Italian will eventually converge around the ages of four and five as well. For the moment then, it can be said that, at least for children acquiring Dutch and English, significant steps are taken in the understanding of mental state terms between four and five years old.

Of course, children not only show significant development in the domains of mental state terms and indirect requests between the ages of four and five; other domains of cognition are also developing rapidly; with their linguistic development and their understanding of other people's mental states starting to take on more adult-like forms around this age as well. The second question underlying this paper, what role does the child's linguistic and ToM ability play in the development of mental state terms and indirect requests, is thus also very pertinent to this age range.

Hierarchical regression analyses conducted in order to answer this second question suggest that ToM plays a role in the child's developing understanding of mental state terms and indirect requests. Even controlling for age and earlier performance in mental state term and indirect request understanding, earlier ToM proved to be a significant predictor of later mental state term and indirect request understanding. Children's ability to appreciate other people's mental states is thus a relevant factor in their coming to understand the nature of mental state terms and indirect requests. However, this effect of ToM disappeared once the language measures were added to the model. Controlling for the child's linguistic abilities then, earlier ToM no longer proved to be a significant predictor of later mental state term and indirect request understanding. This is thus in favour of the idea that language plays a more important role in the child's development of mental state terms and indirect requests than her understanding of other people's mental states. Whether or not language also plays a role in the development of ToM is not addressed here, but it does seem to play a more important role in the child's acquisition of the linguistic encoding of mental states (both at the lexical and the discourse level) than the child's understanding of other people's mental states.

It was not the case that all aspects of language tested here were relevant, however. The child's receptive vocabulary was not a significant predictor of understanding of mental state terms and indirect requests and neither was the ability to understand sentential complementation constructions. These findings are especially interesting given the nature of the mental state terms task. Of course, all the mental state terms are lexical items and, as such, have to be learnt as part of the word learning process. One would think, then, that the child's ability to learn words in a general sense, as indexed by their score on the standardised vocabulary test, would be predictive of their ability to learn words in the more restricted domain of mental state terms as well. This was not the case, however, as once the other measures were taken into account, the child's vocabulary score was not a significant predictor of mental state term understanding. Again for the mental state term task, the finding that understanding of sentential complementation constructions is not a significant predictor is also interesting as, at least in the case of the mental state verbs, the child is often exposed to sentential complementation constructions when she encounters these verbs in day-to-day conversation (although not always, as utterances like "know what?" do not contain sentential complementation constructions). Understanding of sentential complementation constructions was not found to be a significant predictor of mental state term understanding, however, once the other variables in the model were taken into account.

The only language measure that did prove to be a significant predictor of both mental state term and indirect request understanding was the child's performance on the subparts of the Reynell test for language comprehension used here. Only earlier general language comprehension thus proved to be a significant predictor for later mental state term and indirect request understanding. This finding could be considered to be in favour of the view that the child needs a particular level of general linguistic ability in order to make sense of other people's mental states (cf. Astington & Jenkins, 1999). Understanding that other people's mental states can differ from your own requires the child to be able to separate various representations of reality (the child's own representation and that of others). In order to accomplish this feat, the child needs a relatively complex representational system to encode these various representations of reality: the linguistic system. Language may thus provide the scaffolding, the representational means, that allows the child to make sense of the different layers of representation that are necessary for understanding others' beliefs as distinct from one's own.

So how does this relate to the idea that a certain level of language ability may be necessary in order to understand mental state terms and indirect requests? If the child needs a general level of linguistic ability in order to be able to deal with the representational complexities that come with being able to understand other people's mental states, then the child will also need a certain level of general linguistic ability in order to be able to deal with the representational complexity that comes with acquiring the *linguistic encoding* of understanding other people's mental states, i.e. mental language. In order for children to be able to learn how to interpret mental state terms and indirect requests then, they need the conceptual apparatus necessary to understand the underlying mental states and they need the linguistic apparatus necessary in order to deal with the linguistic aspects of these areas of cognition (e.g. a parser that allows the syntactic structure of an indirect request to be analysed). On this view then, language does a dual job in the process of acquiring mental language: it provides the child with the representational apparatus to make sense of other people's mental states and it provides the child with a system for decoding the linguistic format in which these areas of mental language are encoded.

While this explanation is a plausible account of cognitive development in these domains, it is somewhat unsatisfying. One would want to know more about this "general level of linguistic ability". Exactly what level is the child supposed to have in order to be able to understand other people's mental states? In the interest of falsifiability, some metric for this has to be stated as otherwise one is left simply with the claim that those children who demonstrate understanding of other people's mental states have high enough language skills and those who don't, don't. Ideally then, in order to create a more testable prediction, one would specify a particular domain of language that is a necessary (although perhaps not sufficient) factor in the child coming to understand the linguistic encoding of other people's mental states. De Villiers and her colleagues take this tack in suggesting that sentential complementation constructions are a necessary prerequisite for the child to understand mental states (in particular false beliefs). The results from this study go against this idea, however, at least with respect to children's understanding of mental state terms and indirect requests. Whether or not children's understanding of sentential complementation constructions predicts their understanding of mental states, this study does not show any evidence for their understanding of sentential complementation constructions predicting their understanding of the linguistic encoding of mental states in the form of mental state terms or indirect requests. Likely, this is due to the fact that this study employed a novel sentential complementation task that was not related to the understanding of mental states in any way. Once this methodological issue is dealt with, it seems that the link between sentential complements and mental state understanding (and hence between sentential complements and an understanding of lexical items that refer to mental states) is not present. Sentential complementation may thus not be the aspect of language that is relevant in the acquisition of mental state terms and indirect requests, but is there another candidate?

Possibly. On closer examination of the items of the Reynell test for language comprehension that were used in this study, it turned out that about two-thirds of them required the child to understand the nature of locative prepositions like *on*, *next to* and *behind*. The interesting thing about this class of words is that in order to appreciate their meaning, the child has to have some understanding of perspective: although from the point of view of one speaker, the house might be next to the tree, from the point of view of another speaker, the house might be in front of the tree. Understanding of differences of perspective at this relatively concrete, spatial level is thus crucial for the child to understand these terms. The function of a locative preposition is thus to denote the concrete spatial relationship of two objects in space from the point of view of the speaker. Perspective, albeit in a more abstract sense, is of course also crucial in the child's development of ToM. Only if the child appreciates that differing perspectives on events can lead to different representations of those events (and hence potentially to false representations of those events) can the child develop a more advanced understanding of other people's mental states and their linguistic encoding. Potentially then, what unites the child's understanding of mental states, mental language and their performance on the Reynell test is that all three domains rely on the child's appreciation of differences in perspective. Given the more concrete nature of the spatial relation described by the locative preposition (it is in principle verifiable in the context whether or not, from the point of view of a certain speaker, the house can be considered to be next to or in front of the tree), the child might be using the more concrete perspectival nature of the locative preposition to bootstrap understanding of the more abstract perspectival nature expressed in mental language.

If we consider the spatial and the non-spatial items of the Reynell test separately, we see that there is partial support for this idea. If we look at the child's understanding of mental state terms, the spatial items of the Reynell test are the only significant predictor of performance; the non-spatial items are thus not significantly predicting performance in this area. The opposite finding holds for the child's understanding of indirect requests, however. Whereas the spatial items are not a significant predictor in this case, the non-spatial items do significantly predict the child's understanding of indirect requests. So what can we make of these different findings?

It may be that the discrepancy lies in the different demands that the indirect request and the mental state term tasks place on the child's linguistic abilities. The task that was used to assess indirect request understanding requires more advanced verbal skills than the mental state term task. In the mental state term task, the child has to understand the differences in speaker certainty as conveyed by various mental state terms (and thus the task requires the child to have some appreciation of the differences in perspective that these terms convey), but the response required in the task itself is non-verbal (the child can simply point to one of the two boxes). In contrast, in the indirect requests task, the child cannot give a non-verbal answer. The child not only has to understand the intention of the mother that underlies the indirect request (and thus the mother's perspective in the exchange), but she also has to parse the story and the mother's utterance and come up with a coherent verbal response in order to receive credit. The indirect request task may thus require more of the child's general linguistic skills than just her understanding of the mother's perspective on the situation. It could be, then, that a measure that takes into account children's language comprehension at a more general level (i.e. the non-spatial items of the Reynell test that comprise an understanding of passives, negation, question words etc.) is a better predictor of this ability than a language measure that looks at a more narrowly defined area of language (i.e. the spatial items that primarily look at the child's understanding of locative prepositions).

Whereas the child's general linguistic ability may thus be the most important in predicting her ability to understand indirect requests, her understanding of locative prepositions may play a vital role in learning to understand mental state terms. To understand how this might work, consider what a locative preposition does: a locative preposition denotes the concrete relationship of two objects in space from the point of view of the speaker. In the statement "the house is next to the tree", the locative preposition classifies the nature of the relationship between object A (the house) and object B (the tree) as "next to" from the point of view of the speaker. Importantly, this can be verified in an actual situation: is the house indeed next to the tree from the point of view of the speaker? A mental state term can be considered to have very similar characteristics to a locative preposition in this sense, although the relationship holds at a more abstract level. A mental state term gives a more abstract denotation of the triadic relationship between a mind and a proposition from the point of view of the speaker. In the statement "Maxi thinks that the chocolate is in the green cupboard", the mental state term classifies the nature of the relationship between Mind A (Maxi's mind) to proposition B (the chocolate is in the green cupboard) as "thinks" from the point of view of the speaker. This relationship cannot be verified in the concrete environment, though, as there is no overt evidence for the "thinking" relationship. If the child can use the analogy from locative prepositions, however, then perhaps she can use the more concrete nature of this similar perspectival relationship to get to grips with the more abstract perspectival relationship denoted by the mental state term. In this way then, the understanding of locative prepositions may precede and indeed bootstrap the child's understanding of mental state terms in a more direct way than would be the case for the child's understanding of indirect requests.

Of course, this suggestion regarding the relationship between locative prepositions and mental state terms is highly speculative and requires confirmation from future research, but it may be one aspect of language that is relevant in the child's coming to understand the nature of the mind. Whether or not the relationship between spatial language and mental state terms is indeed confirmed, this study does demonstrate that the child's linguistic ability plays a crucial role in her understanding of mental state terms and indirect requests. Although the child's understanding of other people's mental states (as assessed by tests of ToM) is not an irrelevant factor in this development (ToM was a significant predictor in the model without the language measures), this effect was eclipsed once the child's linguistic abilities were taken into account. At least for the development of the areas of communicative competence considered in this study then, it would appear that the child's linguistic abilities are of key importance in allowing the child to develop more adult-like ways of social interaction.

Chapter 5

Interrelationships between theory of mind and linguistic development*

Abstract

This longitudinal study investigates the relationship between Theory of Mind (ToM) and language. 101 Dutch four- and five-year-olds were tested on false belief understanding and various domains of language (vocabulary, general syntax, mental state terms and sentential complements). The results demonstrate a bi-directional relationship between ToM and both vocabulary and mental state term understanding, but no significant relationship between ToM and understanding of sentential complements. The general language measure, and in particular a subset of it that assesses understanding of spatial language, proved to be the best predictor of ToM. These findings suggest that although ToM may influence the development of some aspects of language, other linguistic domains are fundamental for the development of ToM.

Keywords

Theory of Mind; Language acquisition; Mental state terms; Sentential complementation; Spatial language

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* This paper will be submitted in co-authorship with Frank Wijnen and Peter Coopmans.

1. Introduction

Any first-year linguistics student who has read Pinker (2000) would agree: the idea that language has a fundamental influence on thought is absurd. Yes, exotic languages like Apache might translate "normal" sentences like *It is a dripping spring* into something bizarre like *As water, or springs, whiteness moves downward*, but this surely is more a quirk of the translator than a true reflection of the totally different cognitive representations of reality they would seem to engender. Indeed, as Pinker (2000) claims (p. 50) even sentences like *He walks* can be given an outlandish gloss like *As solitary masculinity, leggedness proceeds*, if the translator is feeling particularly creative. But can the idea that language influences thought really be brushed off that easily? Much of contemporary research would suggest not. Although no one would claim that two people speaking different languages have totally incommensurable cognitive representations of the world, more subtle differences in cognitive representations influenced by differences in the linguistic system have been demonstrated in domains as various as spatial representation, object categorisation and colour memory (cf. Gentner & Goldin-Meadow, 2003 for a collection of papers on this topic).

The focus of this paper is more local, however. Instead of considering potential differences in cognition between people speaking different languages, here the topic under investigation is developmental in nature. Does the development of language have an effect on the child's non-linguistic cognitive development? In particular, does the development of language affect the child's ability to understand other people's mental states? As with the cross-linguistic example above, on the face of it, this suggestion is absurd. Surely, children need to understand at least something of other people's mental states before they learn to speak? How else would they be capable of the very first steps in language acquisition: assigning sense to the sounds emanating from other people's mouths. If they didn't have some appreciation of the fact that these sounds *mean* something (i.e. that the people uttering them have an underlying *intention* in uttering these sounds), they would just simply ignore them instead of trying their hardest to assign some kind of representation to it all. Indeed, there is a copious amount of research that suggests that infants are sensitive to a speaker's gaze direction, pointing behaviours and intention to refer to a particular object or action and that they use this information in assigning meaning to the sounds they hear (cf. Baldwin, 1993; Baldwin & Moses, 2001; de Villiers, 2007; Happé & Loth, 2002; Tomasello & Barton, 1994; Tomasello, Strosberg & Akhtar, 1996). At the most basic level then, it seems that some appreciation of other people's mental states must be present before language acquisition can take place.

The picture may be somewhat different, however, if we look at more advanced understanding of other people's mental states. It is one thing to have some appreciation of the fact that people are intentional agents, but fully understanding the representational nature of the mind, how representations affect beliefs and beliefs affect behaviour, may be something else entirely. For one thing, we share the basic understanding that our conspecifics are intentional agents with our primate relatives. Various studies have demonstrated that although chimpanzees may not have full human adult-like understanding of the nature of beliefs, they do have some appreciation of mental states. Not only do they seem to understand that humans are intentional agents (Call, Hare, Carpenter & Tomasello, 2004), but studies by Hare, Call, Agnetta & Tomasello (2000) and Hare, Call & Tomasello (2001) have also demonstrated that they understand that seeing leads to knowing. Subordinate chimpanzees were capable of taking into account whether or not a dominant chimpanzee had seen food being placed in a particular location. If the subordinate knew that the dominant knew where the food was, the subordinate chimpanzee refrained from taking the food. In contrast, if the subordinate knew that the dominant did not know the location of the food (either because he had not seen the food being hidden or was misinformed about the location of the food), then the subordinate took the food. Although there may be some anthropomorphism in the above description, the available evidence does at least seem to suggest that chimpanzees are capable of taking into account other chimpanzees' knowledge states.

Given that chimpanzees do not have anything like the human linguistic system for communication, we can say that this level of understanding of others' mental states evidently is possible without the aid of a human kind of language. There is, however, an area of mental state understanding that, at the moment at least, has not been demonstrated in our primate relatives: false belief understanding. False belief understanding is generally seen as the litmus test of the child's understanding of other people's mental states. On demonstrating false belief understanding, children are said to have a "Theory of Mind", marking their more adult-like ability to assess other people's knowledge states. So how can we tell whether a child understands false beliefs? Generally, this is assessed by using the "false belief test", first inspired by Dennett (1978) and put into practice by Wimmer & Perner (1983) and Perner, Leekam & Wimmer (1987). In the original location change version of this test, the child is told a story in which a boy, Maxi, puts some chocolate in a blue cupboard. In Maxi's absence, his mother moves the chocolate from the blue cupboard to a green cupboard. On Maxi's return, the child is asked the false belief question: "Where will Maxi look for his chocolate?". This task thus requires the child to predict Maxi's behaviour given the latter's false belief about the location of the object. If the child is capable of ignoring her own knowledge about the world and focussing on another person's belief, even if that belief is incorrect given the current state of the world, the child is showing an advanced understanding of what goes on in other people's minds and is said to have a Theory of Mind. Generally, children reach this developmental milestone around four or five years of age (Wellman, Cross & Watson, 2001).

1.1 The Role of Language in ToM Development

Although language may not be a necessary factor in the development of precursors to false belief understanding (understanding others as intentional agents, understanding that seeing leads to knowing etc.), various researchers have suggested that full ToM development can only occur if a linguistic system is present to promote it (see Astington & Baird, 2005 for a collection of papers on this topic and Milligan, Astington & Dack, 2007 for a meta-analysis). A number of different suggestions have been made regarding which aspects of language might be relevant for false belief understanding to develop. Semantic aspects of language may be crucial in that they provide labels for unobservable entities like mental states (e.g. mental state verbs like *know* and *believe*). Once they encounter these labels, children are prompted to think about what these terms mean and to make the conceptual distinctions that they encode. In that sense then, acquiring words like *think* and *guess* could play a vital role in the child's coming to understand mental states (cf. Booth & Hall, 1995; Hall, Scholnick & Hughes, 1987). In line with this idea, Cheung, Chen & Yeung (2009) demonstrate that Cantonese children's understanding of false beliefs was predicted by their understanding of mental state verbs that entail false thought, like the Cantonese verb, /ji5-wai4/ (numbers indicate lexical tones) which translates to "falsely think". It should be noted, however, that the data in this study were correlational, so claims about the causal direction between the two domains cannot be made on the basis of this data. Other data, this time from a longitudinal study detailed in Pyers & Senghas (2009), demonstrates that the use of mental state vocabulary is a prerequisite for the acquisition of false belief understanding in adult and adolescent Nicaraguan signers.

Although semantics might provide the child with labels for mental states, syntax may give the child a format for representing ideas that differ from reality (a crucial prerequisite for false belief understanding, as this requires the ability to separate your own representation of events from, potentially false, representations that others have formed). According to de Villiers and colleagues (de Villiers, 2005, 2007; de Villiers & Pyers, 2002), there is a particular type of syntactic construction that plays a fundamental role in the development of false belief understanding: the sentential complementation construction. Children who have not mastered this syntactic construction will not be able to develop false belief understanding, de Villiers claims. So what is special about sentential complementation constructions? Sentential complementation constructions (see 1 and 2 for examples) are constructions that occur with mental state verbs (*think*, *believe*) and communication verbs (e.g. *say*).

1) Maxi thinks that the chocolate is in the blue cupboard
2) John says that the keys are in the drawer

A crucial thing to notice about the above two examples is that although the sentential complements "the chocolate is in the blue cupboard" and "the keys are in the drawer" can be false (i.e. the relevant objects are in different locations), the whole sentence can be true. As long as Maxi truly thinks that the chocolate is in the blue cupboard and John really said that the keys were in the drawer, the above two sentences are true irrespective of the actual locations of the chocolate and the keys. This observation holds true for sentential complementation constructions in general: the truth conditions of the subordinate sentence and the matrix sentence can differ in sentences with sentential complementation constructions.

According to de Villiers and her colleagues understanding of the syntactic and truth conditional properties of sentential complementation constructions is a crucial prerequisite for the child to be able to understand false beliefs. The process is assumed to go as follows: the child notices the surface syntactic similarity of communication verbs and mental state verbs (as both can occur in sentential complementation constructions). At some point, the child hears a communication verb like *say* occur with a false complement, which alerts her to the fact that it is possible to say things that are not true. Given that there is this surface syntactic similarity between communication verbs and mental state verbs, hearing a false complement embedded under a communication verb may lead the child to wonder whether the similarity between communication verbs and mental state verbs may extend beyond their syntactic forms. If it is possible to *say* something false, it may also be possible to *think* something false. In this way, the understanding of sentential complementation constructions forces the child to contemplate the nature of mental states and to appreciate the fact that it is possible to have 'false' mental states just like it is possible to say things that are not true. Acquiring sentential complementation constructions thus provides the child with a format for representing false beliefs and hence is necessary for the child to develop false belief understanding. In line with this idea, training studies by Lohmann & Tomasello (2003) and Hale & Tager-Flusberg (2003) demonstrate that training children on sentential complementation constructions also enhances their performance on false belief tasks.

However, there are also various studies that have not found a prominent role for sentential complementation constructions in ToM development (Cheung, Hsuan-Chih, Creed, Ng, Wang & Mo, 2004; Perner, Sprung, Zauner and Haider, 2003). Furthermore, Ruffman, Slade, Rowlandson, Rumsey & Garnham (2003) suggest that the way in which understanding of sentential complements is generally tested suffers from methodological flaws in that it confounds the understanding of sentential complements and false beliefs. In a typical sentential complementation task, children are told stories in which the protagonist is described as making a mistake, telling a lie or having a false belief. An example of such a story is the following (from de Villiers & Pyers, 2002):

3) He thought he found his ring, but it was really a bottle cap. What did he think?

De Villiers and colleagues claim that false belief understanding is not necessary to answer the question correctly, as the child only has to repeat the thought verbatim. However, the problem with this test is that the story does not make much sense if you have no concept of false beliefs already in place. As Ruffman et al. (2003) point out, without false belief understanding the child has no basis for reconstructing what was said and hence may find it hard to remember a mistaken proposition. An incorrect answer to the question (i.e. "that he found a bottle cap") may be due to the false belief test failers resorting to answering the question in line with their current level of understanding and hence reasoning in terms of what they know to be true. Note that using a communication verb (e.g. *say*) instead of a mental state verb like *think* in this test set-up does not solve the problem: use of the communication verb entails that the protagonist is lying, which similarly requires some understanding of the nature of false beliefs (i.e. that you can create false beliefs through giving incorrect verbal information). Even if the statement is construed as a mistake instead of a lie, still it could be claimed that at least some appreciation of the notion that thoughts can be incorrect is necessary. It should be noted though that the nature of most of the items generally used in these tasks is much more in line with the protagonist lying than simply making a mistake. Generally, what the protagonist says is much more interesting than the actual state of affairs ("she said there was a spider in her cereal, but it was really a raisin", from Lind & Bowler, 2009) or the actual state of affairs is something that the child might be punished for ("what did she say she was cutting?" in a situation in which a girl tells her father she is cutting paper, when in reality she is cutting her own hair; example from Hale & Tager-Flusberg, 2003). Although a number of studies thus have demonstrated an important role for sentential complementation in the development of false belief understanding, there are some methodological issues surrounding this claim.

In considering the developmental links between language and ToM, various researchers have thus suggested that there are particular areas of language that may be relevant in promoting the child's development of ToM, both at the semantic (understanding of mental state terms) and the syntactic level (understanding of sentential complementation constructions). However, other studies have found that it is not one area of language in particular that is relevant, but that the child's general language ability is the best predictor of false belief understanding (cf. Cheung et al., 2004; Milligan et al., 2007; Slade & Ruffman, 2005). Astington & Jenkins (1999), for example, claim that the child has to have a certain level of linguistic complexity before she can understand false beliefs. On this view, understanding that other people's mental states can differ from your own requires the child to be able to separate various representations of reality (the child's own representation and that of others). In order to accomplish this feat, the child needs a relatively complex representational system to encode these various representations of reality: the linguistic system. Language may thus provide the scaffolding, the representational means, that allows the child to make sense of the different layers of representation that are necessary for understanding others' beliefs as distinct from one's own. Instead of one particular aspect of language being relevant for false belief understanding, the claim is that the child has to have developed the linguistic system as a whole, not just particular syntactic and semantic aspects of language, to a certain level in order to be able to deal with the representational complexities inherent in appreciating other people's mental states.

1.2 The Role of ToM in Language Development

Aside from the relatively large body of research that has found that language development influences ToM development, a smaller number of studies suggest that there may also be an effect in the opposite direction: from ToM to linguistic development. Slade & Ruffman (2005), for example, show in a longitudinal study that whereas earlier linguistic development can be shown to predict later ToM development, the reverse relationship also holds. This bi-directional relationship only became apparent, however, once the ranges of scores in the language and false belief tasks were equated. In general, language tests consist of a considerably larger number of items and ranges of possible scores than tests for false belief understanding (which tend to consist of only a few items). Slade & Ruffman (2005) showed that once the language scores were equated with the ToM scores (i.e. an equal number of items from the language and ToM measures was used), ToM exerts an influence on linguistic development as well, with earlier ToM development predicting later linguistic development. Similarly, Milligan et al. (2007) also find evidence for a bi-directional relationship in their meta-analysis of the relation between language ability and false belief understanding (although the size of the effect was greater from language to ToM than the reverse).

A number of researchers have also suggested that instead of mental state terms promoting the development of ToM, ToM is necessary in order for the child to understand (epistemic) mental state terms. Papafragou (2001a), Papafragou & Li (2001) and Ifantidou (2005), for instance, all argue that children's acquisition of evidential markers (the linguistic encoding of information source, like the hearsay marker *allegedly* in English) is constrained by the development of ToM, in particular their understanding of the source of beliefs and speaker certainty. Moore, Pure & Furrow (1990) also found that the development of ToM and the acquisition of epistemic modal terms (modal adverbs like *probably* and *maybe* and modal auxiliaries like *must* and *might*; terms that indicate the certainty of a speaker's beliefs regarding a particular proposition) was related. Similarly, Moore, Bryant and Furrow (1989) note a relationship between children's comprehension of the mental state verbs *know*, *think* and *guess* and their performance on false belief tests as the timing of coming to understand the difference between these mental state terms and children's passing of standard false belief tasks is very similar. However, as all of these studies are correlational in nature, claims about the direction of the causal link between mental state language and ToM cannot be made on the basis of these findings. A stronger finding regarding the causal link between ToM and mental state terms comes from studies on autistic children. Autism is a clinical condition that has ToM deficiencies as one of its markers (cf. Baron-Cohen, Leslie & Frith, 1985; Kazak, Collis & Lewis, 1997). Various studies have noted that children with this condition also have problems in the acquisition of mental state terms (cf. Tager-Flusberg, 1992; Ziatas, Durkin & Pratt, 1998), suggesting that ToM deficiencies lead to problems acquiring (epistemic) mental state terms.

1.3 Aims of the Study

Despite many studies considering the nature of the relationship between language and ToM, how exactly the two cognitive domains are related is still unclear. This study aims to shed light on this relationship by considering the development of all relevant areas of language (general language comprehension, vocabulary, sentential complementation and understanding of mental state terms) and the development of ToM between the ages of four and five (crucial ages for the development of ToM; cf. Wellman et al., 2001) in the same group of children. In order to deal with the methodological issues that have been raised regarding the use of the "standard" sentential complementation task (standard in the sense that it is often used), a novel task that does not confound false belief understanding with understanding of sentential complements is used. With this novel task, then, the role of the syntactic properties of sentential complementation constructions in the development of false belief understanding can be considered in a new light. By using a longitudinal design and considering many different aspects of language in relation to ToM in the same children, this study thus goes beyond the scope of previous studies in the literature in its assessment of developmental links between ToM and linguistic development.

2. Method[1]

2.1 Participants

101 Dutch-speaking children (47 boys and 54 girls) who were between the ages of 4;0 and 4;11 (*M*= 4;6) at the first time of testing participated in the study. The children were recruited from three primary schools in Rotterdam and one primary school in Rosmalen (both are cities in The Netherlands). Most of the children came from lower middle class or middle class families.

Between the first and the second time of testing, eight months later, an additional nine children could not be tested again. All of these children had moved to different towns in the intervening eight months and were thus dropped from the sample, thereby leaving 101 instead of 110 children for data analysis.

2.2 Procedure

Children were tested individually in a separate room in their school building. For all sessions, two adults were present: the first author (acting as

[1] For additional notes on the methodology of this paper and the reasons behind the choice of the particular tests, see appendix 1.

experimenter) and an assistant. Each child was tested on three occasions separated by at least a day and at most a week between each session. Each session lasted approximately 30 minutes; total testing time was thus around 1.5 hours per child. Some short additional tests were conducted that are not reported in this study; total testing time per session for the tests reported here was approximately 25 minutes. Each child received one of twelve possible testing orders, so that test order effects were minimised. Children received stickers in return for their participation. The second time of testing followed the same procedure as the first time of testing. Although all the tests conducted at the first time of testing were essentially the same as those at the second time of testing, two of the ToM sub-tests had to be modified to some extent for use at the second time of testing (see the description of the various ToM tests below for more information).

2.3 Assessing Theory of Mind

Three different types of false belief task were presented to the children: two appearance-reality tasks (Flavell, Flavell & Green, 1983; Gopnik & Astington, 1988), two location change tasks (Wimmer & Perner, 1983) and two unexpected contents tasks (Perner et al., 1987). At each time of testing all three tasks were given in two different scenarios.

Location Change

The location change tasks involved scenarios much like the original one by Wimmer and Perner (1983). In both versions of the task one character places a marble in one location, which a second character moves to another location in the first character's absence. Two false belief questions were asked; one regarding where the first character will look first for the marble (the prediction question) and one requiring the child to explain the first character's looking behaviour (the explanation question). Following the false belief questions, two control questions were asked to ensure that the child had understood the story and remembered the key events. These questions related to the first location of the marble (Where was the marble first?) and the final location of the marble (Where is the marble really?). Each false belief location change task thus yielded a maximum of two points: one point for the prediction question and one for the explanation question. For the explanation question, answers were scored as correct if they referred to the original location of the object or the character's belief regarding the location of the object. The child was only awarded the points if she correctly answered both of the control questions.

Appearance-Reality

The appearance-reality tasks involved the child understanding that a deceptive object (e.g. a candle that looked like a cake) would initially be considered to be one thing (a cake) by anyone who observed the object casually. Only on closer handling would an observer be able to recognise its true identity (a candle). Two types of false belief questions were posed: one relating to the child's initial false belief regarding the nature of the object (the self-question: What did you say this was when you first saw it?) and one relating to another character's belief (the other-question, relating to puppet Ernie's belief: What will Ernie say this is if we ask him?). Two control questions followed the false belief questions in order to make sure that the children truly understood the nature of the deceptive object (the reality-question: What is this really? and the appearance-question: What does this look like?). Each appearance-reality test thus yielded two points: one for the self-question and one for the other-question. Children were only awarded points for the test questions if they answered both control questions correctly. At the second time of testing (eight months after the first time of testing), children were given different deceptive objects so that the task would legitimately assess false belief understanding (otherwise children may simply remember the true nature of the object).

Unexpected Contents

In the unexpected contents tasks, children were shown familiar containers (e.g. a pencil box) and shown that they contained something unexpected (a piece of string). Three false belief questions followed this demonstration: a self-question (What did you say was in this box when you first saw it?), an other-question (What will Ernie say is in this box if we ask him?) and an explanation-question (Why will Ernie say that?). A control question (What is really in the box?) was included to ensure children had remembered the relevant aspects of the story. The unexpected contents tasks at the second time of testing involved different familiar containers than the first time of testing. Children could receive a maximum of three points for the unexpected contents task: one for the self-belief question, one for the other-belief question and one for the explanation question. Answers to the explanation question were scored correct if they referred to the box' misleading appearance or the puppet's mistaken belief regarding the contents of the box. Children only received the points if they answered the control question correctly. Across all ToM tests, children could thus receive a maximum of 14 points, which, in comparison to other studies, is a relatively broad range.

2.4 Assessing Linguistic Ability

Initially, the test battery was considered to consist of three different linguistic measures, testing children's receptive vocabulary, their understanding of sentential complements and their general language comprehension.

General Vocabulary

The receptive vocabulary test was the Dutch version of the Peabody Picture Vocabulary Test III (PPVT) created by Schlichting (2005). This standardised test of receptive vocabulary involves the participant listening to a word and pointing to the picture that the word refers to. The PPVT test gives both a standardised score in which age is taken into account (a score of 100 represents an exactly average receptive vocabulary for a child of that age in years and months) and a raw score of the number of items on which the child gave a correct answer.

Mental Vocabulary

Mental vocabulary here consisted of mental state verbs, modal auxiliaries and modal adverbs. Following the design employed by previous studies assessing mental vocabulary (e.g. Moore et al., 1989, 1990), children were told they were going to play a sticker finding game. In this game, a sticker was hidden in one of two boxes (a blue box and a red box) and the child had to choose the right box on the basis of advice given by two puppets. In their advice, the puppets used the various mental state terms contrastively. In the mental state verb task, the Dutch verbs *weten* (know), *denken* (think) and *raden* (guess) were used (see 4 for examples). Each contrast (i.e. know vs. think, know vs. guess and think vs. guess) was presented to the child three times for a total of nine trials, allowing the child to score nine points in total. In the modal auxiliary task, *moet* (must) and *kan* (may) were used (see example 5) and in the modal adverbs task, *zeker* (definitely) and *misschien* (maybe) were used (see 6). The contrasts in both modal tasks were presented four times, allowing the child to score a maximum of four on each of the modal tasks. A total of 17 points could thus be scored by the child in the mental state term understanding task. In order to be successful on this task, children had to choose the box denoted by the mental state term that conveyed greater speaker certainty over the term that conveyed lesser speaker certainty.

4)

Ik	weet/denk/raad	dat	de	sticker	in	de	rode	doos	ligt
I	know/think/guess	that	the	sticker	in	the	red	box	lies

I know/think/guess the sticker is in the red box

5)

De	sticker	moet/kan	in	de	blauwe	doos	liggen
The	sticker	must/might	in	the	blue	box	lie

The sticker must/might be in the blue box

6)

De	sticker	ligt	zeker/misschien	in	de	rode	doos
The	sticker	lies	definitely/maybe	in	the	red	box

The sticker is definitely in the red box/
Maybe the sticker is in the red box

Sentential Complementation

In order to test the child's understanding of sentential complementation, a novel test was devised. In this test, children listened to stories involving two characters, Jan and Karin, talking about three objects (both characters and objects were displayed in an accompanying picture). One of the characters would always say something about one of the objects; the other character would then say something about the remaining two objects. At the end of the story, a puppet asked the child about the first character's utterance. An example can be found in 7:

7) [child sees a picture of Jan and Karin in a living room sitting next to a teddy bear, a doll and a book]
   It's Karin's birthday and Karin is showing Jan the presents she got. Jan says that Karin got a teddy bear for her birthday. Karin then says that she also got a doll and a book.
   Puppet: That went a bit fast. They both said something, but what did JAN say Karin got?

Correctly responding "a teddy bear" instead of "a teddy bear, a doll and a book" or other possible answers shows true understanding of the sentential complementation construction: the question regarding the relevant sentence (Jan says that Karin got a teddy bear for her birthday) is properly interpreted as relating to the content of the embedded clause and not as a general question for clarification regarding the presents that Karin received for her birthday. Importantly, none of the utterances in the story are false. All three of the objects are Karin's birthday presents; Jan just chooses to comment on a subset of them. The child thus does not have to take into account mistakes, false beliefs or lies; she only has to remember what objects each character talked about.

To make sure that the children could deal with the memory load imposed by the story, four control stories were added. These stories had the same memory load as the test stories but they did not contain sentential complementation constructions (see 8 for an example):

8) [child sees a picture of Jan and Karin standing next to a crab, a starfish and a shell]
   Jan and Karin are at the beach. They're looking for things they can take home with them. Karin found a starfish. And Jan found a crab and a shell.
   Puppet: Wait a minute. They both found something, but what did KARIN find?

For the sentential complementation task, the child's score was the number of test items, out of six, that she got right. The points were only awarded if the child answered at least three out of the four control questions correctly.

General Language Comprehension
General language comprehension was tested by giving children an abbreviated version of the Reynell test for language comprehension (Van Eldik, Schlichting, lutje Spelberg, van der Meulen & van der Meulen, 1995). The Reynell test is a standardised test, suitable for children from 1;3 to 6;3 years old. All test items involved the child manipulating certain objects out of an array of multiple objects, following a verbal instruction by the experimenter. Given the long

duration of the whole test (approximately 45 minutes per child), only parts 8, 9 and 11 of the test were conducted, consisting of 34 items in total. These parts were chosen as they best tested four- and five-year-old children's language comprehension at the sentential level. These parts of the test do not have specific names, but the test manual states that part 8 assesses "non-standard couplings of two objects through a preposition and the understanding of passive forms", part 9 assesses children's "recognition of properties of objects and understanding of number, question words and prepositions" and part 11 tests children's understanding of "two or more concepts (e.g. question words, colour, superlative forms, pronouns, prepositions and double negatives) in a concrete situation".

Initially then, the child's performance on this task was taken as a measure of her general language comprehension ability. However, on closer examination of the assessment material, it became apparent that a considerable number of the test items involved children's understanding of spatial language, in particular their understanding of locative prepositions (e.g. *in*, *on*, *next to*). Across all three parts of the task, many items required the child to appreciate the relationship between two objects as expressed by a locative preposition. As locative prepositions encode perspective (the locative preposition denotes the nature of the spatial relationship between two objects from the perspective of the speaker) and perspective relates to children's developing ToM (which hinges on children's understanding of the notion that differing perspectives on events can lead to different beliefs regarding those events), the decision was made to not only consider the child's total score on the Reynell test in the further results, but also to look at whether the spatial items in the Reynell test were more closely related to children's understanding of mental states than the non-spatial items. In dividing the Reynell items in parts 8, 9 and 11 into spatial and non-spatial items, spatial items were defined as items that contained locative prepositions and non-spatial items were those that did not contain a locative preposition. In this division of the Reynell test, items with negative elements in combination with locative prepositions (e.g. which pig is *not in* the field?) were discarded from analysis. The reason for this was that the negative element adds an extra level of processing difficulty to the item that comes on top of the computation required by the locative preposition making it unclear to what extent comprehension of the sentence is down to comprehension of the locative preposition or the negative element.

The child's performance on the Reynell test was thus considered in two ways: the score that the child received on all three parts of the test that were administered (34 being the maximum) was taken as a general measure of the child's language comprehension, but aside from that, the children's score on the spatial items (21 as the maximum) and the non-spatial items (9 as the maximum) was also considered in a separate analysis. Note that the remaining four items all contained locative prepositions in combination with a negative element and thus were discarded from analysis.

3. Results

3.1 Descriptive Statistics

Table 1 shows the means, standard deviations and ranges of the various tasks and the participants' ages at the first and second time of testing.

Table 1 Means, standard deviations and ranges of all the tests in the test battery and the participants' age at the first and second time point

		Time point 1			Time point 2		
Measure	Subtest	Mean	SD	Range	Mean	SD	Range
Age in months (years; months)	N/A	54 (4;6)	3.29	48-59 (4;0-4;11)	62 (5;2)	3.28	55-68 (4;7-5;8)
ToM	AR	1.58	1.47	0-4	2.44	1.56	0-4
	LC	2.41	1.61	0-4	3.14	1.33	0-4
	UC	2.47	2.24	0-6	3.44	2.40	0-6
	ToM sum score	6.46	4.34	0-14	9.01	4.27	0-14
Language	ppvt-s	102.60	15.97	57-143	104.77	16.10	70-144
	ppvt-r	66.18	13.78	26-98	76.12	13.31	48-115
	MV	10.31	2.40	5-16	11.15	2.69	6-17
	SC	2.01	2.36	0-6	3.05	2.46	0-6
	RO	21.52	6.61	3-32	24.13	4.19	12-33
	RS	11.68	4.65	0-20	13.46	2.84	6-20
	RNS	7.49	1.75	1-9	8.15	1.25	4-9

Note. Maximum scores: appearance-reality (AR) and false belief location change (LC) = 4; false belief unexpected contents (UC) = 6; ToM sum = 14; no PPVT maximum (ppvt-s is PPVT standardised score; ppvt-r is PPVT raw score); mental vocabulary (MV) = 17; sentential complementation (SC)= 6; Reynell overall (RO) = 34; Reynell spatial (RS) = 21; Reynell non-spatial (RNS)= 9

In the further analyses, all the individual ToM tasks are summed to create an overall ToM sum-score. For the vocabulary measure both the raw scores and the standardised scores are reported in table 1. The standardised scores demonstrate that the subjects' mean score was slightly above average (average is a score of 100). In order to consider the effect of age only once in the analyses, the raw scores are used instead of the standard scores in the further analyses (age is already taken into account in determining the standardised score and as age is considered as a separate variable in the following analyses, age would thus be doubly represented in the vocabulary score if the standardised score is used instead of the raw score).

3.2 Performance on Control Items

Quite a number of children found it hard to answer the control questions for the false belief tests correctly. This problem could be observed at both time points, but was most severe at the first time point. Especially the appearance-reality and unexpected contents tasks proved to be hard for the children as 49 and 23 children respectively gave the correct answer to at least one of the false belief questions in these tasks, but failed at least one of the control questions. This number dropped to 27 and 15 (for the appearance-reality and unexpected contents tasks respectively) at the second time point. In comparison, the false belief location change control questions were easier, as only three children gave incorrect answers to one or more of the control questions whilst answering one or more of the false belief questions correctly at both time points. All children who passed a false belief question, but failed one of the related control questions were scored as failing the false belief question.

This strict scoring policy was necessary to make sure that the children who received points on the false belief questions really understood the false beliefs instead of giving the right answer by chance. The difference between the appearance-reality and unexpected contents task as compared to the location change task is due to differences in the task set-up. To ensure understanding of the location change task, children's memory of key events in the story (where was the marble first and finally) could be probed quite easily. However, this was not possible for the other two tasks. In both the appearance-reality and the unexpected contents task, children had to show that they understood that the object under inspection could seem to be or to contain one thing whilst actually being or containing something else (a more complex requirement than demonstrating understanding of the first and final location of a marble). If the child does not have this understanding of the dual nature of the object, then their (correct) answers to the false belief questions are not very insightful. After all, if the child conceptualises the test object only as being a cake (in the case of the cake/candle) or as containing pencils (in the case of the pencil box), then their answers to the false belief questions would be correct, but not based on proper understanding of false beliefs.

For the sentential complementation task, a strict scoring policy was also maintained. In order to score points on the test questions, children had to answer at least three out of the four control questions correctly. As was the case for the false belief tests, this proved to be quite hard for many children: 46 children answered at least one of the test questions correctly, but failed on at least two of the control questions at the first time point. This number decreased to 32 children at the second time of testing. All these children were scored as failing the test items. Although this finding suggests that the sentential complementation test does not only assess children's understanding of sentential complements, but also places demands on working memory, it does mean that children who score points on this task understand sentential complements. Without these strict controls, seemingly correct answers on the sentential complementation test trials would not necessarily be meaningful. The test set-up dictated that only the first mentioned object (out of the three objects) was correct. If children used a strategy in which they simply always gave the first mentioned object as an answer, they would thus consistently give correct answers (see example 7) even though they did not necessarily understand the nature of the sentential complementation construction. Adding the requirement that children had to answer at least three of the four control questions correctly made sure that children who were using this kind of strategy to answer the questions would not receive points for sentential complementation understanding. Of course, this means that for both the ToM and the sentential complementation tasks some children will not have received any points even though they may in reality have some understanding of false beliefs or sentential complementation constructions. Nonetheless, this strict scoring criterion does ensure that those children who receive points on these measures clearly do understand sentential complements and false beliefs.

3.3 Development over Time and Correlations between ToM and Language

As can be seen in Table 1, mean scores on all of the ToM and language measures increased over time. Paired-sample t-tests demonstrate that this increase is significant for all measures ($p \leq .006$). In the eight months between the first and the second time of testing then, children's performance on the tasks assessing false belief, sentential complementation, mental vocabulary, general vocabulary and language comprehension (both the spatial and the non-spatial items) thus improved significantly.

For the sake of completeness, Table 2 presents all the bivariate Pearson correlations between age, ToM and the language measures at both time points. There are two correlations that are so high (.97 and .95) that they may indicate multicollinearity problems. However, these two correlations are between the spatial items subset of the Reynell test for language comprehension and the overall score of the Reynell test at each time point. As the spatial items represent a subset of the total Reynell items (about two thirds of them), it is expected that the overall test and the spatial items measure very similar constructs. There is reason to believe, however, that the spatial items may be more relevant in explaining the findings described below, so the role of the spatial items will be returned to later in the paper. Disregarding the correlations between the overall Reynell test and its subparts, then, generally the correlations are positive and significant (between .21 and .74). The only exceptions were the correlations between age and mental vocabulary (time 1), mental vocabulary (time 1) and sentential complementation (time 1) and mental vocabulary (time 1) and sentential complementation (time 2); none of these correlations reached significance. Generally then, it can be said that the language measures were

Table 2 Bivariate correlations between age, ToM and language at both time points (N=101)

	Age	ToM1	V1	MV1	SC1	RO1	RS1	RNS1	ToM2	V2	MV2	SC2	RO2	RS2
ToM1	.34***													
V1	.38***	.61***												
MV1	.11	.27**	.27**											
SC1	.24*	.42***	.44***	.11										
RO1	.38***	.67***	.70***	.34***	.40***									
RS1	.37***	.66***	.69***	.31**	.40***	.97***								
RNS1	.33***	.54***	.55***	.32***	.28**	.77***	.61***							
ToM2	.26**	.65***	.58***	.34***	.23*	.63***	.62***	.48***						
V2	.34***	.62***	.67***	.29**	.54***	.71***	.74***	.46***	.57***					
MV2	.22*	.33***	.29**	.32***	.24*	.42***	.42***	.28**	.30**	.42***				
SC2	.21*	.38***	.41***	.14	.53***	.52***	.51***	.39***	.30**	.40***	.30**			
RO2	.29**	.57***	.65***	.34***	.35***	.78***	.76***	.61***	.59***	.68***	.32***	.42***		
RS2	.24*	.56***	.60***	.32***	.32***	.73***	.72***	.53***	.56***	.65***	.24*	.39***	.95***	
RNS2	.35***	.42***	.53***	.27**	.25**	.66***	.61***	.59***	.51***	.54***	.40***	.32***	.75***	.56***

Note. ToM, Theory of Mind; V, Vocabulary; MV, Mental Vocabulary; SC, Sentential Complementation; RO, Reynell Overall; RS, Reynell Spatial; RNS, Reynell Non-Spatial
*p≤.05; **p≤.01; ***p≤.001

highly correlated with each other and with ToM. Furthermore, both ToM and the language measures correlated with age.

3.4 Regression Analyses

In order to determine the developmental relationship between ToM and the various language measures, hierarchical regression analyses were conducted. As performance on measures at the second time point was expected to rely on age and earlier performance on that measure, these two variables were entered first in each analysis.

3.5 Predicting Language from ToM

The first regression analyses considered whether earlier ToM could predict later performance on the individual language measures, controlling for age and earlier performance on the language measure. The first of four analyses considered whether earlier ToM significantly predicts later general vocabulary. Table 3 demonstrates the results for this analysis.

Table 3 Predicting general vocabulary 2 from age, general vocabulary 1 and ToM 1

	B	SE B	β	R²	ΔR²
Model 1					
Age	0.41	0.33	.10	.46	.46***
GV 1	0.61	0.08	.63***		
Model 2					
Age	0.24	0.31	.06	.52	.06***
GV 1	0.44	0.09	.45***		
ToM 1	0.99	0.28	.32***		

Note. GV, General Vocabulary; ToM, Theory of Mind
*p≤.05; **p≤.01; ***p≤.001

The final model (model 2) demonstrates that together with earlier general vocabulary, earlier ToM is a significant predictor of later general vocabulary (t_{97} = 3.60; p = .001). Furthermore, adding ToM to the model allows it to describe 6% more of the variance in general vocabulary at time 2 (a significant addition); the final model thus describes 52,1% of the variance (R^2_{adj} = 50,7%) with an overall significant relationship ($F_{3,97}$ = 35.22; p<.000). Controlling for age and earlier general vocabulary, ToM thus significantly predicts later general vocabulary.

The second regression analysis considered whether ToM would also significantly predict later understanding of mental vocabulary as well as general vocabulary. Table 4 gives the results of this analysis.

Table 4 Predicting mental vocabulary 2 from age, mental vocabulary 1 and ToM 1

	B	SE B	β	R^2	ΔR^2
Model 1					
Age	0.16	0.08	.19*	.14	.14***
MV 1	0.33	0.11	.30**		
Model 2					
Age	0.10	0.08	.12	.18	.04*
MV 1	0.27	0.11	.24**		
ToM 1	0.14	0.06	.22*		

Note. MV, Mental Vocabulary; ToM, Theory of Mind
*p≤.05; **p≤.01; ***p≤.001

The final model demonstrates that aside from earlier mental vocabulary, earlier ToM also significantly predicts later mental vocabulary (t_{97} = 2.19; p = .03). Furthermore, the addition of ToM allows the model to describe a significant additional 4% of the variance in mental vocabulary at time 2 (R^2=17,6%; R^2_{adj} = 15,1%; $F_{3,97}$ = 6.91; p<.000). As was the case for general vocabulary, earlier ToM thus does significantly predict mental vocabulary even when earlier mental vocabulary and age are controlled for.

The third analysis, presented in Table 5, demonstrates whether ToM also predicts children's understanding of sentential complementation constructions.

Table 5 Predicting sentential complementation 2 from age, sentential complementation 1 and ToM 1

	B	SE B	β	R^2	ΔR^2
Model 1					
Age	0.07	0.07	.09	.29	.29***
SC 1	0.53	0.09	.51***		
Model 2					
Age	0.03	0.07	.04	.31	.02
SC 1	0.47	0.10	.45***		
ToM 1	0.10	0.06	.18		

Note. SC, Sentential Complementation; ToM, Theory of Mind
*p≤.05; **p≤.01; ***p≤.001

The final model shows that adding ToM to the initial model with age and earlier understanding of sentential complementation does not enhance the percentage of explained variance significantly and neither is ToM a significant predictor of sentential complementation understanding (R^2= 31,4%; R^2_{adj} = 29,3%; $F_{3,97}$ = 14.80; p<.000).

Table 6 gives the results of the fourth analysis assessing whether ToM predicts the child's performance on the Reynell language comprehension measure. The final model shows that earlier ToM does not significantly predict later Reynell performance, nor does the addition of ToM to the model significantly add to the

Table 6 Predicting Reynell 2 from age, Reynell 1 and ToM 1

	B	SE B	β	R^2	ΔR^2
Model 1					
Age	-0.01	0.09	-.01	.61	.61***
Reynell 1	0.50	0.04	.78***		
Model 2					
Age	-0.02	0.09	-.02	.62	.01
Reynell 1	0.46	0.06	.73***		
ToM 1	0.09	0.08	.09		

Note. Reynell, Reynell test for language comprehension; ToM, Theory of Mind
*p≤.05; **p≤.01; ***p≤.001

percentage of explained variance (R^2= 61,6%; R^2_{adj} = 60,4%; $F_{3,97}$ = 51.81; p<.000).

These four analyses thus indicate that ToM predicts some areas of language, namely general and mental vocabulary, but not all aspects of language assessed here, as ToM did not significantly predict sentential complementation understanding or performance on the Reynell test of language comprehension.

3.6 Predicting ToM from Language

In considering the role of language in ToM, various hierarchical regression analyses were conducted. Two questions were considered: whether the individual language measures would predict later ToM, once age and earlier ToM were controlled for and which of the individual language measures (if any) would prove to be the best predictor of ToM. The results for the first question can be seen in Table 7. Note that this table consists of four different regression analyses: model 1 is the same for each analysis and hence is only given once; each model 2 (a to f) represents an analysis in which each language measure is considered separately.

Table 7 demonstrates that three of the predictors, general vocabulary, mental vocabulary and language comprehension, significantly predict later ToM. Model 2-a shows that adding mental vocabulary to the model adds a significant 3% to the initial 42,7% explained variance (R^2_{adj} = 44%; $F_{3,97}$ = 27.19; p<.000). Model 2-b presents the findings regarding general vocabulary: adding earlier general vocabulary to the model also results in a significant addition to the percentage of explained variance (R^2= 47,6%; R^2_{adj} = 46%; $F_{3,97}$ = 29.34; p<.000). This means that the relationship is bi-directional in the case of ToM and general vocabulary and mental vocabulary: earlier ToM predicts later general and mental vocabulary and earlier general and mental vocabulary predicts later ToM (t_{97} = 3.00; p = .003 for general vocabulary and t_{97} = 2.31; p = .02 for mental vocabulary). Model 2-c shows the results for the relationship between the Reynell test of language comprehension and ToM. The addition of the Reynell test performance allowed the model to explain an extra 7% of the variance in ToM, a significant addition (R^2= 49,5%; R^2_{adj} = 47,9%; $F_{3,97}$ = 31.65; p<.000). A unidirectional relationship was thus observed for the Reynell test and ToM:

Table 7 Predicting ToM 2 from age, ToM 1 and the language measures

	B	SE B	β	R²	ΔR²
Model 1					
Age	0.05	0.11	.04	.43	.43***
ToM 1	0.63	0.08	.64***		
Model 2 - a MV 1 to ToM 2					
Age	0.04	0.10	.03	.46	.03*
ToM 1	0.58	0.08	.59***		
MV 1	0.32	0.14	.18*		
Model 2 - b GV 1 to ToM 2					
Age	-0.02	0.10	-.02	.48	.05**
ToM 1	0.48	0.09	.48***		
GV 1	0.09	0.03	.29**		
Model 2 - c Reynell 1 to ToM 2					
Age	-0.03	0.10	-.03	.50	.07***
ToM 1	0.41	0.10	.42***		
Reynell 1	0.23	0.06	.36***		
Model 2 - d SC 1 to ToM 2					
Age	0.06	0.11	.05	.43	.00
ToM 1	0.65	0.09	.66***		
SC 1	-0.12	0.15	-.07		

Note. ToM, Theory of Mind; MV, Mental Vocabulary; GV, General Vocabulary; Reynell, Reynell test for language comprehension; SC, Sentential Complementation
*p≤.05; **p≤.01; ***p≤.001

whereas earlier ToM did not predict later performance on the Reynell test, earlier performance on the Reynell test did predict later ToM (t_{97} = 3.60; p<.000). Only the relationship between understanding of sentential complementation and ToM did not prove to be significant in either direction (see model 2-d). Adding earlier understanding of sentential complementation did not allow the model to explain more variance in later ToM, nor was earlier sentential complementation a significant predictor of later ToM. Earlier ToM thus doesn't predict later understanding of sentential complements, but neither does earlier understanding of sentential complements predict later ToM.

These initial results suggest that understanding of sentential complements does not play an important role in the development of ToM, but they do not say anything about the relative importance of the language measures. The following regression analysis thus considered this question by creating a model with all the language measures present. The initial model of this analysis is identical to the one presented in Table 7, so only the final step of the model is presented in Table 8.

Table 8 Predicting ToM 2 from age, ToM 1 and all language measures at time 1

	B	SE B	β	R^2	ΔR^2
Model 2					
Age	-0.04	0.10	-.03	.53	.11***
ToM 1	0.40	0.10	.40***		
MV 1	0.20	0.13	.11		
GV 1	0.06	0.03	.19		
Reynell 1	0.16	0.07	.25*		
SC 1	-0.24	0.15	-.13		

Note. ToM, Theory of Mind; MV, Mental Vocabulary; GV, General Vocabulary; SC, Sentential Complementation
*p≤.05; **p≤.01; ***p≤.001

Table 8 shows that the model with all the language measures inserted explains 53,3% of the variance in later ToM (R^2_{adj} = 50,4%; $F_{6,94}$ = 17.91; p<.000). Aside from earlier ToM (t_{94} = 4.00; p <.000), only earlier performance on the Reynell test for language comprehension significantly predicted later ToM (t_{94} = 2.26; p=.03), controlling for age, earlier ToM and the other language measures. Out of all the language measures, then, only children's earlier performance on the general test of language comprehension thus significantly predicted later understanding of other people's mental states.

3.7 The Reynell Test: A Closer Inspection

Although both children's understanding of general and mental vocabulary proved to be a significant predictor of ToM in a simple model (consisting of age, earlier ToM and one language measure), only performance on the Reynell test was a significant predictor of later ToM if all the language measures were taken into account. The Reynell test thus seems to be of prime importance in predicting children's later understanding of mental states. As detailed in the method section, practical considerations dictated that only certain parts of the Reynell test were given, namely those that best assessed the four- and five-year-old child's understanding of language comprehension at the sentential level. On closer examination, however, it became apparent that about two-thirds of the items in these sets involved an understanding of locative prepositions (e.g. *on*, *behind*, *next to*) that indicate the spatial relationship between two objects (e.g. "put one of the pigs *behind* the man"). As locative prepositions encode perspective (the locative preposition denotes the nature of the spatial relationship between two objects from the perspective of the speaker) and perspective relates to children's developing ToM (which hinges on children's understanding of the notion that differing perspectives on events can lead to different beliefs regarding those events), potentially then, it is this aspect of the Reynell test that was of primary importance in explaining the significance of the Reynell test as a predictor of later understanding of mental states. In the following analyses, the relationship between the development of ToM and the spatial and the non-spatial parts of the Reynell test were thus considered separately.

In the first place, the question was addressed whether both parts of the Reynell test would predict later understanding of mental states independently. Table 9 presents these findings.

Table 9 Predicting ToM 2 from age, ToM 1 and Reynell spatial 1 and Reynell non-spatial 1

	B	SE B	β	R²	ΔR²
Model 2 – e Reynell spatial 1 to ToM 2					
Age	-0.02	0.10	-.02	.49	.06***
ToM 1	0.43	0.10	.44***		
Reynell spatial 1	0.31	0.09	.33***		
Model 2 – f Reynell non-spatial 1 to ToM 2					
Age	0.01	0.11	.01	.45	.02
ToM 1	0.55	0.09	.56***		
Reynell non-spatial 1	0.43	0.22	.18		

Note. ToM, Theory of Mind; Reynell spatial, spatial items of Reynell test for language comprehension; Reynell non-spatial, non-spatial items of Reynell test for language comprehension *p≤.05; **p≤.01; ***p≤.001

As can be seen in Table 9 (model 2-e), the spatial items of the Reynell test do significantly predict later ToM (t_{97} = 3.35; p = .001). Furthermore, addition of the spatial items to the model significantly enhances the percentage of explained variance by 6% (R^2= 48,6%; R^2_{adj} = 47%; $F_{3,97}$ = 30.61; p<.000). Although there is a similar trend for the non-spatial items, model 2-f in Table 9 shows that the non-spatial items are not a significant predictor of later ToM (t_{97} = 1.94; p = .06), nor does the addition of the non-spatial items to the model significantly enhance the percentage of explained variance (R^2= 44,8%; R^2_{adj} = 43,1%; $F_{3,97}$ = 26.28; p<.000).

Together with Table 9 (model 2-e), Table 10 demonstrates that the relationship between the spatial items of the Reynell test and ToM is unidirectional: earlier performance on the spatial items predicts later ToM performance, but earlier ToM performance does not predict later performance on the spatial items.

Given these results, the spatial items of the Reynell test thus seem to be a better predictor of later ToM than the non-spatial items. The final analysis, presented

Table 10 Predicting spatial items 2 from age, Reynell spatial 1 and ToM 1

	B	SE B	β	R²	ΔR²
Model 1					
Age	-0.02	0.07	-.03	.51	.51***
Reynell spatial 1	0.44	0.05	.73***		
Model 2					
Age	-0.04	0.07	-.04	.53	.01
Reynell spatial 1	0.38	0.06	.63***		
ToM 1	0.10	0.06	.16		

Note. ToM, Theory of Mind; Reynell spatial, spatial items of Reynell test for language comprehension
*p≤.05; **p≤.01; ***p≤.001

in Table 11, considers whether the spatial items will continue to predict later ToM even when all the other language measures are controlled for.

The results of this analysis (R^2= 53,1%; R^2_{adj} = 49,6%; $F_{7,93}$ = 15.07; p<.000) suggest that this is indeed the case: out of all the language measures, only earlier performance on the spatial items of the Reynell test proved to be a significant predictor of later ToM (t_{93} = 2.01; p = .05). If the parts of the Reynell test used in this study are split into spatial and non-spatial items, only the spatial items thus predict later understanding of mental states, even when age, earlier ToM and all other language measures are controlled for.

Table 11 Predicting ToM 2 from age, ToM 1 and language (spatial and non-spatial separately) at time 1

	B	SE B	β	R²	ΔR²
Model 2					
Age	-0.04	0.10	-.03	.53	.10**
ToM 1	0.40	0.10	.40***		
MV 1	0.22	0.14	.12		
GV 1	0.06	0.03	.20		
SC 1	-0.24	0.15	-.13		
Reynell spatial 1	0.21	0.10	.23*		
Reynell non-spatial 1	0.05	0.23	.02		

Note. ToM, Theory of Mind; MV, Mental Vocabulary; GV, General Vocabulary; SC, Sentential Complementation; Reynell spatial, spatial items of Reynell test for language comprehension; Reynell non-spatial, non-spatial items of Reynell test for language comprehension
*p≤.05; **p≤.01; ***p≤.001

4. Discussion

The aim of this paper was to shed light on the developmental relationship between language and ToM by assessing children's understanding of false beliefs and domains of language suggested to be relevant in the development of ToM (mental vocabulary, sentential complements, general vocabulary and general language ability) between the ages of four and five in the same group of children. The question at the heart of this paper concerned the direction of causality between the two cognitive domains: does ToM influence the child's linguistic development in all or some of the linguistic domains considered? Or will we find an important role of language in the child's developing understanding of other people's mental states? If language does indeed predict later understanding of mental states, which aspect of language, out of the various ones suggested in the literature, will prove to be the most important? Alternatively, there could be a bi-directional relationship between the two domains with ToM and linguistic development influencing each other.

The results of this study indicate that there is a relatively complex relationship between ToM and language development. It is not the case that there is a simple unidirectional relationship between the two domains with ToM predicting each language measure or vice versa; the relationship is more subtle than that. Looking at the relationship between ToM and general and mental vocabulary, evidence was found for a bi-directional relationship. Earlier ToM predicted later general and mental vocabulary, but earlier general and mental vocabulary also predicted later ToM. This finding thus confirms claims by researchers who have suggested that hearing labels for unobservable entities like mental states prompts children to think about what they might be labelling and to conceptualise the distinctions that the various terms make (cf. Booth & Hall, 1995; Cheung et al., 2009; Hall et al., 1987; Pyers & Senghas, 2009). However, this finding is also in line with other researchers who have claimed that an understanding of other people's mental states is what prompts the child to acquire and use appropriately vocabulary that expresses this understanding (cf. Ifantidou, 2005; Papafragou, 2001a; Papafragou & Li, 2001).

It seems likely, then, that development in the domains of vocabulary and understanding of mental states influences each other. Through hearing novel words like mental state terms, the child is given an explicit clue to the existence of (unobservable) entities like mental states. Furthermore, by hearing various types of mental state terms in different situations, the child receives explicit evidence for the idea that different terms express different kinds of mental states. However, this understanding does not arise in a conceptual vacuum. The child is sensitive to other people's mental states and has an understanding of the fact that mental states guide people's behaviour. Rather than simply mapping words to pre-existing concepts or creating concepts from scratch on encountering a novel word, the child uses the novel (mental state) words to guide the process of concept formation and her sensitivity to other people's mental states is recruited in assigning meaning to novel (mental state) words; the development of ToM and (mental state) word understanding are thus interactively related. In this way then, vocabulary and understanding of mental states bootstrap each other, furthering the child's development in both areas of cognition.

Unlike the case of vocabulary, understanding of sentential complementation constructions was not related significantly to ToM development. Earlier ToM did not predict later understanding of sentential complementation constructions, nor did earlier understanding of sentential complements predict later ToM. Given that many previous studies have reported links between understanding of sentential complementation constructions and ToM, this finding is in need of explanation. Of course, future studies would have to replicate this finding with the novel sentential complementation task used here, but this study does suggest that once understanding of sentential complements is assessed with a task that does not run the risk of confounding the understanding of sentential complements with false belief understanding, there is no longer a causal link between the two domains. As stated above, although on the face of it, the traditional task assessing understanding of sentential complements would seem only to require verbatim recall of the test sentence and no understanding of the false beliefs inherent in the story, this assumption can be questioned. In order to make sense of the scenarios in which the sentential complementation constructions are presented, the child likely has to have some appreciation of the nature of false beliefs. Only if the child has at least some basic understanding of false beliefs, is she capable of understanding the story behind utterances of the type "he thought he found his ring, but actually it was a bottle cap" and thus has the conceptual basis necessary for correctly answering the question "what did he think?". If the child does not have any understanding of false beliefs, she may be inclined to answer this question in line with what she knows to be true and thus will not seem to understand sentential complements. With the novel task, understanding of false beliefs, mistakes or lies is not required at any level; the child only has to remember which protagonist commented upon which objects. It would seem, then, that a test that assesses purely the syntactic construction that sentential complements occur with (instead of also assessing the child's understanding of the potential falsity of the complements) is not predictive of children's later understanding of false beliefs. Although this does not necessarily entail that encountering sentential complementation constructions is completely irrelevant from the point of view of developing false belief understanding (given the findings regarding the relevance of mental vocabulary in ToM development, it could be that hearing mental state terms in sentences that have complements that do not reflect reality is one of the clues that prompts the child to think about the nature of mental states), it does argue against the idea that it is the syntactic construction itself that provides the child with the representational means to deal with false beliefs. This finding is thus in contrast to the claims made by de Villiers (2005), (2007) and de Villiers & Pyers (2002).

Sentential complements thus do not significantly predict ToM (or vice versa) and general and mental vocabulary are bi-directionally related to ToM. The only measure that was unidirectionally related to ToM was the Reynell test of language comprehension, as earlier performance on the Reynell test predicted later ToM, but earlier ToM did not predict later performance on the Reynell test. In fact, not only was the Reynell test the only unidirectional predictor of ToM, it was also the only language measure that remained a significant predictor of later ToM even when age, earlier ToM and the other language measures were taken into account. Although general and mental vocabulary thus did predict ToM when only age and earlier ToM were taken into account, they lost this predictive ability once the other language measures were controlled for. Out of all the language measures, then, it seems that the child's earlier performance on the Reynell test of language comprehension is the best predictor of her later understanding of other people's mental states.

What does it mean that the child's performance on the Reynell test is the best predictor of later ToM? This finding would most clearly seem to be in line with the view that the child needs a particular level of general linguistic ability in order to make sense of other people's mental states (cf. Astington & Jenkins, 1999; Cheung et al., 2004; Milligan et al., 2007; Slade & Ruffman, 2005). Understanding that other people's mental states can differ from your own requires the child to be able to separate various representations of reality (the child's own representation and that of others). In order to accomplish this feat, the child needs a relatively complex representational system to encode these various representations of reality: the linguistic system. Language may thus provide the scaffolding, the representational means, that allows the child to make sense of the different layers of representation that are necessary for understanding others' beliefs as distinct from one's own. Of course, this explanation is a perfectly plausible account of the relationship between ToM and linguistic development. Although the child is sensitive to other people's mental states before the onset of more complex language, honing her linguistic abilities (and thereby adding to the complexity of the linguistic system) may well play a fundamental role in being able to sort out the nature of false beliefs and understanding their effects on behaviour. However, the problem with this explanation is that it is somewhat unsatisfying. What exactly does "having a general level of linguistic ability" mean? How can we determine what constitutes a high enough level of linguistic ability, without resorting to the circular claim that those who pass false belief tests evidently have a high enough level of linguistic ability and those who don't do not? Ideally then, in order to create a more testable prediction, one would specify a particular domain of language that is a necessary (although perhaps not sufficient) factor in the child coming to understand false beliefs. De Villiers and her colleagues take this tack in suggesting that sentential complementation constructions are a necessary prerequisite for the child to understand mental states (in particular false beliefs). The results from this study go against this idea, however, as understanding of the syntactic construction that sentential complements come with did not predict later ToM. Although many papers have suggested that sentential complements may thus be *the* aspect of language that is relevant for the development of ToM, this study casts doubt on that assumption.

But what other aspect of language might play a role in scaffolding the child's understanding of false beliefs? The answer may lie in a closer inspection of the sub-parts of the Reynell test that were used in this study. As stated above, on further analysis of this test, it appeared that only the spatial items, testing the child's understanding of locative prepositions, significantly predicted later understanding of other people's mental states and that the non-spatial items were not a significant predictor. This finding was further strengthened by the regression analysis with all the language measures in the model. This analysis demonstrated that only the spatial items of the Reynell test were a significant predictor of later understanding of mental states, even when age, earlier ToM and all the other language measures were controlled for. If the Reynell test is divided into a spatial and a non-spatial component, the spatial component, assessing understanding of locative prepositions, thus seems to be the best predictor of later ToM out of all the tested language measures.

Of course, this finding raises the question why understanding of locative prepositions would predict children's false belief understanding. The interesting thing about locative prepositions like *behind*, *next to* and *on* is that in order to appreciate their meaning, the child has to have some understanding of perspective: although from the point of view of one speaker, the house might be next to the tree, from the point of view of another speaker, the house might be in front of the tree. Understanding of differences of perspective at this relatively concrete, spatial level is thus crucial for the child to understand these terms. The function of a locative preposition is thus to denote the concrete spatial relationship of two objects in space from the point of view of the speaker. Perspective, albeit in a more abstract sense, is of course also crucial in the child's development of ToM. Only if the child appreciates that differing perspectives on events can lead to different representations of those events (and hence potentially to false representations of those events) can the child develop a more advanced understanding of other people's mental states. Potentially then, what unites the child's understanding of mental states and their performance on the spatial items of the Reynell test is that both domains rely on the child's appreciation of the nature of perspective. Given the more concrete nature of the spatial relation described by the locative preposition (it is in principle verifiable in the context whether or not, from the point of view of a certain speaker, the house can be considered to be next to or in front of the tree), the child might be using the more concrete perspectival nature of the locative preposition to bootstrap understanding of the more abstract perspectival nature implicit in ToM. In this way, then, the understanding of locative prepositions may precede and indeed bootstrap the child's understanding of mental states.

Of course, this suggestion regarding the relationship between locative prepositions and mental states is highly speculative and requires confirmation from future research, but it may be one aspect of language that is relevant in the child's coming to understand the nature of the mind. Whether or not the relationship between spatial language and mental states is indeed confirmed, this study does demonstrate that the child's linguistic ability plays a crucial role in her understanding of mental states. Out of the four language measures that were considered, three predicted later ToM development. In the child's dawning understanding of other people's mental states, then, various aspects of her linguistic ability are relevant, not only at the semantic level (general and mental vocabulary), but also at the syntactic level (both in a general sense and potentially in a specific sense, through the understanding of locative prepositions). The idea that language might influence the child's understanding of other people's mental states is thus anything but absurd; the findings here suggest that it is a fundamental part of ToM development.

However, it should also be noted that the relationship between language and ToM is not entirely unidirectional either. Yes, various aspects of the child's linguistic development are crucial in her coming to understand false beliefs, but the child's more advanced appreciation of other people's mental states, as indicated by her ability to pass false belief tests, also plays an important role in furthering particular aspects of linguistic development. Most notably in the area of vocabulary, both in the general sense and more specifically in the realm of lexical items referring to mental states, the child's earlier understanding of false beliefs proved to be a significant predictor of later lexical development. From the very earliest steps in language acquisition, then, the child is sensitive to other people's intentions in assigning meaning to words and this sensitivity remains crucial in the process of word learning even as the child gets older and the meaning of words that have to be learnt gets more abstract (e.g. epistemic modals like *definitely* and *might*). It seems then that the more advanced the child's understanding of other people's mental states is, the better she is able to acquire (mental state) words. The development of ToM and language is thus truly interrelated, with developments in both domains allowing the child to enter into more advanced interaction both in the linguistic and the social domain.

Conclusion

So, here we are, at the end of the line. The real die-hards who have hung in there throughout the introduction and all five chapters will have ploughed through hundreds of hours worth of data regarding the EF, ToM and (mental) language capacities of three, four, five and six year olds in typically and atypically developing populations. This is not the end yet, however, as the results of the five studies reported in this dissertation still need to be tied together.

1. Recap of the Findings

The question at the heart of this dissertation concerns the nature of the relationship between ToM and language: Does the development of language influence the child's capacity to attribute mental states to others or is the child's understanding of other people's mental states crucial in the development of language? Each of the five chapters in this thesis attempts to address this question by focussing on particular aspects of ToM and language. The first chapter (*Children's production of referring expressions: Contributions from executive function, theory of mind and linguistic development*) considers mental language ability at the discourse level in three- and young four-year-old children. Specifically, this study looked at whether these children could use referential expressions appropriately and what the role of language, ToM and the inhibition component of Executive Function (EF) is in the development of referential communication. The findings of this study contrast with previous findings in the literature suggesting that appropriate referential communication in the standard version of the referential communication task is not generally evident until children are about six years old (cf. Deutsch & Pechmann, 1982; Glucksberg, Krauss & Weisberg, 1966; Krauss & Glucksberg, 1969, although more recent studies do demonstrate appropriate use of referential expressions in naturalistic data at an earlier age, see De Cat, 2004; Skarabela & Allen, 2002; Rozendaal & Baker, 2008). Instead, the results of this study demonstrate that if the referential communication task is simplified in various respects, at least some level of appropriate referential communication can already be demonstrated at three years old. Regarding the role that EF, ToM and language play in this development, the findings of the study are that only performance on the ToM tasks is significantly correlated with the ability to produce appropriate referential expressions. EF and general linguistic ability thus do not predict referential communication abilities, suggesting that referential communication relies more on children's understanding of others' mental states than on inhibitory or general linguistic abilities. Regarding the relationship between

ToM and language, this study thus suggests that at least for the development of this aspect of mental language, ToM is more relevant than general linguistic ability.

The second chapter in this dissertation (*Children's understanding of epistemic modality: Contributions from theory of mind and linguistic development*) extends this finding in a domain of mental language at the lexical level, understanding of epistemic modality. This study considers four-year-old children's understanding of the differences in speaker certainty as conveyed by various epistemic modals and the role that ToM and language play in the acquisition of these terms. In line with previous studies considering the understanding of epistemic modals in English-speaking children (cf. Byrnes & Duff, 1989; Moore, Pure & Furrow, 1990), but in contrast to findings regarding Italian-speaking children (cf. Bascelli & Barbieri, 2002), this study demonstrates that Dutch four-year-olds can make distinctions between various epistemic modal terms based on their understanding of the differences in speaker certainty that these terms convey. The acquisition of the modal system is not yet complete at this age (ceiling performance was not reached), but some appreciation of the distinction between the modal auxiliaries *moeten* (must) and *kunnen* (might) and the modal adjuncts *zeker* (definitely) and *misschien* (maybe) is already present. Regarding the role of ToM and language in the understanding of epistemic modals, again, the findings suggest that ToM is the better predictor of children's understanding of epistemic modals. Although one of the language measures in the battery, performance on the Reynell test for language comprehension, did significantly predict understanding of epistemic modals, this effect disappeared once ToM was entered into the model. The results of this study thus suggest that ToM is the better predictor of epistemic modal understanding. Just like the first chapter, the second chapter therefore also provides evidence that in the acquisition of mental language ToM has a more important role to play than the child's linguistic abilities.

In the third chapter (*Modal auxiliaries in typically developing and autistic children: A theory of mind account*), the understanding of epistemic modal auxiliaries and the role that ToM and linguistic ability play in their acquisition was also investigated. However, in this study an older population was considered and the epistemic modals that were assessed were more complex than those in the second chapter. In line with the previous findings for four-year-olds, the six-year-olds tested here were found to understand the differences in speaker certainty as conveyed by epistemic modal auxiliaries (*moeten* 'must', *zullen* 'should' and *kunnen* 'might'), although ceiling performance was not yet obtained for this more complicated tripartite distinction. As well as considering six-year-olds' understanding of epistemic modal auxiliaries, this study also looked at the performance of an atypically developing population in this domain: children who had been diagnosed with a disorder in the autistic spectrum (a clinical population known to have a ToM deficit). The reasoning underlying this choice was that if ToM is relevant in the development of mental language, individuals who have impaired ToM development should also display poor mental language ability. In other words, the autistic subjects should have more problems in understanding epistemic modal auxiliaries than their typically developing peers. In first instance, the findings of this study did not seem to bear out this line of reasoning, as the autistic group did not demonstrate inferior epistemic modal understanding in comparison to the typically developing group. However, once the subjects were divided according to whether they passed all the ToM tests that were administered ("ToM passers") or failed at least one of the ToM test questions ("ToM failers"), not according to clinical diagnosis, it became clear that the ToM passers understood the differences in speaker certainty as conveyed by the epistemic modals better than the ToM failers, even though the two groups did not differ in age or in general linguistic ability. Furthermore, the opposite pattern was not found: those who passed the epistemic modal task did not have a higher ToM-score than those who failed the epistemic modal task. The results of this study thus suggest that if ToM has not (yet) developed fully, the acquisition of mental language at the lexical level, epistemic modal auxiliaries in this case, will also be delayed, again suggesting an important role for the development of ToM in children's ability to acquire mental language.

So far, then, the findings presented in this dissertation suggest that ToM is of key importance in the development of at least those areas of language that relate directly to the understanding of other people's mental states (i.e. mental language). In the acquisition of this area of cognition at the interface of ToM and language, an understanding of others thus seems to play a more important role than general linguistic abilities. However, as already stated in the introduction, all three of these studies suffer from drawbacks that limit the strength of the conclusions that can be drawn from them. The first two studies are correlational in nature. Although they both find that ToM is strongly related to mental language, more so than the child's general language ability, the stronger claim, that ToM is what drives the development of mental language, cannot be made on the basis of this data. Given the data from these studies, it is equally possible that the development of mental language is what drives ToM. The third study suffers from a similar drawback, although the fact that it includes a clinical population that has a ToM deficit as one of its clinical markers does make it more robust than the other two studies. However, even the third study is correlational in nature, so although a ToM deficit (and not a mental language deficit) is generally considered to be the primary deficit in autism, it is still possible that problems in mental language are affecting the development of ToM instead of (or as well as) the other way round. Furthermore, it should be noted that the results of the third study indicated that the main difference in epistemic modal auxiliary understanding was not between the autistic group and the typically developing group as such, but between ToM passers and ToM failers (thereby diminishing the relevance of the clinical diagnosis for the ability to understand epistemic modal auxiliaries). In order to clinch the argument for a driving role of ToM in the development of mental language, a research design that allows stronger conclusions to be drawn with regards to the direction of the causal effect is thus needed to supplement this data.

This, then, is the primary objective of the fourth chapter. The fourth chapter (*Developing communicative competence: The acquisition of mental state terms and indirect requests*) investigates the development of mental language at both the lexical and the discourse level (specifically, the understanding of mental state terms and indirect requests) at two different time points: first when the child is four years old and again eight months later. Results of this study demonstrate that, generally, children's performance on the mental state terms and indirect requests tasks increases significantly across the two time points. There was, however, one area of mental language that did not develop significantly over time: children's understanding of the difference in speaker certainty as conveyed by the mental state verbs *denken* (think) and *raden* (guess). Although children were capable of appreciating the difference in speaker certainty between *weten* (know), on the one hand, and *denken* (think) and *raden* (guess), on the other, thereby showing that they appreciated the distinction between certainty and uncertainty, they were not yet capable of distinguishing between the two terms, *denken* and *raden*, which both denoted some level of uncertainty. Apart from this distinction, then, between four and five years old, children's understanding of mental state terms and indirect requests develops considerably, although ceiling performance is not yet reached for either mental state term or indirect request understanding at this age.

Aside from charting the development of these two areas of mental language, the fourth chapter also considers the role that ToM and language play in this development. Which is the better predictor of children's later understanding of indirect requests and mental state terms: earlier ToM or earlier linguistic ability? If the results of the first three studies are considered, it would be expected that earlier ToM would prove to be the better predictor of later mental language. This was not entirely borne out by the results, however. Although ToM did predict both mental state term and indirect request understanding in a basic model (with only age and earlier performance on the particular mental language task controlled for), this effect disappeared once the language measures were also taken into account. In contrast to the expectations raised by the first three studies, earlier language thus seems to be the better predictor of later mental state term and indirect request understanding. However, it was not just any aspect of the child's linguistic ability that was relevant in predicting later mental language, only one aspect proved the be relevant: performance on the Reynell test. This, then, would suggest that the child's general linguistic ability at the sentential level is the most relevant in predicting later mental language; a conclusion in line with the suggestion by Astington & Jenkins (1999) that the child needs a particular level of general linguistic ability in order to make sense of other people's mental states. However, on closer inspection of the Reynell test, it appeared that the test items used in this investigation could be split into two parts: one part assessing children's understanding of spatial relationships as encoded by locative prepositions and another part that tested children's language comprehension skills at a more general level. Taking these separate parts of the Reynell test into account, it appeared that only the spatial part of the Reynell test predicted later understanding of mental state terms and only the non-spatial part predicted children's understanding of indirect requests.

What might explain the fact that the spatial items on the Reynell test predict children's understanding of mental state terms, whereas the non-spatial items predict indirect request understanding? Understanding of locative prepositions gives the child a concrete way of understanding differences in perspective between speakers. On encountering a locative preposition, the child is faced with a different way of encoding reality depending on the spatial location of the speaker. Importantly, the child can literally put herself in the speaker's position and see whether, from the speaker's point of view, a statement with a given locative preposition (e.g. the cow is behind the man) is true or not. This concrete linguistic encoding of the speaker's point of view could then be used to bootstrap the child's understanding of linguistic encodings of perspective at a more abstract level, that is, they could bootstrap understanding of mental state terms. Of course, the question arises why this understanding of perspective at a more concrete level does not also predict the child's performance on the indirect requests task, as this task similarly requires an appreciation of another speaker's point of view. This difference can be explained by appealing to the different linguistic requirements imposed by the two mental language tasks. Although the indirect requests task requires the child to appreciate the speaker's underlying request (and hence requires the child to be aware of the speaker's perspective on events), in order to receive credit for the task, the child also has to be able to parse the story and the mother's utterance and come up with a coherent verbal response. In this sense, then, the indirect request task may require more of the child's general linguistic skills than just her understanding of the speaker's perspective on the situation. In contrast, the mental state term task did not place such high demands on the child's linguistic skills. Although they had to have acquired the relevant lexical items (the mental state terms that were assessed) and understand the verbal task instructions in order to receive credit for the task, other linguistic skills at the sentential level were not called on as much.

The findings from the fourth chapter thus point to an important role for language in the development of mental language and, in particular, they suggest that children's understanding of locative prepositions may be relevant in bootstrapping the child's understanding of differences in perspective as encoded by mental state terms. The fifth chapter (*Interrelationships between theory of mind and linguistic development*) builds on these findings by posing a more general question than the fourth chapter: Can earlier linguistic ability (i.e. the various domains of language that have been suggested to be relevant in previous research) predict later ToM or does earlier ToM predict later linguistic ability? The results of this study suggest that there is a complex developmental relationship between the two cognitive domains, with bi-directional relations between some domains of language and ToM, but a unidirectional relationship going from other domains of language to ToM. However, in contrast to previous research (de Villiers, 2005, 2007; de Villiers & Pyers, 2002), this study did not find a significant relationship between ToM and children's understanding of sentential complementation constructions. Presumably, this is the result of using a sentential complementation task that does not require understanding of false beliefs in order to understand the sentential complementation construction. Although this finding is in need of replication, it suggests that the link between sentential complementation and false belief understanding may be spurious, an artefact of the method of testing, instead of a true reflection of the process of cognitive development in the domains of ToM and language.

In line with previous studies suggesting a relationship between mental state term understanding and the development of ToM (cf. Booth & Hall, 1995; Cheung, Chen & Yeung, 2009; Hall, Scholnick & Hughes, 1987; Moore, Bryant and Furrow, 1989; Moore et al., 1990; Pyers & Senghas, 2009; Tager-Flusberg, 1992; Ziatas, Durkin & Pratt, 1998), earlier ToM was found to predict later mental vocabulary and, in fact, later general vocabulary as well and, conversely, earlier general and mental vocabulary also predicted later ToM. The relationship between ToM and general and mental vocabulary is thus bi-directional. The only unidirectional relationship was found between ToM and performance on the Reynell test of language comprehension. Earlier performance on the Reynell test predicted later ToM, but the reverse did not hold. Furthermore, the Reynell test also turned out to be the only significant predictor of later ToM, once all the other factors were taken into account. Although both general and mental vocabulary predict later ToM when only age and earlier ToM are taken into account, this predictive value disappears once the other language measures are added to the model. In a model with age, earlier ToM, general and mental vocabulary, sentential complementation and the Reynell test, only the Reynell test proved to be a significant predictor of later ToM. A re-analysis of the Reynell test into spatial and non-spatial items (as was done for the Reynell test in chapter four as well) showed that the spatial items in particular were responsible for predicting later ToM. The spatial subset of the Reynell test thus does not only predict later understanding of mental state terms, but later ToM as well, suggesting an important role for locative prepositions not only in the understanding of lexical items related to the understanding of beliefs, but to false belief understanding itself as well.

2. Putting the Pieces Together: Integration of Results

As the recap above will have made clear, the conclusions that were reached in the individual chapters are not entirely consistent throughout the dissertation. Although the first three chapters suggest that ToM plays an important role in the development of (mental) language, the fourth and fifth chapter instead provide evidence that it is (mental) language that plays an important role in the development of ToM. Of course, this discrepancy has to be explained, but how? In the first place, the nature of the data in the first three studies already merits a number of caveats regarding the strength of the conclusions that can be drawn. Purely on the basis of the stronger experimental design employed in chapters four and five, then, the results of the first three chapters could be put aside. However, that conclusion is a bit too easy and more rash than it needs to be. Firstly, let's consider the findings from chapters two and three in relation to the outcome of chapter five. What was found in chapters two and three was that ToM is more strongly related to mental language at the lexical level (specifically, the understanding of epistemic modals) than general language ability, but, as the data are correlational, the direction of effects between ToM and mental language could not be determined. In that sense, then, the only firm conclusion that could be drawn from these two studies was that ToM and mental language are highly correlated and that this correlation, considered at one time point, is stronger than the correlation between general language and mental language. In addition to corroborating this result, chapter three also provided evidence for the idea that a ToM deficit co-occurs with a deficit in mental language at the lexical level (in the sense that those who performed poorly on the ToM measures, be they autistic or not, also performed worse on the mental language measure than those who performed well on the ToM measures).

Although on the face of it, the findings presented in chapter five may seem to be at odds with the above conclusions, on closer examination, they might not be. After all, chapter five demonstrates that earlier ToM does predict later understanding of mental state terms, as would be expected given the findings from chapters two and three. However, chapter five also demonstrates the reverse relationship: earlier mental state term understanding predicts later ToM as well. So, what could not be determined from studies two and three (i.e. whether ToM predicted mental state term understanding or vice versa) becomes clear given the outcome of study five: ToM does predict mental state term understanding, but mental state term understanding also predicts ToM. The relationship is thus bi-directional. Given that fact, it makes sense that ToM and mental language at the lexical level are strongly correlated and that a deficit in ToM is detrimental to mental language understanding: they influence each other, so the development of one is bound to have an effect on the development of the other. What was less expected given the findings from chapters two and three was the finding in chapter four that out of all the predictor variables it would be one of the language measures, performance on the Reynell test, that would turn out to be the best predictor of mental state term understanding. Although the outcome from study two did already suggest that the Reynell test was the most important measure of the language tests, in that study, its effect on mental state term understanding disappeared once ToM was taken into account. However, in the longitudinal study, this effect was reversed: earlier ToM predicted later understanding of mental state terms, but this effect disappeared once the Reynell test was taken into account. Closer inspection of the Reynell test suggested, though, that it might not be the child's general language comprehension as such that was responsible for this finding, but the fact that the Reynell test assessed understanding of perspective as encoded by locative prepositions. Indeed, if the components of the Reynell test were split so that the effect of the spatial language items was considered separately from the non-spatial items, it appeared that only the spatial language items were relevant in predicting later mental state term understanding; a possibility that was not considered in the earlier studies.

Based on the findings in chapter one, chapter four yielded another unexpected finding regarding the development of indirect requests. The results of the first chapter suggested that ToM was most strongly correlated with referential communication, an aspect of mental language at the discourse level. However, chapter four demonstrated that the Reynell test, not ToM, was the best predictor of children's understanding of indirect requests, another aspect of mental language at the discourse level. It should be noted though that given the nature of the two tasks, referential communication and indirect request understanding, the question is whether findings from one task could really be used as a basis for expectations about the other. One of the aims of the first chapter was to create a referential communication task that would be doable for children younger than six years old (the age at which successful performance in standard referential communication tasks is generally demonstrated). On the upside, the study succeeded in doing so and demonstrated at least some understanding of appropriate referential communication in this much younger age group. However, the downside of this simplification was that the task was now too easy for the four- and five-year-olds assessed in later chapters. Four-year-olds were already very good at this task and five-year-olds had reached ceiling performance. Given that there was hardly any development in performance on this task between the two time points (because performance at the first time point was already so high), it was not possible to determine the role that ToM and language played in referential communication ability as assessed by this task. Chapter four thus did not look at this domain of mental language at the discourse level, but instead looked at children's performance on a more complicated task: understanding of indirect requests. There is thus no direct longitudinal comparison for the findings presented in chapter one, although on the basis of these findings it was expected that earlier ToM would be the better predictor of later mental language at the discourse level than earlier linguistic ability (because ToM was more strongly correlated with another aspect of mental language at the discourse level than linguistic ability). The fourth chapter did not uphold this expectation (the non-spatial items of the Reynell test turned out to be a better predictor of later indirect request understanding than ToM), but, at the same time, it did demonstrate that ToM is relevant in the development of indirect request understanding: earlier ToM did predict later understanding of indirect requests, even when age and earlier understanding of indirect requests were controlled for. The relevance of ToM in the development of mental language at the discourse level was thus confirmed by chapter four, in line with expectations raised by chapter one.

Although the findings in chapters four and five might go against the spirit of the argument as presented in chapters one to three, the findings do not, strictly speaking, go against the conclusions that could be drawn from the data in the first three chapters. ToM has an important role to play in the development of various aspects of language, both at the general level (general vocabulary) and at the mental level (mental state term and indirect request understanding), but various aspects of the child's linguistic ability (most notably understanding of locative prepositions) also play a vital role in the development of ToM and in the acquisition of mental language.

3. The Relationship Between Language and Thought: ToM and (Mental) Language

So what do these results tell us about the relationship between language and ToM and, ultimately, about the relationship between language and thought more generally? Clearly, there is no simple causal relationship between the development of ToM and language. Both domains are broad in their scope; many other aspects of ToM and language could have been considered. What this collection of studies has demonstrated is that one core component of ToM, false belief understanding, is causally related to some, but not all, aspects of language that were considered here. Throughout the five chapters, evidence has been presented for a high correlation between ToM and referential communication, indirect request understanding, general and mental vocabulary, general language comprehension and understanding of locative prepositions. Notably absent from this list, however, is the relationship between ToM and sentential complementation. Although much of prior research has suggested strong links between understanding of sentential complementation constructions and false belief understanding, this research did not find any evidence for this link. Of course, future research will have to replicate these findings using the novel sentential complementation task presented here, but it seems that once the methodological flaws that beset the traditional sentential complementation task are ironed out, there is no developmental link between children's understanding of false beliefs and sentential complementation constructions in either direction.

In contrast to the finding for sentential complementation constructions, ToM and both general and mental vocabulary were found to be bi-directionally related, suggesting that the child uses her sensitivity to other people's mental states as a basis for assigning meaning to words in general and mental state terms in particular and that hearing words in general and mental state terms in particular primes the child to consider what these terms may refer to. Especially in the case of the acquisition of mental state terms and concepts, this kind of cognitive architecture makes sense: mental states are non-observable entities, making them relatively hard to learn. On hearing mental state terms, the child is forced to consider what they may refer to, but is guided in this process by her dawning understanding of other people's mental states which, in turn, primes the child to "look out" for terms referring to mental states in the input. It is interesting to note that a similar bi-directional relationship is not present for the child's performance on the Reynell test of language comprehension in relation to false belief understanding. This relationship was strictly unidirectional going from language to false belief understanding. This would suggest that children need a certain level of linguistic ability in order to be able to deal with the representational complexities inherent in understanding mental states and their linguistic encoding (both at the lexical and the discourse level). As well as providing the child with labels for unobservable entities like mental states (which presumably enhances the child's understanding of mental states at the conceptual level), language may thus also provide the child with a representational system that is complex enough to be able to deal with different levels of representation that are necessary for false belief understanding. However, aside from this role of language in the development of ToM, potentially there may be a more specific aspect of linguistic development that is (also) relevant in coming to understand false beliefs: locative prepositions.

4. The Role of Spatial Language in the Development of ToM and Mental State Terms

While the findings for the relevance of understanding locative prepositions in the development of ToM and mental state terms is potentially interesting, it must be stated clearly that this finding was post hoc. Only when the Reynell test was found to eclipse the relevance of ToM in predicting later understanding of mental state terms and indirect requests (ToM predicted later indirect request and mental state term understanding, but this effect disappeared once the Reynell test was added to the model) were the individual items of this test inspected more thoroughly. The thinking was that if earlier ToM was relevant to later understanding of mental state terms and indirect requests, then, potentially, the Reynell test was eclipsing the role of ToM in the model because it too appealed to an understanding of beliefs at some level. Looking at the Reynell test through this lens led to the finding that there was a substantial number of locative prepositions in the subtests of the Reynell test that were used. Taking this finding further in chapter five, it transpired that not only did the spatial items of the Reynell test predict one aspect of mental language, understanding of mental state terms, but they also predicted later ToM. It was not the case, however, that the spatial subset of the Reynell test predicted everything that the whole Reynell set also predicted, as the overall Reynell score did predict indirect request understanding, but the spatial subset did not (only the non-spatial subset predicted indirect request understanding). This dissociation between the spatial subset of the Reynell test predicting one aspect of mental language and the non-spatial subset predicting another, although initially unexpected, does mean that more basic explanations of the relevance of the spatial subset can be ruled out. If the spatial subset of the Reynell test was simply the most complex test of language in the test battery (in the sense that it posed the highest demands on linguistic ability in general and/or on non-linguistic abilities like working memory or attention) then one would expect this part of the Reynell test to be the best predictor of any other complex skill in the test battery. This was not the case, however, as the spatial component did predict mental state term understanding and ToM, but not understanding of indirect requests.

So, there does seem to be something special about the relationship between the spatial subset of the Reynell test, mental state terms and mental states. But what might this finding mean for the nature of the relationship between ToM and (mental) language? It suggests that children can use their understanding of perspective in a concrete, spatial sense, as conveyed by locative prepositions, to bootstrap understanding of more abstract perspective relationships that are at the basis of false belief and mental state term understanding. This idea has an embodied cognition feel to it: by physically placing yourself in the position of a speaker to verify a statement with a locative preposition ("is the cow really behind the man from the speaker's point of view or is it in front of the man, which is the way it seems from my point of view"), you can literally *see* what it is to have two different perspectives on the same state of affairs. This kind of experience also demonstrates that language can be used as a tool to encode these differences in perspective: what can be described as *behind* from one point of view is described as *in front of* from another point of view. Both of these experiences, being made aware of the fact that it is possible to have different points of view on the same state of affairs and hearing these two points of view described using different linguistic means, may be formative in the child's development of understanding of mental states.

There are, however, still some creases that need to be ironed out in this account. At least two questions still remain: to what extent is an understanding of perspective inherent in all locative prepositions? And to what extent is the linguistic encoding of perspective differences a necessary part of the process? Regarding the first question, it is clear that some locative prepositions rely on an understanding of perspective more than others. Terms like *behind* and *next to* clearly depend on the speaker's perspective on the state of affairs, but for terms like *in* and *on* this may not be so obvious. So, to what extent is an understanding of perspective crucial in the understanding of these locative prepositions as well? The intuition is not as clear as in the case of locative prepositions like *behind* and *next to*, but even these terms depend, to some extent at least, on the speaker's physical location: although the cheese might seem to be *on* the bread to one speaker, the cheese would be considered to be *under* the bread for another speaker looking at the scene standing in a handstand. And where *in* might be considered to be the most appropriate preposition by one speaker, another would perceive the same relationship as *on* or *under*, depending on their spatial orientation regarding the state of affairs (although in this case the debate might be more about the definition of the locative preposition rather than the perspective relationship it encodes). But apart from this, understanding of terms like *in*, *on*, *behind* and *next to* might reflect a dawning understanding of these kinds of terms in general; performance on the spatial items of the Reynell test might reflect a comprehensive assessment of all these terms that relate to perspective in some sense. Although at an individual level, the terms may not all rely on a clear understanding of perspective, a measure of children's understanding of the class of locative prepositions may still reflect their understanding of spatial perspective in a general sense. Of course, future research is needed to demonstrate whether it is the prototypical perspective denoting locative prepositions (*behind*, *in front of*, *next to*) that are of prime importance in predicting later ToM and mental state term understanding or whether the understanding of locative prepositions as a whole class of lexical items is a better indicator of perspective understanding.

The second question (to what extent is the linguistic encoding of perspective differences a necessary part of the process?) also awaits future research. What neither chapter four nor chapter five can tell us is whether it is the linguistic encoding of perspective (via locative prepositions) that is relevant or whether it is the conceptual understanding of differences in spatial orientation that is the key to understanding other people's mental states and the mental state terms that are used to describe those states. Does hearing a different linguistic description of a spatial relationship between objects (i.e. different locative prepositions) give the child an extra boost in understanding that speakers can differ in their perspective of events? Or is it enough for the child to reach understanding at a conceptual level that different perspectives on spatial relationships between objects are possible depending on one's spatial orientation in relation to these objects? In other words, is it fundamental to hear different *linguistic* descriptions for different spatial relationships between objects in order to understand false beliefs and/or mental state terms? It is possible, then, that actually what was found in chapters four and five is not so much linguistic bootstrapping for the understanding of mental states (that is, locative prepositions scaffolding children's understanding of mental states), but general spatial bootstrapping (children's understanding of spatial relationships between objects scaffolding understanding of mental states) which happened to be encoded linguistically in the task that was used. Future research is needed to disentangle these two possible interpretations of the findings.

5. Outstanding Issues: Verbal False Belief Tests and False Belief Understanding in Infancy

The interpretation of the results regarding locative prepositions thus remains an outstanding issue to some extent. Aside from this, there are (at least) two other issues that also need to be discussed as a final note to this thesis. The first of these regards the use of verbal false belief tests. It may seem strange that a study that aims to disentangle the contributions of ToM to language and language to ToM would use a verbal ToM test. After all, how can we be sure that the verbal demands of the ToM task are not hindering the child in her ability to demonstrate what she knows about other people's mental states? To some extent this concern is warranted; it would have been purer, methodologically speaking, to assess ToM without the use of language. However, use of a nonverbal version of the false belief test proved to be unfeasible from a practical point of view, because strictly nonverbal analogues of the standard ToM test tend to take a lot of time to conduct (approximately 30 minutes in Colle, Baron-Cohen & Hill, 2007), as they involve lengthy training sessions before the actual test session. The duration of the whole test battery was already approximately 90 minutes in total (split over three sessions), so adding an extra 20 minutes would most likely have overstretched the attention spans of the subjects. The question is, however, whether the results would have changed if a nonverbal test had been used instead of a verbal one. The results of Call & Tomasello (1999) would suggest not. This study compared performance on a verbal and a nonverbal version of the standard false belief task and found that the correlation between the two versions was very high and that both tests were passed at very similar ages. It seems likely, then, that the fact that the ToM tasks posed demands on the linguistic skills of the child as well as on her mental state understanding did not affect performance. An additional bonus of using the verbal version of the false belief test is that this is the version that the vast majority of studies looking at ToM development use as well. The results from the chapters presented in this dissertation can thus be compared easily to those obtained in other studies assessing the relationship between language and ToM (the vast majority of which have also used verbal false belief tests).

Recently, however, a special set of nonverbal false belief "tests" has become the centre of attention for ToM researchers. A significant number of studies (see Baillargeon, Scott & He, 2010, for a review) demonstrate that infants in the second year of life already seem to understand false beliefs. Of course, children of this age are not very linguistically mature, so their understanding is not assessed using test questions that require explicit verbal answers. Instead, infants are given violation-of-expectation (VOE) or anticipatory looking (AL) paradigms that show their sensitivity to other people's mistaken beliefs. In a typical VOE task, children are shown a scenario in which an agent should end up with a false belief, but the infants then witness the agent acting in a way that is inconsistent with that false belief. To give an example: the child sees an agent place an object in a particular location, which is then moved to another location whilst the agent isn't looking. However, instead of searching in the location where the agent had last seen the object (and thus where she should mistakenly believe it to be), the agent then proceeds to retrieve the object from the place where it actually is. In these kinds of scenarios, infants as young as 15 months old (cf. Onishi & Baillargeon, 2005) look reliably longer at the scene in which the agent acts in a way that is inconsistent with her false belief than at a control scene that shows the agent acting in a way that is consistent with the false belief. The reasoning of the researchers is that the 15-month-old infant understands that the situation facing the agent should lead her to have a false belief and hence is surprised when the agent does not turn out to act in accordance with that belief (and surprise, in this case, translates into longer looking times for the surprising scenario). Similar findings using the VOE paradigm have also been obtained for other nonverbal analogues of false belief contexts (cf. He, Bolz & Baillargeon, 2010, for an unexpected contents task; Scott & Baillargeon, 2009, for an object identity task; Song & Baillargeon, 2008, for understanding of false perceptions). Findings for the AL paradigm suggest a later understanding of false beliefs, but even these paradigms find that children as young as 25 months old can already anticipate where an agent with a false belief about the location of an object will search for it (cf. Southgate, Senju & Csibra, 2007, building on earlier work by Clements & Perner, 1994, that demonstrated correct anticipatory looking in children from 2;11 onwards). In short, the number of studies supporting the idea that infants have an understanding of false beliefs in a diverse set of scenarios using various experimental paradigms is mounting. These findings suggest that the subject population in this dissertation may have been ill chosen: instead of looking at the performance of four-year-olds, infants should have been the focus of attention. Of course, if 15-month-old infants already have false belief understanding, then the question at the heart of this dissertation (does language influence false belief understanding or vice versa?) is a non-starter: 15-month-old infants are not known for being particularly linguistically perspicacious, so their linguistic skills are unlikely to have aided them in understanding an advanced concept like false belief.

Whilst this is a legitimate issue to raise given the recent findings in the literature, it may still be a bit too soon to take these findings as definitively showing false belief understanding in infants. Although more and more studies are coming out demonstrating what at least would seem to be sensitivity to other people’s false beliefs in various different contexts, these studies are not without criticism. Various other explanations could be offered for these findings that do not require attribution of false belief understanding to the infant. For instance, it is possible that infants are capable of coming up with behavioural rules that guide their looking behaviour (e.g. agents who are searching for an object typically search for it where they last saw it), or that infants do have a certain appreciation of goal-directedness and a rationality assumption that would lead them to believe that an agent acts in a way to achieve her goal in the most efficient way, without necessarily understanding beliefs at a mentalistic level (cf. Haith, 1998; Ruffman & Perner, 2005; Perner & Ruffman, 2005). Aside from these alternative explanations of the findings, Sirois & Jackson (2007) claim that the infant studies suffer from methodological problems and statistical limitations that make the results of these studies equivocal. While the findings regarding infants’ purported understanding of false beliefs are intriguing, the interpretation of the findings may thus not be clear-cut. For the moment, then, four-year-olds thus still remain an interesting population from the point of view of ToM research.

Whilst the above caveats regarding the infant findings are in order and things could be left at that, they are a bit of a cop out, side-stepping the issue, rather than tackling it head on. So, let’s grant that infants have an understanding of false beliefs when they are 15 months old, if for nothing else than the sake of argument. What would this mean for the findings presented in this dissertation? It is clear, of course, that something must happen between 15 months and four years of age. 15 month-olds may understand false beliefs at some level, but it takes them a good three more years before they are capable of passing standard false belief tests (or even completely nonverbal analogues of these tests; see Call & Tomasello, 1999). So what is going on here, why does it take three years for this knowledge to surface in the standard test? The hallmark of the standard false belief test is that it requires explicit knowledge of others' false beliefs. In order to actively predict another person's false belief, it is not enough to have some level of sensitivity to false beliefs; this understanding has to be quite clearly articulated in the child's mind in order for her to be able to pass standard false belief tests. In contrast, this kind of explicit knowledge is not required (and would of course be an impossible requirement) for the infant false belief tests. What seems to be going on, then, is that although infants might possess an implicit understanding of false beliefs, this knowledge is not explicitly available to them; they cannot call upon this knowledge consciously in order to answer questions that require an explicit response (which cannot be due only to verbal limitations, given their failure on nonverbal analogues of standard false belief tasks as well). Indeed, a study by Ruffman, Garnham, Import & Connoly (2001) demonstrates that children who show implicit understanding of false beliefs through their eye-gaze (by looking towards the location where an agent with a false belief would search for her object on hearing the false belief test question) do not give an explicit answer in line with their implicit knowledge. Not only that, but those who show implicit knowledge of the correct answer also fail to show any signs of uncertainty about their incorrect explicit answer (they were prepared to bet a high number of counters on their false explicit answer being correct even when their eye gaze indicated that at some level they were aware of the correct answer). Some important developmental steps thus have to be taken for the progression from implicit false belief understanding, as evidenced by infants in VOE and AL paradigms, to the kind of explicit understanding that allows children to pass standard false belief tasks.

Potentially, a model like Karmiloff-Smith's (1992) representational redescription model can account for this process. Applying this model to the current false belief data, we could say that 15-month-old infants have knowledge of false beliefs at the I-level (the implicit level), which gets progressively more explicit[1] until at four years old, children have full explicit knowledge of other people's false beliefs that can be described verbally. Evidence of intervening stages of explicitness comes from, for example, the active helping paradigm (cf. Buttelmann, Carpenter & Tomasello, 2009) that demonstrates that at 18 months old children will actively help an agent with a false belief retrieve an object. At this age, children are still not able to succeed on a standard false belief task, but they may have so-called E1-representations (see Karmiloff-Smith, 1992) regarding their understanding of false beliefs. They cannot yet make their

[1] Note that the implicit-explicit distinction is not treated as a dichotomy in this model; multiple levels of explicit knowledge are posited.

understanding explicit at the verbal level (which would require an E2/E3-representation), but they can tap into their knowledge of false beliefs to some extent, so that they can perform behaviours that are more explicit in nature than simply looking in a particular direction or looking at a particular event for a particular amount of time. Eventually, then, by redescribing their knowledge through a number of phases, their initially implicit knowledge is rendered increasingly explicit until the point that children have conscious, verbal access to this knowledge and can pass standard false belief tests.

Potentially, what language does in this development is help this representational redescription process along. The acquisition of particular aspects of language (e.g. locative prepositions or mental vocabulary) and/or the possibility for representational complexity that having a linguistic system provides may be factors that allow the child to go from implicit knowledge of false beliefs to the more explicit knowledge required for successful performance on standard false belief tests. Although the child may thus display implicit sensitivity to false beliefs at a very young age, the question posed in this thesis, does language influence ToM development or vice versa?, is still relevant if we consider the relationship between language and the explicit version of ToM that allows children not only to pass false belief tests, but also to reason about other people's mental states in a conscious, more adult-like way than a 15-month-old ever could. Regarding this issue, then, this dissertation presents findings that suggest that various aspects of the child's linguistic ability drive the development of explicit ToM, but that the capacity to think about other people's mental states at an explicit level is also relevant in the development of some areas of language.

A number of questions regarding the interpretation of results thus remain and various directions for future research have been suggested. Nonetheless, if the findings presented in this dissertation are generalised, we can say that there is an interactive relationship between the development of language and thought with bi-directional relationships between certain areas of development, but unidirectional ones between others. The general question that has been the topic of so much debate in the last few centuries "does thought precede language or does language precede thought?" thus does not really seem to be the right question to ask. Given how broad in scope both of these terms are (and in this dissertation only some aspects of language and one aspect of thought were considered), it is unlikely that all of thought in all its complexity would be present before any of language is acquired by the child. Conversely, it is also improbable that a full adult-like linguistic system would have to be in place before the child is capable of any non-linguistic thought. The key to answering the general question would thus seem to be to consider particular domains of language and thought separately: which aspects of language/thought might be required for the child to be able to develop which aspects of thought/language? The findings from this dissertation suggest that an answer to this question would be that false belief understanding is necessary for general and mental vocabulary to develop and vice versa, that sentential complementation is not necessary for false belief understanding to develop, but that a general level of language comprehension and, possibly, an understanding of locative prepositions are necessary requirements for false belief understanding to appear.

Appendix 1

Notes on the operationalisation of terms and the choice of tests

Defining the Terms

The aim of this thesis was to consider the developmental relationships between a number of domains of cognition, namely (mental) language, Theory of Mind (ToM) and, to a lesser extent, Executive Function (EF). As remarked on in various places in this dissertation, any research looking at these fields of study runs into the problem that they are all so broad in their scope that, of necessity, only particular aspects of each domain can be considered. In trying to chart the development of these cognitive domains over time, a decision thus had to be made regarding exactly which aspects of each area of cognition would be considered. Although the premise of this dissertation is thus to consider the developmental relationships between (mental) language, ToM and EF, strictly speaking, only those aspects of each domain that were actually assessed can be commented upon. However, every effort was made to ensure that as broad a picture of these domains was obtained as was practically possible.

Theory of Mind

In practice, this entailed that only one particular aspect of ToM was considered: the child's capacity to understand false beliefs. Although children's social understanding is broader than only their capacity to understand false beliefs, the false belief task is generally considered to be the litmus test of mental state understanding (see, for example, Wellman, Cross & Watson, 2001, for a review). Putting aside recent findings suggesting that infants are already sensitive to false beliefs (see the conclusion for an elaborate discussion of this topic), most researchers, even those who do not think that the false belief task should be used as the standard test for ToM (Bloom & German, 2000), agree that if children can pass the standard false belief task, they are demonstrating a relatively sophisticated understanding of other people's mental states. In this sense, then, performance on the false belief task can be taken as a good indicator of children's understanding of mental states more generally. Of course, this is not to say that other aspects of children's understanding of mental states would be irrelevant to their development of language in general or mental language in particular, but as this aspect of ToM has received so much attention in the literature and its relationship to linguistic development has been debated so extensively, the decision was made to focus only on this aspect of social understanding.

Executive Function

A similar decision was made regarding the assessment of EF. As is the case for ToM, EF is a broad term used to refer to children's inhibition capacity, their working memory span, their ability to plan future actions and their attention spans. However, the inhibitory component of EF has been suggested to be the most relevant one in relation to ToM development (cf. Perner & Lang, 1999; Perner, Lang & Kloo, 2002; Schneider, Schumann-Hengsteler & Sodian, 2005). Given practical limitations regarding testing time, the choice was thus made to only consider the relationship between the inhibition component of EF and the other domains of study. Again, this does not entail that other aspects of EF would not have been worthy of consideration, simply that most of previous research looking at EF in relation to ToM has focussed on this aspect of EF. In the interest of comparability to other studies, the decision was thus made to consider children's inhibitory capacities, instead of working memory, planning or attention.

Language

Language was operationalised in a broader sense than ToM and EF. Whereas the ToM and EF measures focus on one aspect of each domain, in order to determine children's linguistic capacities, receptive vocabulary, language comprehension at the sentential level and understanding of sentential complementation constructions were all assessed. The choice of these aspects of language was guided by the current debate in the literature. Although many researchers would agree that there is some relationship between ToM (that is, false belief understanding) and language development (see, for example, Astington & Baird, 2005 for a collection of papers on this topic and Milligan, Astington & Dack, 2007, for a meta-analysis), there is no consensus regarding which aspect of language might be most important. According to some (e.g. Astington & Jenkins, 1999), the child's general linguistic ability is the most relevant, whilst others state that particular aspects of language (e.g. sentential complementation constructions in de Villiers, 2005 and 2007 or understanding of mental state vocabulary in Pyers & Senghas, 2009) are relevant. In order to consider the merits of these various claims, both general measures of language were used (receptive vocabulary as assessed by the standardised PPVT test and language comprehension as assessed by parts of the standardised Reynell test for language comprehension) as well as more specific measures (a novel task assessing understanding of sentential complementation constructions and, as part of the mental language assessment, a number of tasks assessing understanding of mental state terms). Taken together, these measures thus give a relatively comprehensive overview of the child's linguistic abilities. However, taken separately, each test is also informative regarding the relationship between that particular aspect of language and ToM. Again, the choice of these particular tests is not definitive: other (standardised) vocabulary tests or general language comprehension tests could in principle also have been used. However, for reasons elaborated on in various parts of the thesis (chapters 2, 4 and 5), the traditional method of assessing sentential complementation constructions was purposely not used in this thesis. Given the various methodological issues that surround this task, the decision was made to assess understanding of sentential complementation constructions using a novel task instead of the one that is generally reported in the literature.

Mental language

Mental language was deemed an interesting area of cognition to investigate as it is at the interface of ToM and language, requiring both linguistic ability and understanding of other people's mental states. However, in assessing children's mental language ability, again, only a small set of possible types of mental language was considered: some aspects of mental language at the lexical and discourse level. Mental language at the lexical level was deemed to be interesting as it requires an understanding of the particular mental terms that were assessed (relying on children's general vocabulary ability), but in order to understand the underlying concepts, children also have to have an appreciation of the mental states that the particular lexical items refer to (relying on their ToM skills). Many different types of mental state terms could have been considered, but as previous research (e.g. Moore, Bryant & Furrow, 1989; Ziatas, Durkin & Pratt, 1998) has looked primarily at children's understanding of the English mental state verbs *know*, *think* and *guess* in relation to ToM ability (in both typically and atypically developing populations), the choice was made to look at the Dutch translational equivalents of these words. Similarly for the modal terms, previous research (e.g. Moore, Pure & Furrow, 1990; Noveck, Ho & Sera, 1996) has concentrated on children's understanding of modal auxiliaries and adverbs like *must*, *might* and *maybe*, so Dutch translational equivalents of these terms were used. Furthermore, in the interest of comparability, the task design that has been used to test understanding of these terms in previous studies was also used in this thesis.

Aside from mental language at the lexical level, mental language at the discourse level was also investigated. Mental language at the discourse level requires more from the child's linguistic abilities than mental language at the lexical level, as not only vocabulary skills are required, but also an understanding of language at the sentential level. In order to test children's mental language ability at the discourse level, referential communication and understanding of indirect requests were considered. Indirect request understanding is an interesting area to consider, as it requires the child to understand the linguistic form of the utterance in which the indirect request appears, but also that she appreciate the intention of the speaker underlying the utterance. Understanding of this type of speech act thus requires both linguistic and ToM ability. The same can be said for successful performance on referential communication tasks: the child has to verbally describe a picture (thereby employing her linguistic skills), but also take into account the point of view of the listener, so that the description makes sense from their perspective (thereby employing ToM skills). For reasons discussed extensively in chapter one of the thesis, the traditional form of the referential communication task was simplified in various respects so that it would be more suitable for the age group tested.

In short, the domains under consideration in this study have been defined in a relatively narrow sense. ToM refers specifically to false belief understanding and EF to the child's inhibition capacities. Mental language at the lexical level is operationalised as the child's understanding of the mental state verbs *weten* (know), *denken* (think) and *raden* (guess), the modal auxiliaries *moeten* (must), *zullen* (should) and *kunnen* (can) and the modal adverbs *zeker* (definitely) and *misschien* (maybe). Mental language discourse is defined as children's understanding of indirect requests and their ability to use appropriate referential expressions in a modified version of the standard referential communication task. General language can be split into three different sections: vocabulary, language comprehension at the sentential level and sentential complementation constructions. This choice was made on the basis of results in previous literature and on practical considerations (which standardised tests were easily available, for instance). These particular choices do not entail that other choices would be wrong or irrelevant. Other aspects of (mental) language, EF and ToM could have been considered and may also have been interesting from the point of view of the research questions underlying this thesis. However, as time was a limited resource, not all aspects of these broad domains could be tested and particular choices had to be made.

General Test Requirements

Once the domains of cognition considered in this thesis had been specified more precisely, specific tests had to be chosen for their assessment. The particular tests in the battery were chosen based on a number of constraints. At a general level, each test had to be appropriate for children in the age range assessed in these studies. The tests thus had to be relatively hard for three-year-olds, doable for four- and five-year-olds, relatively easy for six-year-olds and adults had to perform at ceiling level on each of the tests. Based on results from previous studies in the literature and as determined by pilot testing, the tests in the test battery generally fit this criterion. This was not the case for the referential communication task and the EF tasks, however, as these proved to be rather too easy for children older than three. In the thesis, the results of these tasks are thus only presented in the first chapter, which deals with the three-year-olds' performance. Aside from the requirement that the task complexity be suitable for four- and five-year-olds, the test duration also had to be appropriate for this age group, so that the attention spans of the children would not be overtaxed. Pilot testing determined that thirty minutes was the maximum amount of time that children in this age range could pay attention and practical considerations determined that no more than six testing sessions would be viable for each child (that is, three sessions per measure point in the longitudinal set-up). Not only were tests chosen on the basis of their complexity and duration, attention was also paid to the child-friendliness of the tasks. For the children to want to pay attention to the task, each test had to be engaging. To this end, puppets, colourful pictures and interesting toys were employed in all cases where this was possible.

These three general constraints regarding the complexity, duration and child-friendliness of the tests were guiding principles in the choice of the particular tests involved in the study. Of course, many different tests could have been chosen, even if those that could be considered too hard, long or boring are set aside. The fact that particular tests were chosen for inclusion in the test battery thus does not necessarily mean that only those tests would be informative; other tests of EF, ToM, general and mental language could have been chosen. However, the tests that were included in the test battery were all either standardised tests or had been used often in previous literature (there are two exceptions to this, the sentential complementation task and the referential communication task, but the reasons for using novel tasks for these domains are discussed extensively in the thesis). This reliance on tried-and-tested forms of assessment thus made the results of the studies presented in this thesis easier to compare with other results in the literature.

Specific Notes on the Tests

In order to assess children's ToM abilities, their performance on various different false belief tasks (as originally presented in Wimmer & Perner, 1983 and Perner, Leekam & Wimmer, 1987) was considered. Whereas many studies that assess ToM in relation to other domains of cognition often only conduct one false belief test with only a false belief prediction test question, the power of this study lies in the fact that three different types of ToM tasks were conducted, each in two different scenarios involving different types of question. The false belief location change task was chosen as it is generally considered to be the standard ToM task. However, the false belief unexpected contents and the ToM-version of the appearance-reality task are also used often in research assessing ToM. The combination of all three tasks thus gives a comprehensive view of the child's ToM abilities, assessed using various different question types, materials and contexts. To be precise, each child was required to respond to fourteen different ToM questions (two self-questions and two other-questions in the appearance-reality task, two self questions, two other-questions and two explanation questions in the unexpected contents task and two other-questions and two explanation questions in the location change task). For each individual task, it may be possible for the child to succeed by guessing or by using a strategy that does not require mental state computation. However, given the large number of different ToM tasks, good performance on the total ToM score is very likely to indicate a high level of ToM.

Language tasks

The Peabody Picture Vocabulary Test III (Dutch version by Schlichting, 2005) is a standardised test used widely to assess children's receptive vocabulary. The Reynell test for language comprehension (Van Eldik, Schlichting, lutje Spelberg, van der Meulen & van der Meulen, 1995) is also a standardised test that assesses children's language comprehension in a more general sense (not only receptive vocabulary, but also understanding of complex sentences is assessed). However, as the whole Reynell test would have been too long to be incorporated in the test battery, only those parts of the test that assessed children's understanding of more complex language at the sentential level were chosen. A test of sentential complementation constructions was also added to the language part of the test battery as various studies have suggested that the understanding of these constructions is necessary for the child to be able to understand false beliefs. However, the traditional way in which these constructions have been tested is potentially flawed (requiring understanding of false beliefs in order to understand the premise underlying the test story), so a novel test was devised for the assessment of these constructions (see articles 2, 4 and 5 for extensive discussion of the problems with the traditional test and justification of the novel task). Each language test separately is thus relevant in that it allows the role of that particular aspect of language to be related to the development of ToM and mental language. Furthermore, if the scores on the different tests are combined, a relatively comprehensive measure of the child's linguistic capacities can be derived, allowing a more general assessment of the developmental relationship between language, mental language and ToM.

Mental Language

Mental language at the lexical level was assessed using a test design that has been employed frequently in studies assessing children's understanding of mental state terms (see for instance Hirst & Weil, 1982 or Moore, Bryant & Furrow, 1989). By making children choose the location of a desirable object on the basis of contrastive use of mental state terms, their understanding of the different shades of meaning conveyed by the various mental state terms can be assessed. Of course, the choice of the particular mental state terms used in this study could have been different, but as previous studies in languages other than Dutch have concentrated on particular mental state verbs, modal auxiliaries and modal adjuncts, translational equivalents of these terms were used. In comparison to other studies, this thesis thus assessed understanding of mental language at the lexical level in a novel language (Dutch) and with more different types of lexical mental language (not only mental state verbs or modal terms, but a combination) than most studies reported in the literature usually do.

Mental language at the discourse level was assessed by looking at children's understanding of indirect requests and their performance on a simplified form of the standard referential communication task. Indirect requests were tested by telling children a story in which a character utters an indirect request (using a design similar to, for example, Elrod, 1987). Following the indirect request, a puppet who had been listening to the story with the child then asks the child to explain the utterance with the indirect request. Referential communication was tested by using a modified form of the standard referential communication task. In its standard form (cf. Deutsch & Pechmann, 1982; Glucksberg, Krauss & Weisberg, 1966; Krauss & Glucksberg, 1969), a child has to choose a particular picture and describe it to a listener who does not have visual access to that picture. As studies in previous literature have suggested that children find this version of the task very challenging until they are around six years old, it was deemed necessary to simplify the task to make it more appropriate for the tested age group. Simplification of the referential communication task consisted of decreasing the demands placed on the ToM, language and EF capacities of the child. ToM demands were decreased by making it clear to the child beforehand what information the listener would require. Importantly, the child thus still had to take the listener's perspective into account (the child could not simply use referential expressions that were in line with her own view of the picture), but she did not have the extra task of discerning the precise nature of the information the listener needed. Presenting the child with only one target picture at a time reduced demands on the child's EF, as irrelevant features from other pictures did not have to be directly inhibited. However, children did still need to inhibit the use of referential expressions that would be in line with their own view of the picture. The task thus still demanded some level of inhibitory control. In order to alleviate the linguistic demands of the task, children were helped if they were unable to describe a character or an action before the test trials began. Although children thus still had to draw on their verbal ability to describe the picture appropriately, unsuccessful performance due to lexical gaps was reduced in this way.

Again, other domains of mental language could have been considered, both at the lexical and the discourse level, but by considering multiple different types of words at the lexical level and two kinds of tasks at the discourse level, the selected tests do give a relatively comprehensive view of the child's mental language abilities.

Executive Function

In order to test children's inhibition capacities, various tasks that have been used for this purpose in previous studies have been used. The dimensional change card sort task is generally considered to be the standard task for assessing children's ability to inhibit prepotent responses (cf. Perner & Lang, 1999) and was thus incorporated into the test battery. The false sign location change task and the false sign contents change task (based on Sabbagh, Moses & Shiverick, 2006) were both chosen because they resemble quite closely the false belief location change and the false belief unexpected contents task respectively. In the case of the location change scenarios, both the false belief and the false sign task have essentially the same story. Both involve two characters and two containers. In first instance, one of the containers receives a prominent role in the story (either because one of the characters is located there or because an object has been placed in it), but then the other container becomes relevant from the point of view of the test question (because the character moves there or because the object is moved to that container). Both test scenarios thus involve children having to inhibit a prepotent response (namely to consider the initially salient container to be the relevant container), however, the primary difference is that whereas an incorrect representation has to be attributed to a mind in the false belief scenario, in the false sign scenario, the misrepresentation has to be attributed to a sign (that is, an arrow pointing to the incorrect location). In the case of the false sign contents change and the false belief unexpected contents task, both tasks involve one container that contains something unexpected given either the outward appearance of the container itself (in the false belief task) or a sign posted next to the container that is related to the container's contents (in the false sign task). Again, both tasks require salient aspects of the appearance of the container or the sign next to the container to be ignored. However, the difference lies in the fact that in the false belief scenario, an incorrect representation of the contents of the container has to be attributed to a mind, whereas for the false sign version of the task, the misrepresentation concerns the sign. The child thus has to perform similar computations for the false sign tasks and the ToM tasks, but the false sign tasks do not involve the attribution of mental states, merely misrepresentations of reality. In this sense, these tasks are good controls for the inhibitory demands of the ToM tasks. It appeared, however, that these tests of EF weren't clearly related to ToM or linguistic development in the three-year-olds and that they were too easy for the four- and five-year olds. Only in the chapter concerning the three-year-olds' performance are these tasks thus presented. These results do suggest, however, that other domains of EF or more complicated tasks of the inhibition component of EF would perhaps be more suitable for future research on the relationship between EF, ToM and (mental) language.

Appendix 2

Test procedure

ToM tasks
(two versions of each for each time point, one version is given as an example)

Type 1: Appearance Reality
Materials: Ernie, cake/candle, saucer

E: experimenter
A: assistant

E: Look, here's someone you might know. He's called Ernie. Shall we play a game together with [name child], Ernie?

A (as Ernie): well, actually I'm a bit tired. Do you know what: I'll go and take a nap and then you can play a game with [name child], ok?

E: Fine, so let's play a game together and then Ernie can take a nap.

A: [places Ernie under the table, who doesn't appear again until E calls him]

E: Okay, I'm going to show you something. I'll put it here and then you can take a look. What is this?

E: It looks like a cake, doesn't it? But now feel it and look at the wick. It isn't a cake, is it? What is it?

[test question 1]
E: So when you saw this for the first time, before you touched it and before you saw the wick. I asked you then what it was, what did you say?

[test question 2]
E: *Okay, Ernie is still sleeping, remember. So he has never seen this and he hasn't touched it either. If I ask him what this is, what will he say?*

E: Hey, Ernie seems to be awake again. Did you have a good nap, Ernie?

A (as Ernie): yes, I'm wide awake again, but I can see something on the table.

[control question 1]
E: Tell Ernie what this REALLY is.

[control question 2]
E: And it looks like a…?

Type 2: False Belief Location Change
Materials: Paul, Laura, marble, basket, box

E: Here we have two dolls. This is Paul

A: [points to Paul]

E: and this is Laura

A: [points to Laura]

E: Laura has a marble, look. Laura wants to put her marble somewhere, so she walks to the basket and puts her marble in the basket

A: [moves Laura to the basket and puts the marble in the basket].

E: Laura is hungry, so she goes away to get some food

A: [moves Laura under the table]

E: But look, Paul takes the marble from the basket and puts it in the box! There's Laura again.

[test question 1]
E: Where will Laura look first for the marble?

[test question 2]
E: Why will Laura look there first for the marble?

[control question 1]
E: Okay, so to make sure you were listening properly: where is the marble really?

[control question 2]
E: And where was the marble first?

Type 3: False Belief Unexpected Contents
Materials: Ernie, egg box, toy car

E: Look, here's Ernie again! Do you want to play another game with me and [name child], Ernie?

A (as Ernie): Well, that would be fun, but I'm a bit tired actually. I'll take a nap instead.

E: Okay, no problem. Have a good sleep, Ernie

A: [moves Ernie under the table]

E: Then we'll just play a game!

E: Look what I have here. What's in it?

[test question 1]
E: Now I'll open it and then we can see what's in it. Look what's in! There's a toy car in it, not eggs at all! *When you saw this box for the first time, before I'd opened it and we'd looked in it. Then I asked you what was in it, what did you say?*

[control question 1]
E: Okay, what's really in the box?

[test question 2]
E: Ernie is sleeping now, isn't he. So he has never seen this box before. He hasn't opened it and he hasn't looked in. *If we show this box closed up to him. And then we ask him "what's in this?" What will he say?*
[test question 3]
E: *And why will he say that?*

EF tasks
(All EF tasks given here)

Type 1: Dimensional Change Card Sort
Materials:
Pile 1: 2 practice cards (1 green car, 2 yellow cars) and 2 target cards (2 green cars, 1 yellow car)
Pile 2: 7 preswitch cards (4 green, 3 yellow)
Pile 3: 9 post-switch cards (4 green, 5 yellow)

E: Here we have two cards. Take a look at this card [points to one of the target cards]

E: How many cars are there on this card?

E: And which colour are the cars on this card?

E: Now take a look at this card [points to other target card]

E: How many cars are there on this card?

E: And what colour is the car on this card?

E: Okay, now we're going to play a game. The game is called the colour game. In this game, all cards with green on them go in this box

A: [points to the box with the two green cars target card]

E: and all cards with yellow on them go in this box

A: [points to the box with the one yellow car target card].

E: So this card, with yellow on it, goes...
A: [gives card]
E: put it in the slot

E: and this card with green on it, goes...
A: [gives card]
E: put it in the slot

E: Okay, now we've done two cards together. Now [assistant] will give you more cards and you can put them in the slots like we do for the colour game

A: [hands the child the pre-switch cards]

E: Here's a green one. Put it in the slot.

[E labels the colour of each card that A gives the child]

[And so on until the child has sorted all 7 pre-switch cards]

E: Okay, now we're going to play a new game. This game is called the number game, or the counting game, you can call it that too. The number game is like the game we just played, but it's a bit different. In the number game, all cards with one car one them go here

A: [points to box with 1 car target card]

E: and all cards with two cars on them go in this box

A: [points to the box with the 2 car target card].

E: So this card, with 1 car on it goes…

A: [gives card with 1 car on it to child]

E: and this card goes...

A: [gives card with 2 cars on it to child]

E: Now [assistant] is going to give you more cards and then you can put them in the slots again like you're supposed to for the number game.

A: [gives child the 7 remaining post-switch cards]

Type 2: False Sign Location Change
Materials: arrow, two houses, Paul (boy figure) and Laura (girl figure)

E: Here we have an arrow, two houses, a boy Paul and a girl Laura

A: [points to each object]

E: The arrow can point to this house
A: [turns arrow so that it points to one of the houses]
E: or to this house, can you see?
A: [turns the arrow so that it points to the other house]

E: This boy, Paul, sometimes plays in this house
A: [places Paul in one house]
E: and he sometimes plays in this house.
A: [places Paul in the other house and then takes him out again and places him in the original position]
E: Because you can't see Paul from the outside when he's playing in one of the houses, he uses the arrow to show everyone in which house he's playing.

A: [turns the arrow so it is pointing to one of the houses]

[arrow practice question 1]
E:If the arrow is pointing like this, where is Paul playing?

A: [turns the arrow to point to the other house]

[arrow practice question 2]
E: *And if the arrow is pointing like this, where is Paul playing?*

E: Okay, now I'll tell you a story about Paul and his friend Laura

E: Paul and Laura want to play together and they're trying to decide in which house they will play. But they can't choose, so it's taking a while. Then Laura gets hungry.

A (as Laura): I'm so hungry, I'm going to go and get something to eat. I'll be right back

A (as Paul): Fine, I'm going to play already. I'll leave the arrow pointing to the house that I'm playing in.

E: Now Laura is leaving, do you see, and Paul makes the arrow point to the house in which he's playing

A: [Laura leaves and Paul turns the arrow to point to the house in which he goes to play].

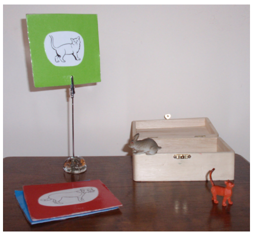
E: But it has already been quite a while and Laura still hasn't come back yet. Then Paul decides that he wants to play with the toys in the other house

A: [Paul is taken from one house and put in the other house].

[test question 1]
E: But look, Paul left the arrow where it was! Now Laura comes back and she's looking for Paul. *Where does the arrow say that Paul is playing?*

[control question 1]
E:Where is Paul really playing?

Type 3: False Sign Contents Change
Materials: Paul, cat, dog, rabbit, box, picture holder, picture of dog, picture of cat and picture of rabbit



E: Look, here's a boy, Paul, do you remember him? Paul has three pets. This is his...
A: [points to the cat]

E: and this is his…
A: [points to the dog]

E: and this is his…
A: [points to rabbit]

E: Paul also has a box in which his animals can rest when they are tired
A: [points to the box]

E: But only one pet can be in the box at a time, cause then they have enough room. Paul also has cards with pictures of his pets on them. He has a card of his...
A: [shows dog picture]
E: and a picture of his...
A: [shows cat picture]
E: and a picture of his...
A: [shows rabbit picture]

E: so if there's a pet in the box, then Paul puts a card with that pet next to it, so he can see what's in the box

E: Now Paul's going to tell you a story.

A (as Paul): the dog looks so tired, the dog can go and take a rest in the box. Jump in the box, dog. And then I'll put the picture of the dog next to the box. Ok, the dog can take a rest and you two can go off and play.

A: [cat and rabbit exit scene from one side of the table and Paul exits scene from the other side].

[control question 1]
E: Paul has left, can you see?
What does the card say is in the box?

E: Now Paul, the cat and the rabbit are coming back

A (as Paul): You're all rested now, dog. Come on cat, you look a bit tired. You can go and rest in the box. And now I'll put the picture of the cat next to the box. Okay, the cat can take a rest and you two can go off and play again.

A: [dog and rabbit exit scene from one side of the table and Paul exits scene from the other side].

E: But look what's happening! The rabbit has come back.

A (as rabbit): I'm going to take a rest now. I'm so tired. Cat, why don't you go and play

A: [cat is taken out of the box and rabbit put in]

[test question 1]
E: And there's Paul again.
What does the card say is in the box?

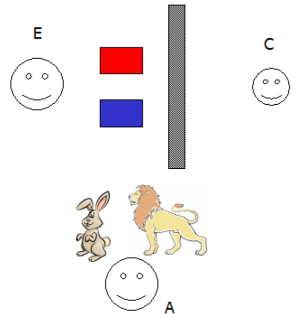
[control question 2]
What's really in the box?

Mental language tasks

Mental language at the lexical level

(9 trials for mental state verb comprehension given, 3 presented here; 4 trials for modal adverb comprehension given, 2 presented here; 4 trials for modal auxiliary comprehension given, 2 presented here)

Type 1: Mental State Verb Comprehension
Materials: Two puppets, an opaque red box and an opaque blue box, stickers and an opaque screen



E: We're going to play the sticker game now. In that game, you can win a whole load of pretty stickers. I'm going to hide a sticker, this one [holds up a sticker]
E: [puts sticker in blue box]
E: This way, you can't see from the outside in which box it is, can you? But this time it was easy, now you saw that I put it in here [points to blue box]. But when the game really starts, I'm going to hide the sticker when I'm sitting behind this
E: [places screen between child and self and removes again]
E: now you can't see where I'm hiding the sticker. But I have some friends here to help you find the sticker. Here they are.

A (as Rabbit): I'm rabbit
A (as Lion, no voice change): and I'm lion and we're going to help you out

E: Rabbit and lion will tell you something about where to find the sticker. You have to listen to them really carefully and then you have to choose a box. We'll start off with some easy ones. I'll hide a sticker and then both of the puppets will tell you something about where to find the sticker. So first you have to listen to both of the puppets and then you have to choose a box.

[E: places screen between child and self. A: holds the two puppets in front of her without drawing attention to them]

[Practice trial 1]

[E: removes the screen]

E: first rabbit will tell you something

A (as Rabbit): the sticker is in the red box

E: okay, now lion

A (as Lion): the sticker is NOT in the blue box

[if child doesn't choose a box] E: choose a box

[trial is repeated if child gives incorrect answer]

E: yes, look the sticker is in the red box! Here, you can have it.

[E puts screen between child and self]

[Practice trial 2]

[E: removes screen]

E: okay, let's do one more easy one. Lion tell [name child] something

A (as Lion): the sticker is in the blue box

E: okay, now rabbit

A (as Rabbit): the sticker is NOT in the red box

[if child doesn't choose a box] E: choose a box

[trial is repeated if child gives incorrect answer]

E: yes, look the sticker is in the red box! Here, you can have it.

E: okay, so now we'll make it a bit harder, because rabbit and lion are going to say different things now. But you just have to listen to them really carefully again and then you have to pick a box. And don't just say this one [points to blue box] or this one [points to red box]. Because the sticker can be here [points to blue box] loads of times or here [points to red box] loads of times or it can be here [points to blue box] once and here [points to red box] once. You will only find the sticker if you listen really carefully. And I'm not going to show you whether you made the right choice every time anymore. But I am going to write it down and then at the end, once we're all done, you'll get all of the stickers you won. Okay, now I'm going to hide a sticker again.

[screen is placed on the table]

[Trial 1]
[screen is removed]

A (as rabbit): I KNOW the sticker is in the BLUE box

A (as lion): I THINK the sticker is in the RED box

[if child doesn't choose] E: choose a box

E: Ok, but I'm not going to show you yet whether you made the right choice. I'm going to write it down and then you'll get the stickers you won at the end of the game. Now I'm going to hide a sticker again.

[screen placed on the table]

[Trial 2]
[screen is removed]

A (as rabbit): I GUESS the sticker is in the RED box

A (as lion): I KNOW the sticker is in the BLUE box

[if child doesn't choose] E: choose a box

[screen placed on the table]

[Trial 3]
[screen is removed]

A (as rabbit): I THINK the sticker is in the RED box

A (as lion): I GUESS the sticker is in the BLUE box

[if child doesn't choose] E: choose a box

[screen placed on the table]

Type 2: Modal Adverb Comprehension
(same preamble and materials as mental state verbs)

[Trial 1]
[screen is removed]

A (as rabbit): the sticker is DEFINITELY in the RED box

A (as lion): the sticker is MAYBE in the BLUE box

[if child doesn't choose] E: choose a box

E: Ok, but I'm not going to show you yet whether you made the right choice. I'm going to write it down and then you'll get the stickers you won at the end of the game. Now I'm going to hide a sticker again.

[screen placed on the table]

[Trial 2]
[screen is removed]

A (as rabbit): the sticker is MAYBE in the BLUE box

A (as lion): the sticker is DEFINITELY in the RED box

[if child doesn't choose] E: choose a box

[screen placed on the table]

Type 3: Modal Auxiliary Comprehension
(same preamble and materials as mental state verbs)

[Trial 1]
[screen is removed]

A (as rabbit): the sticker MIGHT BE in the RED box

A (as lion): the sticker MUST BE in the BLUE box

[if child doesn't choose] E: choose a box

E: Ok, but I'm not going to show you yet whether you made the right choice. I'm going to write it down and then you'll get the stickers you won at the end of the game. Now I'm going to hide a sticker again.

[screen placed on the table]

[Trial 2]
[screen is removed]

A (as rabbit): the sticker MUST BE in the BLUE box

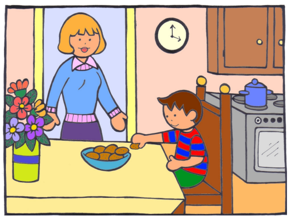
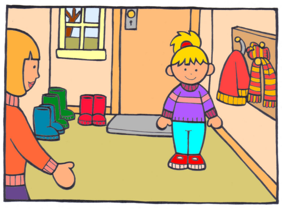
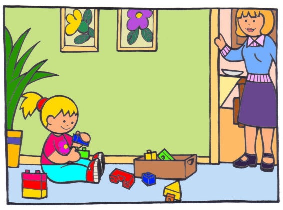
A (as lion): the sticker MIGHT BE in the RED box

[if child doesn't choose] E: choose a box

[screen placed on the table]

Mental language at the discourse level

Type 1: Understanding Indirect Requests
(8 test questions given, 3 presented here)
Materials: Ernie and 8 coloured drawings depicting the stories

E: Hey Ernie, we're going to play a story game!

A (as Ernie): Really, that's great! Can I play too?

E: yes, of course

A: okay, but [name child] sometimes I find it a bit hard to understand the stories. Will you help me then?

E: okay, let's start. First I'll introduce you to the characters in the story. Here's the boy Jan [points to Jan], the girl Karin [points to Karin] and Jan and Karin's mum [points to the mum]. Karin and Jan are two very sweet kids. They're always really nice and they always do what their parents tell them to do. Are you as sweet as they are? I'm sure you are.

[1]
E: Here's the first story. It's about Jan. Jan is sitting at the kitchen table and sees a bowl of cookies on the table. Jan really like cookies, so he has taken one. Then mum comes in and says: those cookies are for tonight's guests.

[test question 1]
A (as Ernie): I don't get it. *Why does mum say that to Jan?*

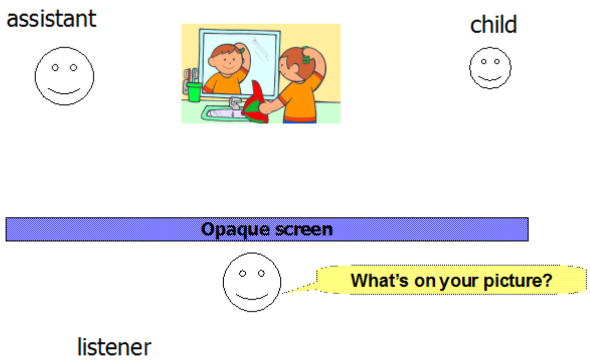
[2]
E: This story is about Karin. Look, Karin is standing in the hallway and she wants to play outside. Next to Karin is a hat stand with her coat, her scarf and her gloves [points to these]. When Karin wants to go outside, mum sees her. And mum says: it's really cold outside.

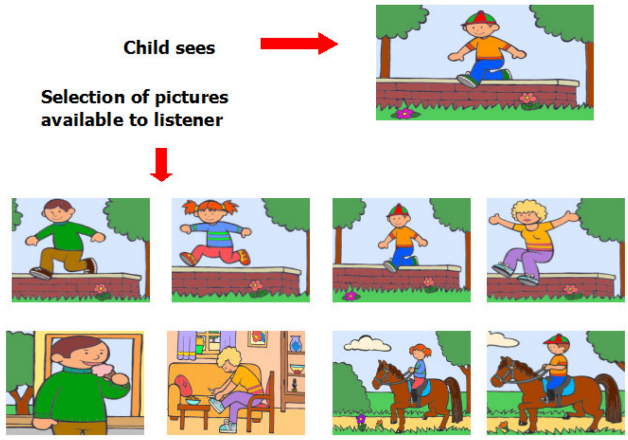
[test question 2]
A: Huh, *Why does mum say that to Karin?*

[3]
E: The next story is about Karin again. Karin is playing with her toys. She has just emptied a box of lego on the floor. Karin is playing with the lego. Mum comes in and says: it's dinner time, Karin.

[test question 3]
A: Wait a minute, *why does mum say that to Karin?*

Type 2: Informing an Ignorant Individual
Materials: Sixteen coloured pictures depicting one of four characters (man, woman, boy, girl) engaged in an action, a booklet for the experimenter filled with the same pictures and an opaque screen.





E: Look what I have here: a whole load of pretty pictures. Let's take a look at them.
Look this is a ….. [waits for child to name actor in picture]
E: and what is the [actor name] doing?

(repeat this exchange for all pictures)

E: Ok, so now we're going to play a game - we're going to look at pictures.
In a moment [assistant] is going to show you a picture and then you will have to tell me exactly what you see on your picture so that I can find the same picture in my big book of pictures [shows book with pictures]. Well, you might say that's really easy. You can see the picture that [assistant] is showing me! But in a moment, I'm going to sit behind this [shows screen] and then I can't see which picture [assistant] is showing you.

E: Ok let's try one. Maybe [assistant] will show you this picture of a man jumping over the wall.
A: [shows a picture of the man jumping over the wall]
E: But in MY book I have a picture of a woman jumping over the wall [shows picture], a boy jumping over the wall [shows picture], a girl jumping over the wall [shows picture] and a man jumping over the wall [shows picture]. That's the same one, do you see?
E: So, in a moment you're going to have to tell me WHO is doing something in your picture, (a boy, girl, man or woman) and WHAT they're doing

E: Ok let's give you another example. Maybe [assistant] will show you this picture of a girl on a horse
A: [shows picture]
E: But in my book I have a picture of a woman on a horse [shows picture], a boy on a horse [shows picture], a girl on a horse [shows picture], that's the same one, do you see? But I also have a man on a horse [shows picture]. So, in a moment

you're going to have to tell me WHO is doing something in your picture, (a boy, girl, man or woman) and WHAT they're doing

E: Ok, so we'll start off with a bit of practice. I'll put the screen in front of me so I can't see anymore.

A: [shows picture of a boy jumping over a wall]

E: Ok, tell me what do you see in your picture?
[if child refers to correct actor and action] E: that must be this one [shows picture]
[if child gives incorrect answer, E shows incorrect picture corresponding to answer or if that is not possible, E stresses that she needs to be told the actor and the action]

E: Ok, let's practice one more time. So you have to tell me very carefully who's doing something and what they're doing.

A: [shows picture of a woman on a horse]

E: Ok, tell me what do you see in your picture?
[if child refers to correct actor and action] E: that must be this one [shows picture]
[if child gives incorrect answer, E shows incorrect picture corresponding to answer or if that is not possible, E stresses that she needs to be told the actor and the action]

E: Ok, let's go on, but I'm not going to show you which picture I choose every time anymore. You just have to tell me who is doing something, a girl, a boy, a man or a woman and what they are doing. Then I can find the same picture. Ok, let's start.

[Trial 1]
A: [shows picture of woman putting on her shoes]

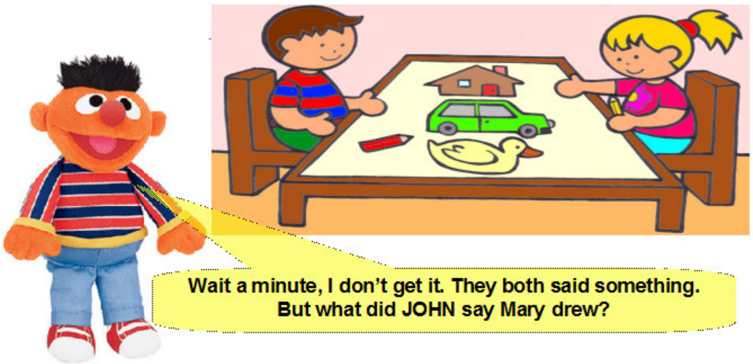
E: What do you see in your picture?

[repeat for next 7 pictures]

Language tasks

(6 sentential complementation test questions asked, 2 presented here; 4 sentential complementation control questions asked, 1 presented here)

Type 1: Sentential Complementation



E: This is a game that I'm sure my friend Ernie will want to play with us. It's a story game.

A (as Ernie): Stories? That's great! Can I play too [name child]?
A (as Ernie): But I don't always understand stories so well. So will you help me a bit?

E: Okay, listen up, in a minute, we'll have a story about Jan and Karin. Look here they are. This is Jan and this is Karin [points to figures in the picture]. So we've got to know them. Now we'll go on to the first proper story.
E: Ernie doesn't always understand the words I use, so can you tell him what this is called [points to each of three objects in picture]

[1]
E: Good, now I'll tell you a story. Jan and Karin are drawing. Karin looks at what Jan is drawing. Karin says that Jan has drawn a house. Then Jan says that he has also drawn a duck and a car.

[test question 1]
A (as Ernie): Hey, wait a minute. I don't get it. *So they both said something, but what did KARIN say that Jan had drawn?*

[2]
E: Look, here's a different picture. Tell Ernie what this is called [points to all three objects in the picture].
E: I'll tell you a story to go with it now. It's time for arts and crafts and Jan and Karin are making beautiful things out of paper. Karin shows Jan what she has made. Jan says that Karin made a swan. Then Karin says that she made a shoe and a basket too.

[test question 2]
A (as Ernie): that's pretty, but let me ask you something. *They both said something, but what did JAN say Karin had made?*

[3]
E: Take a look at this pretty picture. Tell Ernie what this is called [points to all three objects in the picture].
Listen to the story. Karin and Jan are walking on the beach. They're looking for things that they can take home with them. Karin has found a starfish. And Jan has found a crab and a shell.

[control question 1]
A (as Ernie): what a great story! But I want to ask you something. *They both found something, but what did KARIN find?*

Type 2: PPVT
(Word that goes with the example picture is "fruit")

Test procedure determined by standard PPVT test manual. Child is shown four pictures and hears a word. The child's task is to choose the picture out of those four that best goes with the word.

Type 3: Subparts of the Reynell test for language comprehension
(Items categorised as spatial language are underlined, items not taken into account in the spatial-nonspatial division are in boldface)

Subpart 8:
1. Put the brick on the plate
2. Put the rabbit in the box
3. Put the spoon on the cup
4. Put the chair in the box
5. The brick is being put in the cup
6. The knife is being put on the box
7. The broom is being put in the box
8. The chair is being put on the plate
9. The horse is being bitten by the dog
10. The dog is being bitten by the rabbit

Subpart 9:
11. Show me the smallest button
12. Take the yellow pencil
13. Give me the longest red pencil
14. Put all the white buttons in the cup
15. Put the black button under the cup
16. Put the three short pencils in the box
17. Which button is not in the cup?
18. Take two buttons out of the cup
19. Which pencils have been put away?
20. Which red pencil has not been put away?

Subpart 11:
21. Put two horses next to each other
22. Which horse is grazing?
23. Take the biggest pink pig and show me its eyes
24. Put one of the pigs behind the man
25. Put a little pig next to the black pig
26. Put the farmer and one of the pigs in the meadow
27. Put all of the pigs behind the brown horse
28. Put all of the pink pigs around the meadow on the outside of it
29. The pink pigs are standing around the meadow. Put all the other animals and the farmer inside of the meadow

30. Which pig is not outside of the meadow?
31. Put a small pig next to the farmer
32. Which small pig has not been put in the meadow?
33. Which pigs are furthest away from the farmer?
34. Put all the animals except for the black pig in the bag

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Summary in Dutch; Nederlandse Samenvatting

De puzzelstukjes op hun plaats:
De ontwikkeling van theory of mind en (mentale) taal

Putting the pieces together: The development of theory of mind and (mental) language

Stel, een driejarig kind krijgt een zakje chips te zien en wordt gevraagd wat hij denkt dat er in de chipszak zit. De typische driejarige zal ‘chips’ antwoorden. Vervolgens mag het kind zien wat er echt in het zakje zit: het zakje bevat geen chips, maar gummetjes. Nadat het kind deze vreemde inhoud heeft opgemerkt, wordt hem het volgende gevraagd: “Jouw beste vriend heeft dit zakje nog nooit eerder gezien. Wat zal je vriend zeggen als we hem vragen wat er in het zakje zit?” De meeste driejarigen zullen hun eerste reactie vergeten zijn en ‘gummetjes’ antwoorden. Pas als kinderen een jaar of vier zijn, beginnen ze te begrijpen dat de vriend niet kan weten dat er geen chips, maar gummetjes in het zakje zitten en dus ook nooit het goede antwoord kan geven. Als kinderen dit ontwikkelingsstadium hebben bereikt, wordt er gezegd dat ze een ‘Theory of Mind’ (ToM) hebben. Het kind is zich er dan van bewust dat andere mensen ook eigen gedachtes en gevoelens, ofwel een bepaalde “mentale staat”, hebben, die kan verschillen van die van het kind zelf. In deze dissertatie wordt er onderzocht of er een verband is tussen de ontwikkeling van ToM en de talige ontwikkeling van het kind. De kernvraag van deze dissertatie is dan ook: beïnvloedt de ontwikkeling van taal het vermogen van het kind om aan anderen een bepaalde mentale staat toe te schrijven of is het juist het begrip van andermans mentale staat dat cruciaal is in de ontwikkeling van taal? Elk van de vijf hoofdstukken in dit proefschrift poogt deze vraag te beantwoorden door de relatie tussen bepaalde aspecten van ToM en taal nader te onderzoeken.

ToM en taal: gebruik van begrippen

Het begrip ToM wordt in de literatuur op diverse manieren gebruikt. In brede zin verwijst de term naar sociale cognitie in het algemeen, maar vaak wordt de term ook gebruikt in een meer specifieke zin, namelijk het vermogen om zogenaamde “false beliefs” te begrijpen. False beliefs, ofwel verkeerde overtuigingen, zijn gedachten die niet overeenkomen met de realiteit: als ik denk dat er chips in het chipszakje zitten in de hier boven beschreven situatie, dan heb ik een verkeerde overtuiging wat betreft de inhoud van het chipszakje. In de studies die in dit proefschrift gepresenteerd worden, wordt de term ToM in deze specifieke zin gebruikt; de term ToM kan dus ook vervangen worden door “false belief-begrip". Ook in de operationalisering van het begrip "taal" zijn in dit proefschrift bepaalde keuzes gemaakt op basis van bevindingen in eerdere literatuur die suggereren dat bepaalde aspecten van taal relevant zouden zijn voor ToM ontwikkeling. Taal wordt opgedeeld in twee categorieën: algemene taal en mentale taal. In dit proefschrift wordt algemene taal getest door middel van de PPVT gestandaardiseerde woordenschattest en delen van de Reynell test voor taalbegrip. Daarnaast wordt ook het begrip van sententiële complementatie-constructies bekeken. Belangrijk is dat deze onderdelen van taal geen direct verband hebben met het vermogen om mentale staten te begrijpen. Mentale taal, daarentegen, verwijst juist wel naar die onderdelen van taal die refereren aan mentale staten. In dit proefschrift wordt ook de categorie mentale taal in twee delen gesplitst: mentale taal op conversatie en lexicaal niveau. Op het conversatie niveau wordt gekeken naar het vermogen van kinderen om verwijzende uitdrukkingen te produceren (zegt het kind "een man", "de man" of "hij", als het gaat om een mannelijke figuur die voor de luisteraar onbekend is?) en naar het begrip van indirecte vragen (zoals het gebruik van "het is hier koud" om indirect iemand te vragen om het raam dicht te doen). Op het lexicale niveau wordt in diverse hoofdstukken gekeken naar het begrip van de epistemische termen *weten*, *denken* en *raden*; *moeten*, *zullen* en *kunnen*, en *zeker* en *misschien*. Deze woorden verwijzen allemaal naar hoe zeker een spreker is van de propositie die hij uitdrukt. Als een spreker zegt dat hij *weet* dat de sleutel in de la ligt, geeft hij aan dat hij met een grotere mate van zekerheid iets zegt over de locatie van de sleutel dan een spreker die zegt dat hij *denkt* dat de sleutel in de la ligt. Op deze manier drukken epistemische termen dus iets uit over de mentale staat van de spreker: hoe zeker is hij van zijn uitspraak?

In elk hoofdstuk wordt dus de relatie tussen ToM en bepaalde aspecten van (mentale) taal bekeken. Het eerste hoofdstuk voegt daar nog een variabele aan toe: executieve functie (EF). Net als ToM is EF een brede term; het heeft betrekking op het vermogen om dingen te onthouden, je aandacht ergens op te richten en te plannen. In het eerste hoofdstuk wordt echter maar één onderdeel van EF bekeken: inhibitie, ofwel het vermogen om misleidende informatie te negeren. Deze component van EF zou wat betreft de relatie tussen ToM en taal van belang kunnen zijn, omdat er in de literatuur wordt gesuggereerd dat inhibitievermogen zowel bij taal- als bij ToM-ontwikkeling een rol zou kunnen spelen. Dit gegeven kan relevant zijn voor de onderzoeksvraag. Als er namelijk een verband wordt gevonden tussen ToM en taalontwikkeling, dan kan dit betekenen dat er een betekenisvolle relatie is tussen deze twee variabelen, maar het kan ook duiden op de aanwezigheid van een derde variabele die zowel aan ToM als aan taal gerelateerd is. Als dit laatste het geval zou zijn, dan is er dus geen direct verband tussen ToM en taal, maar zijn de twee variabelen indirect aan elkaar gerelateerd door de gemeenschappelijke afhankelijkheid van een derde variabele. EF is een mogelijke kandidaat om deze rol als derde variabele te vervullen. Door te kijken naar het inhibitievermogen van kinderen, kan er dus ook bekeken worden of er een directe relatie is tussen taal en ToM of dat er slechts sprake is van een indirecte relatie.

ToM, (mentale) taal en EF: bevindingen van hoofdstuk 1

Het doel van het eerste hoofdstuk is tweeledig: deze studie bekijkt de mentale taalvermogens van driejarige en jonge vierjarige kinderen en het onderzoekt wat de rol is van ToM, algemene taal en EF in de ontwikkeling van mentale taal in deze groep kinderen. In het bijzonder wordt bekeken of deze kinderen verwijzende uitdrukkingen (dat wil zeggen: mentale taal op het conversatie niveau) op een juiste manier kunnen gebruiken. De bevindingen van deze studie staan in contrast met eerdere studies die stellen dat adequate verwijzende communicatie (het vermogen om verwijzende uitdrukkingen te gebruiken zoals volwassenen dat in een dergelijke situatie zouden doen) normaal niet waargenomen wordt tot kinderen ongeveer een jaar of zes zijn (cf. Deutsch & Pechmann, 1982; Glucksberg, Krauss & Weisberg, 1966; Krauss & Glucksberg, 1969). De resultaten van deze studie tonen namelijk aan dat als de verwijzende communicatie-taak op diverse punten versimpeld wordt, zelfs driejarigen al adequate verwijzende communicatie kunnen laten zien. Driejarige kinderen hebben dus al enig besef van dit onderdeel van mentale taal op het conversatie niveau.

Wat betreft het tweede deel van de onderzoeksvraag (de rol die EF, ToM en taal spelen in de ontwikkeling van mentale taal) laat deze studie zien dat alleen de ToM-taak significant gecorreleerd is met het vermogen om juiste verwijzende uitdrukkingen te produceren. EF en algemene taalvaardigheid zijn dus niet gerelateerd aan de verwijzende communicatieve vaardigheden van het kind. Deze bevinding suggereert dat verwijzende communicatie meer afhankelijk is van het begrip dat kinderen hebben van de mentale staten van anderen dan van hun inhibitievermogen of algemene taalvaardigheid. In algemenere zin wijst deze bevinding op het belang van ToM bij de verwerving van mentale taal, aangezien ToM in ieder geval bij dit onderdeel van taal (verwijzende communicatie) een belangrijkere rol speelt dan de andere factoren die in deze studie getest zijn.

Mentale taal op het lexicale niveau: bevindingen van hoofdstuk 2

Het tweede hoofdstuk in deze dissertatie kijkt naar een ander domein van mentale taal, ditmaal op het lexicale niveau. Ook nu staan er twee vragen centraal: zijn vierjarige kinderen in staat om mentale taal op het lexicale niveau te begrijpen en welke rol spelen ToM en algemene taalvaardigheid in de ontwikkeling van dit domein van mentale taal? (Omdat EF in het vorige hoofdstuk geen belangrijke rol bleek te spelen in de relatie tussen ToM en taal, is besloten om in verdere hoofdstukken deze factor niet meer bij het onderzoek te betrekken.) Dit hoofdstuk breidt dus de bevindingen van hoofdstuk 1 uit in een ander domein van mentale taal, het begrip van epistemische modaliteit. Epistemische modale termen zeggen iets over de mate van zekerheid waarmee een spreker een bepaalde uiting doet. Epistemische modaliteit kan op verschillende manieren geëncodeerd worden, maar in dit hoofdstuk werd bekeken of vierjarige kinderen het verschil in zekerheid tussen de epistemische modale hulpwerkwoorden *moeten* en *kunnen* en de modale bijwoorden *zeker* en *misschien* zouden begrijpen.

In overeenstemming met eerdere studies die het begrip van epistemische modale termen van Engelssprekende kinderen onderzocht hebben (cf. Byrnes & Duff, 1989; Moore, Pure & Furrow, 1990), maar in tegenstelling tot bevindingen betreffende Italiaanssprekende kinderen (cf. Bascelli & Barbieri, 2002), toonde dit hoofdstuk aan dat Nederlandse vierjarigen het onderscheid tussen deze epistemische modale termen begrijpen. De verwerving van het modale systeem is op deze leeftijd echter nog niet compleet (de maximale score werd gemiddeld nog niet bereikt), maar een bepaald begrip van het verschil tussen de modale hulpwerkwoorden *moeten* en *kunnen* en de modale bijwoorden *zeker* en *misschien* is al aanwezig. Wat betreft de rol van ToM en taal bij het begrip van epistemische modale termen laat deze studie zien dat ToM hoger gecorreleerd is met het begrip van modale termen dan algemene taalvaardigheid. Hoewel een van de taalmaten in de testbatterij, de Reynell test voor taalbegrip, in eerste instantie wel een significante voorspeller was van het begrip van epistemische modale termen, verdween dit effect op het moment dat ToM aan het model werd toegevoegd. De resultaten van deze studie suggereren dus dat ToM de betere voorspeller is van het begrip van epistemische modale termen. Net zoals het eerste hoofdstuk, voert het tweede hoofdstuk dus bewijs aan dat ToM een belangrijkere rol speelt bij de verwerving van mentale taal dan het algemene taalvermogen van een kind.

Lexicale mentale taal bij normale en autistische kinderen: bevindingen van hoofdstuk 3

Net als het tweede hoofdstuk, bekeek het derde hoofdstuk het begrip van epistemische modale hulpwerkwoorden en de rol die ToM en taalontwikkeling spelen in de verwerving van die termen. In het derde hoofdstuk werd echter een oudere populatie onderzocht en de epistemische modale termen die getest werden waren complexer dan in het tweede hoofdstuk (in plaats van alleen het onderscheid tussen *moeten* en *kunnen* te maken, moesten de proefpersonen een drievoudige onderscheiding maken tussen de termen *moeten*, *zullen* en *kunnen*). In overeenstemming met de uitkomst van hoofdstuk 2 wat betreft vierjarigen, vond deze studie dat zesjarigen het verschil in spreker-zekerheid, zoals weergegeven door deze epistemische modale hulpwerkwoorden, wel begrepen, ook al scoorden ze gemiddeld nog niet de maximale score voor deze complexere drievoudige onderscheiding. Deze studie keek echter niet alleen naar het begrip van epistemische modale hulpwerkwoorden bij normale zesjarige kinderen, maar ook naar het vermogen van een zich atypisch ontwikkelende populatie om deze termen te doorgronden. Kinderen die gediagnosticeerd waren met een syndroom in het autisme-spectrum (een klinische populatie waarvan bekend is dat ze een ToM-stoornis hebben) kregen ook dezelfde tests voorgelegd als de normale zesjarige kinderen. De redenering die aan de keuze voor deze klinische populatie ten grondslag lag was dat als ToM relevant is voor de ontwikkeling van mentale taal, dit zou betekenen dat individuen met een verstoorde ToM-ontwikkeling ook problemen zouden moeten hebben in hun vaardigheid op het gebied van mentale taal. Met andere woorden, de autistische proefpersonen zouden meer problemen moeten hebben bij het begrijpen van epistemische modale hulpwerkwoorden dan hun leeftijdsgenoten uit de niet-klinische groep.

In eerste instantie leken de bevindingen van deze studie niet in overeenstemming te zijn met bovenstaande redenering, aangezien de autistische groep geen slechter begrip van epistemische modale termen liet zien in vergelijking met de zich typisch ontwikkelende groep. Echter, toen de proefpersonen verdeeld werden in een groep met kinderen die alle ToM testvragen goed beantwoord had (de ToM-slagers) en een groep met kinderen die minimaal één ToM testvraag fout had (de ToM-zakkers), in plaats van de verdeling te maken naar klinische indicatie, werd een interessant verschil duidelijk. De ToM-slagers begrepen namelijk het verschil in spreker-zekerheid beter dan de ToM-zakkers, hoewel de twee groepen verder niet verschilden in leeftijd of algemene taalvaardigheid. Daarnaast moet ook opgemerkt worden dat het tegengestelde patroon niet gevonden werd: diegenen die slaagden voor de epistemische modale taak hadden geen hogere ToM-score dan diegenen die zakten voor de epistemische modale taak. De resultaten van deze studie suggereren dus dat als ToM (nog) niet geheel ontwikkeld is, dat de verwerving van mentale taal op het lexicale niveau, epistemische modale hulpwerkwoorden in dit geval, ook vertraagd zal zijn. Wederom suggereert dit hoofdstuk dus dat er een belangrijke rol is voor de ontwikkeling van ToM in het vermogen van kinderen om mentale taal te verwerven.

ToM en taal: een duidelijk verband?

Tot nu zijn de resultaten die in deze dissertatie gepresenteerd zijn in overeenstemming met het idee dat ToM van cruciaal belang is voor de ontwikkeling van ten minste die aspecten van taal die gerelateerd zijn aan het begrip van mentale staten (dat wil zeggen: mentale taal). In de verwerving van mentale taal, een aspect van cognitie op het raakvlak van ToM en taal, lijkt het begrip van anderen dus een grotere rol te spelen dan algemene taalvaardigheid. Echter, voor alle drie de studies geldt dat de onderzoeksopzet slechts beperkte conclusies over de richting van het causale verband toelaat. De eerste twee studies zijn correlationeel van aard. Hoewel in beide studies geconcludeerd wordt dat ToM sterk gerelateerd is aan mentale taal, sterker dan het algemene taalvermogen van het kind, kan de sterkere conclusie, dat ToM de ontwikkeling van mentale taal drijft, niet gemaakt worden op basis van deze data. Gegeven de aard van de data van deze studies is het ook mogelijk dat de ontwikkeling van mentale taal juist ToM drijft in plaats van andersom. De derde studie heeft een vergelijkbaar minpunt, hoewel het feit dat een klinische populatie met een ToM-stoornis onderdeel is van het onderzoek deze studie wel robuuster maakt dan de eerdere twee. Dit neemt niet weg dat ook de derde studie correlationeel van aard is, dus hoewel een ToM-stoornis (en niet een mentale taalstoornis) doorgaans gezien wordt als de primaire stoornis bij autisten, is het nog steeds mogelijk dat problemen in de verwerving van mentale taal zorgen voor problemen bij de ontwikkeling van ToM in plaats van (of zowel als) andersom. Daarnaast moet ook opgemerkt worden dat de resultaten van de derde studie aantoonden dat het voornaamste verschil in begrip van epistemische modale hulpwerkwoorden gevonden werd tussen de ToM-slagers en de ToM-zakkers, niet tussen de autistische en niet-autistische groep (waarmee de relevantie van de klinische diagnose bij het vermogen om epistemische modale hulpwerkwoorden te begrijpen verkleind wordt). Om krachtiger te kunnen beweren dat ToM de ontwikkeling van mentale taal drijft, moet een onderzoeksvorm gebruikt worden die sterkere conclusies over de richting van een mogelijk causaal verband toelaat.

ToM, taal en mentale taal longitudinaal gemeten: bevindingen van hoofdstuk 4

Een mogelijke manier om de correlationele data van de eerste drie hoofdstukken aan te vullen is om longitudinaal metingen te verrichten, zodat er bekeken kan worden of eerdere taal dan wel ToM-vaardigheid voorspellend blijkt voor latere mentale taalvaardigheid. Deze onderzoeksopzet werd dan ook gehanteerd in hoofdstuk vier en vijf. Het vierde hoofdstuk onderzoekt de ontwikkeling van mentale taal op zowel het lexicale- als het conversatieniveau (in het bijzonder het begrip van mentale staat-termen en indirecte vragen) op twee verschillende momenten: eerst als het kind vier jaar oud is en nogmaals acht maanden later. De resultaten van deze studie tonen aan dat de scores op de mentale staat-termen en de indirecte vragen-taken significant beter worden tussen het eerste en het tweede tijdpunt. Er was echter één onderdeel van mentale taal dat niet significant verbeterde tussen de twee tijdpunten: het begrip van het verschil in spreker-zekerheid zoals weergegeven door de epistemische termen *denken* en *raden*. Hoewel kinderen in staat waren om het verschil in spreker-zekerheid tussen *weten*, aan de ene kant, en *denken* en *raden* aan de andere kant te begrijpen en dus daarmee lieten zien dat ze het verschil tussen zekerheid en onzekerheid doorgrond hadden, waren ze niet in staat om het verschil te maken tussen de twee termen *denken* en *raden*, die allebei een bepaalde mate van onzekerheid aanduiden. Behalve dan het verschil tussen deze twee termen, zien we dat kinderen tussen hun vierde en vijfde jaar een significante ontwikkeling doormaken in het begrip van mentale staat-termen en indirecte vragen. Daarbij moet echter wel opgemerkt worden dat een maximale score gemiddeld niet bereikt werd voor ofwel mentale staat-termen ofwel indirecte vragen op deze leeftijden.

Het vierde hoofdstuk kijkt niet alleen naar de ontwikkeling van deze twee domeinen van mentale taal, maar ook naar de rol die ToM en taal spelen in deze ontwikkeling. Wat is de beste voorspeller van later begrip van indirecte vragen en mentale staat-termen: eerdere ToM of eerdere taalvaardigheid? Als de resultaten van de eerste drie studies in beschouwing genomen worden, dan is het te verwachten dat eerdere ToM de beste voorspeller van latere mentale taal zal zijn. Dit was echter niet helemaal het behaalde resultaat van deze studie. Hoewel ToM wel mentale staat-termen en het begrip van indirecte vragen voorspelde in een eenvoudig model (waarin alleen leeftijd en de eerdere score op de desbetreffende mentale taal-taak gecontroleerd werd), was dit effect niet meer significant op het moment dat de taalmaten ook opgenomen werden in het model. Sterker nog, in dit complexere model waarin alle relevante variabelen opgenomen waren, bleek juist een van de taalmaten de enige significante voorspeller van mentale taalvaardigheid te zijn. In tegenstelling tot wat we op basis van de eerste drie studies zouden kunnen verwachten, bleek eerdere taalvaardigheid dus de betere voorspeller van latere mentale staat-termen en het begrip van indirecte vragen te zijn en niet ToM. Daarbij moet echter opgemerkt worden dat het niet zomaar een willekeurig onderdeel van taalvaardigheid was dat relevant bleek voor het voorspellen van latere mentale taal; slechts één onderdeel was relevant: de score op de Reynell test. In zijn geheel afgenomen, geeft deze test een algemeen beeld van het taalbegripsniveau van het kind. Deze bevinding suggereert dan ook dat het algemene taalvermogen van het kind (in plaats van een specifiek aspect van taal, zoals het begrip van sententiële complementatie-structuren) het meest relevant is bij het voorspellen van latere mentale taal. Deze conclusie is in lijn met de claim van Astington & Jenkins (1999) dat het kind een bepaald niveau van algemene taalvaardigheid nodig heeft om de mentale staat van anderen te kunnen doorgronden. Echter, als de items van de Reynell test die voor deze studie gebruikt zijn beter bekeken werden, bleek dat ze in twee delen gesplitst konden worden. Slechts een deel van de test-items gaf een globaal overzicht van het taalbegrip van de kinderen, de rest had duidelijk betrekking op het begrip van spatiële relaties zoals geëncodeerd door locatieve prepositiess. Als deze twee verschillende delen van de Reynell test (dat wil zeggen: het algemene deel en het spatiële deel) apart beschouwd werden, dan werd duidelijk dat alleen het spatiële deel van de Reynell test later begrip van mentale staat-termen voorspelde en dat het algemene deel juist later begrip van indirecte vragen voorspelde.

Hoe zou het verklaard kunnen worden dat het spatiële deel het begrip van mentale staat-termen voorspelt, terwijl het algemene deel juist het begrip van indirecte vragen voorspelt? Begrip van locatieve prepositiess geeft het kind een concrete manier om verschillen in perspectief tussen sprekers te begrijpen. Als het kind een locatieve prepositie aantreft, dan merkt het kind dat er een andere manier is om de realiteit te encoderen, afhankelijk van de spatiële locatie van de spreker. Het is hierbij belangrijk om op te merken dat het kind zichzelf letterlijk in de positie van de spreker kan plaatsen en vanuit die positie kan zien of een uiting met een bepaalde locatieve prepositie (bijvoorbeeld “de koe staat *achter* de man”) waar is of niet. Deze concrete talige encoderingen vanuit het perspectief van de spreker kunnen dan gebruikt worden bij het begrijpen van talige encoderingen van perspectief op een abstracter niveau, dat wil zeggen: ze kunnen helpen om mentale staat-termen te begrijpen. Uiteraard rijst de vraag waarom dit begrip van perspectief op een concreet niveau niet ook de score van het kind op de indirecte vragen taak voorspelt, gezien het feit dat deze taak ook begrip van het perspectief van de spreker vereist. Dit verschil kan uitgelegd worden door te kijken naar de verschillende talige vereisten van de twee mentale taal-taken. De indirecte vragen-taak vereiste namelijk niet alleen dat het kind het perspectief van een verhaalfiguur begreep, maar ook dat het kind een verhaal kon volgen en in staat was om een uitgebreid antwoord te geven, waarin het perspectief van de spreker benoemd werd. Hierdoor vereiste de indirecte vragen-taak wellicht meer van de algemene taalvaardigheid van het kind dan alleen het begrip van het perspectief van de spreker op de situatie. De mentale termen-taak, daarentegen, eiste minder van de talige vermogens van het kind, omdat het antwoord op de vraag uit één woord kon bestaan en het kind geen uitgebreid verhaal hoefde te begrijpen om de taak te kunnen uitvoeren.

Het causale verband tussen ToM en taal: bevindingen van hoofdstuk 5

De bevindingen van het vierde hoofdstuk wijzen dus op een belangrijke rol van taal in de ontwikkeling van mentale taal. In het bijzonder suggereren ze dat het begrip van locatieve preposities relevant is in het begrijpen van verschillen in perspectief zoals geëncodeerd door mentale staat-termen. Het vijfde hoofdstuk bouwt voort op deze bevindingen door een algemenere vraag te stellen dan de kernvraag van het vierde hoofdstuk: voorspelt eerdere taalvaardigheid latere ToM of voorspelt eerdere ToM juist latere taalvaardigheid? De resultaten van deze studie suggereren dat er een complexe ontwikkelingsrelatie is tussen de twee cognitieve domeinen, met bidirectionele relaties tussen sommige domeinen van taal en ToM, maar een unidirectioneel verband tussen andere domeinen van taal en ToM. Er moet echter wel opgemerkt worden dat in tegenstelling tot eerder onderzoek (de Villiers, 2005, 2007; de Villiers & Pyers, 2002), deze studie geen significant verband vond tussen ToM en het begrip van sententiële complementatie-constructies. Vermoedelijk valt deze onverwachte uitkomst te verklaren door verschillen in de gebruikte sententiële complementatie-taak. Waar de sententiële complementatie-taak die de Villiers en haar collega's gebruiken een beroep doet op het false belief-begrip van het kind om het verhaal achter de sententiële complementatie-taak te begrijpen, komen false beliefs helemaal niet voor in de sententiële complementatie-taak die in dit proefschrift gebruikt wordt. Hoewel deze bevinding gerepliceerd moet worden, suggereert het dat de link tussen sententiële complementatie en ToM spurieus is, een artefact van de testmethode, in plaats van een waarheidsgetrouwe reflectie van het proces van cognitieve ontwikkeling in de domeinen van ToM en taal.

In overeenstemming met eerdere studies die een verband tussen het begrip van mentale staat-termen en de ontwikkeling van ToM opmerken (cf. Booth & Hall, 1995; Cheung, Chen & Yeung, 2009; Hall, Scholnick & Hughes, 1987; Moore, Bryant and Furrow, 1989; Moore et al., 1990; Pyers & Senghas, 2009; Tager-Flusberg, 1992; Ziatas, Durkin & Pratt, 1998), vond ook deze studie dat eerdere ToM latere mentale woordenschat voorspelde; sterker nog: eerdere ToM voorspelde ook latere woordenschat in algemene zin. Het omgekeerde verband werd ook gevonden: eerdere mentale en algemene woordenschat voorspelde ook latere ToM. Het verband tussen ToM en algemene en mentale woordenschat is dus bidirectioneel. De enige unidirectionele relatie werd gevonden tussen ToM en de score op de Reynell test voor taalbegrip. Eerdere score op de Reynell test voorspelde latere ToM, maar het omgekeerde werd niet gevonden. Daarnaast bleek de Reynell test ook de enige significante voorspeller van latere ToM op het moment dat alle andere factoren ook opgenomen waren. Hoewel zowel algemene als mentale woordenschat latere ToM voorspelt als alleen leeftijd en eerdere ToM zijn gecontroleerd, verdwijnt deze voorspellende waarde als de andere taalmaten aan het model toegevoegd worden. In een model met leeftijd, eerdere ToM, algemene en mentale woordenschat, sententiële complementatie en de Reynell test, bleek alleen de Reynell test een significante voorspeller van latere ToM. Een her-analyse van de Reynell test, waarbij deze test werd opgedeeld in een spatiële en niet- spatiële component (zoals ook werd gedaan met de Reynell test in het vierde hoofdstuk), liet zien dat vooral de spatiële items verantwoordelijk waren voor het voorspellen van latere ToM. Het spatiële deel van de Reynell test voorspelt dus niet alleen later begrip van mentale staat-termen, maar ook latere ToM. Dit suggereert dat er een belangrijke rol is voor locatieve preposities, niet alleen bij het begrijpen van lexicale items die gerelateerd zijn aan het begrijpen van bepaalde mentale staten, maar ook bij het begrip van de mentale staat zelf.

Betekenis van de bevindingen

De resultaten van de hoofdstukken uit dit proefschrift tonen aan dat ToM een belangrijke rol speelt in de ontwikkeling van diverse aspecten van taal, zowel op het algemene niveau (algemene woordenschat) als het mentale niveau (mentale staat-termen en het begrip van indirecte vragen), maar dat diverse aspecten van de taalvaardigheid van het kind (vooral het begrip van locatieve preposities) ook een cruciale rol spelen in de ontwikkeling van ToM en de verwerving van mentale taal. Wat kunnen we uit deze resultaten opmaken over de relatie tussen taal en ToM, en, uiteindelijk, over de relatie tussen taal en denken in meer algemene zin? Het moge duidelijk zijn dat er geen eenvoudige causale relatie is tussen de ontwikkeling van ToM en taal. Wat deze vijf hoofdstukken aangetoond hebben, is dat een kerncomponent van ToM, namelijk false belief-begrip, causaal gerelateerd is aan sommige, maar niet alle, aspecten van taal die in deze studies onderzocht zijn. De vijf hoofdstukken laten zien dat er een hoge correlatie is tussen ToM en verwijzende communicatie, begrip van indirecte vragen, algemene en mentale woordenschat, algemeen taalbegrip en het begrip van locatieve preposities. Er werd echter geen verband gevonden tussen ToM en het begrip van sententiële complementatie-constructies, hoewel dit wel vaak in bestaande literatuur beweerd wordt. Uiteraard moet deze bevinding gerepliceerd worden met de sententiële complementatie-taak die in deze dissertatie gebruikt is, maar het ziet er naar uit dat als de methodologische onvolkomenheden van de normaal gebruikte taak weggewerkt worden, er geen sprake meer is van een verband tussen de twee variabelen.

In tegenstelling tot de bevinding wat betreft de sententiële complementatie-constructie, demonstreert dit proefschrift dat ToM en zowel algemene als mentale woordenschat bidirectioneel aan elkaar gerelateerd zijn. Dit suggereert dat het kind zijn gevoeligheid voor de mentale staat van anderen aanwendt als basis voor het toeschrijven van betekenis aan woorden in het algemeen en mentale staat-termen in het bijzonder en dat het horen van woorden in het algemeen en mentale termen in het bijzonder het kind er toe aanzet om na te denken over hun mogelijke betekenis. Vooral wat betreft de verwerving van mentale staat-termen en concepten zou een dergelijke cognitieve ontwikkeling logisch zijn: mentale staten zijn niet-observeerbare entiteiten, waardoor ze relatief moeilijk te leren zijn. Als het kind mentale staat-termen hoort, wordt hij gedwongen om te bedenken waar die termen naar zouden kunnen verwijzen, maar tegelijkertijd wordt hij geholpen in dit proces door zijn ontwakende gevoeligheid van de mentale staten van anderen, die hem weer aanzet om te letten op het gebruik van termen in de linguïstische input die naar die staten zouden kunnen verwijzen. Het is interessant om op te merken dat een vergelijkbare bidirectionele relatie niet aanwezig is wat betreft de relatie tussen de Reynell test voor taalbegrip en het begrip van false beliefs. Deze relatie was strikt unidirectioneel van taal naar false belief-begrip. Dit suggereert dat kinderen een bepaald niveau aan taalvaardigheid nodig hebben om de representationele complexiteit, inherent aan het begrip van mentale staten en hun linguïstische encodering (zowel op het lexicale als het conversatie niveau), te kunnen doorgronden. Niet alleen geeft taal het kind dus labels voor mentale staten (waardoor vermoedelijk het begrip van mentale staten op het conceptuele niveau verbeterd wordt), maar taal zorgt dus mogelijk ook dat het kind een representationeel systeem heeft dat complex genoeg is om de verschillende niveaus van representatie te kunnen verwerken die noodzakelijk zijn om false beliefs te kunnen begrijpen. Echter, buiten deze rol van taal in de ontwikkeling van ToM, is er mogelijk ook een specifieker aspect van de talige ontwikkeling van het kind dat (ook) relevant is in het begrijpen van false beliefs: locatieve preposities.

We kunnen dus zeggen dat er wederzijdse beïnvloeding is tussen de ontwikkeling van taal en ToM met een bidirectionele relatie tussen sommige domeinen van ontwikkeling, maar een unidirectionele relatie tussen andere. Wat zegt dit over de relatie tussen taal en denken in algemenere zin? Het maakt in ieder geval duidelijk dat de aloude vraag "is denken de voorloper van taal of taal van denken?" niet de juiste vraag is. Gegeven de complexiteit van beide concepten (en in deze dissertatie werden slechts een paar aspecten van taal en één aspect van denken onderzocht), is het onwaarschijnlijk dat al het denken in al zijn complexiteit aanwezig moet zijn voordat taal mogelijk is, noch dat een volledig linguïstisch systeem noodzakelijk is voordat het kind in staat is om te denken. Cruciaal voor het beantwoorden van de algemene vraag is het dus om bepaalde aspecten van taal en denken apart te bekijken: welke aspecten van taal/denken zijn noodzakelijk voor het kind om welke aspecten van denken/taal te kunnen ontwikkelen? De bevindingen van deze dissertatie suggereren dat een antwoord op deze vraag is dat false belief-begrip noodzakelijk is voor de ontwikkeling van algemene en mentale woordenschat en vice versa, dat sententiële complementatie niet noodzakelijk is voor de ontwikkeling van false belief begrip, maar dat een bepaald algemeen taalniveau en, mogelijk, het begrip van locatieve prepositities wel noodzakelijk is voor het kind om false beliefs te kunnen begrijpen.

Curriculum Vitae

Hannah De Mulder was born on the 3rd of July 1983 in Capelle aan den IJssel, the Netherlands. In 2001, she obtained her Gymnasium diploma at the Emmauscollege in Rotterdam, the Netherlands, after which she went on to study linguistics at University College London, United Kingdom. In 2004, she received her Bachelor's degree, awarded a first, from this institution. Continuing her studies at the University of Utrecht in the Netherlands, she enrolled in the Research Master Linguistics in 2004 following the language acquisition and psycholinguistics tracks. As part of the research master, she collected data for her Master's thesis during a three-month internship at the University of Edinburgh, United Kingdom. In 2006, she obtained her Master's degree (cum laude) from the University of Utrecht with a thesis on second language acquisition. From 2006 until 2010, she worked on her PhD thesis at the University of Utrecht, during which she spent a one-month period at the University of Toronto, Canada, in Professor Janet Wilde Astington's Theory of Mind lab. Since finishing her PhD-thesis she has worked as a lecturer at the University of Utrecht, teaching various courses in linguistics.