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Theory of Mind: Specialized capacity or emergent property?

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Theory of Mind (ToM), the cognitive capacity to attribute emotions, intentions and knowledge to oneself and others, has been claimed a hallmark of human cognition. Nonetheless, ToM is considered limited in young children and people with autism. Moreover, its presence in animals is much investigated, and hotly debated. For cross-disciplinary discussions and real insight in this unique capacity it is essential to know what constitutes ToM. We aim to tackle this question by combining insights from three different scientific fields that study ToM: animal behaviour, typical child development and developmental disorders such as autism and AD/HD. In this introductory paper, we will first discuss different theoretical views of ToM: that it can be considered a specialized capacity or an emergent property. Essential features of these views will be deduced and predictions will be derived. Subsequently, we review how ToM is studied in the three discussed fields and how this relates to these theoretical views. After that we will review the contributions to this special issue and discuss how they relate to the different predictions. Last, we will combine the evidence and propose our view on what constitutes ToM. The data are more consistent with the view that ToM is an emergent capacity. The employment of ToM appears to depend on the functioning of its constituting capacities, represented mental states and context factors. A focus on the ingredients that

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contribute to and allow the expression and employment of ToM will enable us to start understanding when and how individuals, whether human or non-human, deal with the minds of others.

Keywords: Theory of Mind; Animal behaviour; Human development; Autism; Emergence.

Humans pride themselves in being the species with the most advanced cognitive capacities. One of these advanced capacities is Theory of Mind (ToM), the ability to attribute emotions, intentions and knowledge to oneself and others (Flavell, 2004). Nevertheless, not all humans are equipped with this capacity. ToM is traditionally considered limited in young children (Wellman, Cross, & Watson, 2001) and people with autism (Baron-Cohen, Leslie, & Frith, 1985), and recent studies even question the use of ToM skills by normal adults (Keysar, Lin, & Barr, 2003). Moreover, its presence in animals is much investigated (Call & Tomasello, 2008; Premack & Woodruff, 1978), and hotly debated (Bolhuis & Wynne, 2009; Penn, Holyoak, & Povinelli, 2008; Povinelli & Vonk, 2003, 2004). However, research on the capacity for ToM in humans and non-human species has proceeded relatively independently, resulting in different methods to prove its presence and different conceptualizations to define its nature. This is unfortunate, because the interdisciplinary study of ToM in different species forces a sharpening of methodological and conceptual choices. For example, if animals show ToM skills, then language may not be a necessary component of ToM. Therefore, for cross-disciplinary discussions and real insight in this unique capacity, it is essential to determine what constitutes ToM in a species-independent way.

We aim to tackle this question by combining insights from three different scientific fields that study ToM: animal behaviour, typical child development and developmental disorders such as autism and AD/HD. This interdisciplinary approach highlights human versus non-human and typical versus pathological development. In this introductory paper, we will first discuss different theoretical views of ToM. Essential features of these views will be deduced and predictions will be derived. Subsequently, we review how ToM is studied in the three discussed fields and how this relates to these theoretical views. After that we will review the contributions to this issue and discuss how they relate to the different predictions. Last, we will combine the evidence and propose our view on what constitutes ToM.

TWO DIFFERENT VIEWS ON THEORY OF MIND

Two different theoretical views on what constitutes ToM will be examined. First, one may consider ToM a specialized capacity (Saxe, 2005) or module (Fodor, 1983). This idea has been put forward by scholars in the field of

psychology, biology and philosophy, and is considered consistent with the idea that human cognition is unequalled and distinct from animal cognition (Macphail & Bolhuis, 2001). Alternatively, ToM may require a number of different, independent capacities (Tomasello, Carpenter, Call, Behne, & Moll, 2005), the combination of which leads to the emergence of ToM (Barrett, Henzi, & Dunbar, 2003). The theoretical implications of these two views will be explored and compared to the empirical and theoretical evidence.

The specialized capacity or modular view considers ToM an innate cognitive module (Scholl & Leslie, 1999) or mechanism (Baron-Cohen, 1995) with a unique conscious cognitive nature (Barrett et al., 2003). This conception features domain specificity, i.e., ToM only operates on certain kinds of input, specifically meta-representations of propositional attitudes (Gerrans, 2002). Moreover, modules are fast, offer constrained outputs and can be selectively impaired by neural damage. Therefore, ToM will be either present or absent—however, see Leslie, Friedman, and German (2004) for a modular, yet gradual view on the developmental of ToM. The operation of a specialized capacity is considered mandatory, i.e., it is impossible not to interpret situations as involving intentional agents (Scholl & Leslie, 1999). It can be selectively impaired by neural damage and the capacity disappears entirely when any of its constituent parts fail to operate. While the modular approach has been an effective way of distinguishing the concept of ToM as a social skill, the approach may be less helpful in the exploration of the nature of ToM. It should be noted that considering ToM a specialized capacity or module is independent from evidence for or against neural localization, since a single capacity might also be based on distributed neural architectures (and vice versa—an emergent property may operate on a network of tightly defined neural substrates).

The view of ToM as an emergent property provides a framework to explore the constituent parts of ToM. An emergent property is a new property that results from the combined action of a number of features (Grimm & Railsback, 2005). An example of an emergent property is a conversation: it is the result of two (or more) people talking in interaction with each other. The verbal output from a single person cannot be considered a conversation, but is a crucial constituent part of it. An emergent outcome is not deducible to one of the constituting features and, in turn, may lead to new processes and outcomes. Considering ToM an emergent property would entail that it includes multiple capacities that alone do not lead to ToM. This approach allows for different levels of complexity of ToM abilities. ToM will show gradual emergence when one of the constituting cognitive capacities becomes available at an advanced enough stage. Likewise, it will show gradual decline when the constituent parts fail. How these multiple capacities are combined may be a crucial feature. This approach assures that the constituent parts are separate, distinct abilities, rather than simpler versions of the same construct.

While some people may find the above presentations cartoon-like, we aim to provide a clear contrast between the view of ToM as a special capacity or an emergent property.

THE VIEW OF THEORY OF MIND IN ANIMAL RESEARCH

In animal research ToM was initially treated as one advanced capacity that could be measured with single tests. A ToM test was designed where chimpanzees had to understand the intentions and situation of others (Premack & Woodruff, 1978). Mirror recognition tasks assessed whether animals may have a concept of self (Gallup & Capper, 1970). These tests were criticized, since alternative explanations were possible, such as previous associative learning yielding the correct outcome of a presented sequence (Heyes, 1993) or co-ordinated reactions to mirror images that could have represented co-movement with an other instead of exploring own movements (Povinelli, 1993). Moreover, chimpanzees did not pass the hallmark test of ToM (see below), the false-belief task (Call & Tomasello, 1999), presumably because they failed to understand the content of others' beliefs (Povinelli & Eddy, 1996b). These critiques and failures led some to conclude that animals do not have ToM (Macphail & Bolhuis, 2001; Wynne, 2004) and that we do not proceed in understanding animal's cognition by squeezing them into this anthropocentric cognitive framework (Barrett & Henzi, 2005). Others continued investigating ToM by developing new approaches.

The new approach dissects the capacity and assumes that ToM consists of different capacities that can have simpler components. For example, one important prerequisite for ToM is that an animal understands the visual perspective of another individual (Emery, 2000; Povinelli & Eddy, 1996b). This can range from a simple co-orientation with the looking direction of the other based on associative learning (Burkart & Heschl, 2006), to understanding that the other is looking at a particular location, even if its own view is blocked (Brauer, Call, & Tomasello, 2005; Povinelli & Eddy, 1996a), to the advanced capacity to form a mental representation of the visual knowledge of the other (Hare, Call, & Tomasello, 2001; Dally et al., 2010 this issue). This approach has resulted in the proposal that ToM emerges from a suite of other cognitive capacities. One proposal postulates that its constituting capacities are causal reasoning, analogous reasoning, episodic memory, inhibition and a large processing capacity to combine information (Barrett et al., 2003). These capacities are also considered cognitively advanced, but they can be investigated separately. Evidence for these constituting capacities indicates that these animals may have ToM or components thereof.

Crucial for determining ToM and other advanced capacities in animals is to show that the evidence does not allow an alternative, cognitively simpler interpretation, since cognitively simpler explanations should be preferred over those requiring cognitively advanced ones for the principle of parsimony (Lloyd Morgan's canon, e.g., Shettleworth, 1998). These simpler explanations include solving the problem via learning or understanding the situation or behaviour without a mental state representation. The outcome of tasks assessing advanced cognitive capacities in animal research has to be distinguished from cognitively simple associative learning: where one (combined) stimulus is linked to one behavioural outcome. Training on the final task is not allowed, since this would provide the animal the opportunity to form a simple association between one feature and an outcome. However, training on behaviour that has to be used in a novel situation is allowed. In the novel situation, the predicted novel behaviour has to be produced through combining different strands of information for the first time (see Clayton, Bussey, & Dickinson, 2003, for episodic-like memory). This novel situation is ensured by providing unique, or only a few, trials to the tested animal. It should be impossible to solve the problem with a simple rule (e.g., long vs. short time for episodic-like memory), but only through abstraction from earlier experiences (triangulation; Heyes, 1993). Therefore, the flexible combination of information is an essential feature of tasks assessing advanced cognitive capacities, including ToM, in animal research. ToM paradigms have also been criticized for not proving that animals may interpret behaviour without a cognitive representation of other's mental states (i.e., "behaviour reading"; Povinelli & Vonk, 2003), which has led to improved testing of various control conditions to exclude behaviour reading as an explanation. The requirement to explicitly exclude such alternative behaviour reading explanations has been evoked less often in human studies. However, it could be argued that flexible and spontaneous application of skills may also be required as evidence for human ToM (see below). Altogether, animal research has advanced from viewing ToM as a singular capacity to viewing it as a capacity composed of several capacities. This marks a crucial difference in approach.

THE VIEW OF THEORY OF MIND IN DEVELOPMENTAL PSYCHOLOGY

Much like the research in animal behaviour, ToM research in developmental psychology started out highlighting the false-belief task (Wellman et al., 2001), though the essentials of ToM may be traced back to Piaget (1929). To date many textbooks and scientific papers still equate ToM with false-belief reasoning, and consequently state that the ability has a clear stage-like onset, leaving little room for further development. Indeed, false-belief

reasoning is one of the most researched topics in child development, resulting in clear developmental stages: most 3-year-olds do not pass the false-belief task, and most 5-year-olds do (Wellman et al., 2001). This evidence favours the specialized capacity perspective; once ToM is acquired, the skill may be fine-tuned, but its presence is indisputable, much like learning to walk. However, studies using adaptations of the same false-belief test contrast this account. Better skills than expected were shown in infants, with 13-month-olds showing a preliminary understanding of false beliefs (Onishi & Baillargeon, 2005). At the same time, normal adults show poorer skills than expected, since many well-known experiments from the domain of social psychology challenge an overly optimistic view of adult ToM (Saxe, 2005).

Indeed, adolescents and adults, who show a conceptual understanding of meta-representations, may still fail more complex and behavioural measures. This aspect is illustrated extensively in the contributions by Roeyers et al. and Begeer et al. (2010 this issue). Studies on human development increasingly take a broader perspective on ToM, with a strong focus on its components in young children, such as imitation, shared attention, social referencing, but also delineating the constituent parts of ToM, highlighting the role of imagination, executive functions and pragmatic language skills (Geurts et al., 2010 this issue) and the difference between competence and performance (Begeer et al., 2010 this issue). Furthermore, going beyond the childhood years, recent studies increasingly target ToM skills across the adult life span, including its decline in older age (Sullivan & Ruffman, 2004). This endeavour is a promising route for a truly comprehensive perspective on the development of ToM.

THE VIEW OF THEORY OF MIND IN DEVELOPMENTAL DISORDERS

The atypical development of ToM has been studied in a variety of mental and physical disorders, such as schizophrenia, psychopathy, deafness and blindness, but, by far, most studies have focused on autism, a disorder that is sometimes defined as an impairment in ToM or “mind blindness”. In general, school-aged children with autism have a well-established limitation on ToM tasks (Wellman et al., 2001), but when children with autism are normally intelligent or “high functioning”, they often score adequately on most elementary and many advanced measures of their ToM understanding (Senju, Southgate, White, & Frith, 2009). In his book entitled *Mind-blindness*, Baron-Cohen (1995) attempted to differentiate between underlying mechanisms of ToM and its impairment in autism. Two of these are often presented as precursors of ToM: the ability to share attention and the ability to detect eye directions. The third mechanism, the “intentionality

detector”, refers to the ability to interpret self-propelled motion stimuli in terms of volitional mental states of goal and desire. Finally, the somewhat homuncular term “theory of mind mechanism” is evoked to explain the ability to attribute epistemic mental states such as pretending, thinking, knowing, believing, while the ToM ties the volitional, perceptual and epistemic mechanisms together (Baron-Cohen, 1995). While individuals with autism were initially presented as impaired on all four domains, recent studies increasingly show that high-functioning individuals were able to conceive of mental representations and are even quite eloquent and aware about ToM. Nevertheless, they generally failed to apply this conceptual understanding in their daily life interactions (Begeer, Rieffe, Meerum Terwogt, & Stockmann, 2003; Frith, Happé, & Siddons, 1994; Senju et al., 2009).

The increasing focus on the adequate performance of individuals with autism and average or above average IQ levels challenges the boldness of the mind-blindness hypothesis. Many individuals with autism even state that they are in fact the only humans with a ToM, referring to their theoretical approach to other minds. Those without autism use less theory and more intuitive simulation in their attempts to make sense of others’ subjective experiences (Gallese, 2007). Without trivializing the limitations of individuals with autism, these contrasting perspectives call for a better conceptualization of the construct.

Studies on autistic individuals have also highlighted the role of other information-processing impairments such as their tendency to miss the big picture and focus too much on detailed information (weak central coherence; Frith & Happé, 1994). Central coherence and executive functions are often presented, together with ToM, as the three main explanatory theories on autism. However, ToM in itself is not a scientific theory. Rather, it should be conceived of as an ability that can to some extent be explained by central coherence and executive functioning. Longitudinal studies on the development in these domains will have to shed more light on the causal relationships between them. Thus, while autism research first focused on the modular approach to ToM, the adequate conceptual abilities of individuals with autism and average or above IQ levels undermines the ideas of an impaired module.

CONTRIBUTIONS TO THE CURRENT SPECIAL ISSUE

Non-human theory of mind

Research on ToM capacities in non-human animals combines the results of multiple behavioural experiments to deduce the nature of applied cognitive capacities. The contribution of Dally, Emery, and Clayton to this issue

reviews evidence for a mental representation of visual knowledge in scrub jays. Scrub jays are a food-hoarding corvid species. Wild scrub jays store food in many places and can recover it at a later stage. Conspecifics, however, can exploit food stored, “stealing” it from the individual that stored it. The reviewed behavioural experiments investigate how scrub jays react when conspecifics know where they hid food. Observed jays recovered and cached food in new locations. Re-caching of food, however, depended critically on the subject’s own experience of stealing hoarded food from another bird. Moreover, the subject’s actions depended on the identity of the observing bird, not its behaviour. Since the correct behaviour of a subject jay depended on a combination of information, not on one cue, the authors argue that they have a mental representation of the knowledge of other jays: namely whether they observed the hoarding of food at a particular location or not.

This study indicates that scrub jays combine different strands of information to guide their behaviour when they can re-cache food. First, an animal translates its own actions in the past into the appropriate action against this action, namely stealing of food translates into hiding of food. This may represent a degree of causal (if hoarding is seen, then food can be stolen) and analogous (if I can steal after seeing hoarding, so can an observer when I hoard food) reasoning. Second, it forms a memory of a particular event, the location where food was hidden in combination with the observation of this action by a particular individual, and this memory can be considered an episodic-like memory of a past unique event. These two strands of information are combined with the current presentation of the hoarding tray and the presence of a particular conspecific now. A simple explanation, one cue or reading the behaviour of the observing bird, cannot explain the reaction. Therefore, the alternative, that jays use a mental representation of the observing bird’s knowledge, is the best explanation of the results. This indicates that the formation of this mental representation consists of different constituent parts.

It has been argued that chimpanzees form mental representations of others’ knowledge, intentions and goals (see Call & Tomasello, 2008, for a review), but not of false beliefs (Kaminski, Call, & Tomasello, 2008). This conclusion was based on the combined results of multiple experiments, analogous to the approach on scrub jays, and has been taken by Koski and Sterck (2010 this issue) as a starting point to investigate chimpanzee’s empathic concern for others, a capacity related to ToM. The paper proposes at what cognitive level chimpanzees may express empathy. Although empathy has been linked to advanced cognitive processing in emotional state representation, it may also be based on cognitively simpler mechanisms (Preston & de Waal, 2002), as empathy is based on two partially distinct components, namely emotional and cognitive processing. Koski and Sterck

propose that chimpanzee processing of others' emotions depends on the combined action of emotional contagion, some level of the cognitive distinction between own and other's emotional states and the ability to inhibit own emotions. The first, emotional contagion, makes it possible to feel what the other feels. The later two capacities determine whether an individual understands the emotional state to be other's rather than their own, and potentially how the co-feeling with the other is translated in behaviour beneficial for the other. Following the evidence from chimpanzees' capacity for representing some mental states of others and of inhibiting own responses (Dufour, Pele, Sterck, & Thierry, 2007), they propose that chimpanzees may have the capacity for veridical empathy, which is cognitively simpler than full cognitive (ToM) empathy, but more advanced than mere emotional contagion. Thus, the partial capacity for ToM in chimpanzees is used as a constituting component determining the ascent of cognitive complexity of chimpanzee empathy.

Human development

In both humans and non-humans, the definition of ToM often mistakenly includes a one-sided focus on attributing mental representations to others, neglecting the ascription of mental representations to oneself. Consequently, most research to date—focusing on humans, from the traditional false-belief tasks to the more recent advanced ToM measures, employs a similar focus on mental representations of other individuals rather than those of oneself (see Begeer et al., 2010 this issue; Roeyers et al., 2010 this issue). The contribution of Mitchell, Bennett, and Teucher includes a perspective on children's acknowledgment of their own mental representations. When considering our own minds or mental representations, it is often taken for granted that *we* know best what is on our mind. The privileged access to one's own experiences is assumed to result in direct knowledge about the content of our own mind. Interestingly, when children are asked who knows best about their (the children's) own interior states, they often denote others, such as their parents or a teacher, rather than themselves. Mitchell et al. discuss this phenomenon in a review of findings on typical development from preschool age to preadolescence. While children seem to start out thinking they may not be best qualified to know their own minds, they increasingly acknowledge their own authority. This development depends not only on the type of knowledge at hand, but also on cultural background. Individualistic cultures seem to focus more on the individual itself, while collectivist cultures focus more on the context. The developing understanding of own and other people's access to subjective mental representations offers an intriguing aspect of the broader understanding of ToM, which encompasses a much overlooked awareness of our own inner states.

Following the more traditional focus on attributing mental representations to others, Ketelaars et al. present a much-needed longitudinal approach. Their research investigates the development of different aspects of ToM in normally developing children between 5 and 7 years. They highlight the understanding of mental representations that differ in complexity, from simple emotions to understanding more complex processes of emotion display rules, mixed emotions and false beliefs. While emotion attribution remained relatively stable, all other measures improved with age. Moreover, performance of these tasks, and also language ability, at a particular age was correlated and predictive of performance at a later age. Confirming earlier studies, children were generally able to perform the simpler tasks at a younger age than the more advanced tasks, indicating that the mental representations become more complex with age. In addition, the ability to perform simpler tasks likely functioned as a prerequisite for performing more complex tasks. However, what is the precise cognitive change that allows children to perform more complex tasks remains unclear.

Pathological human development

The section on pathological human development has a strong focus on autism, which is unsurprising, given that difficulties with ascribing mental representations to others can be seen as one of the core features of autism. The section starts with a contribution by Begeer, Malle, Nieuwland, and Keysar, describing two new instruments that measure the application of ToM skills during the representation and partaking in social interactions. Highlighting normally intelligent, or high-functioning children and adolescents with autism spectrum disorders (HFASD), the authors argue for a strong need for new ways of measuring ToM in complex, real-life settings. This is important because, from preadolescence, most traditional ToM tests do not target the problems of individuals with HFASD, who seem to grasp the elementary principles from ToM on a theoretical level, but primarily fail to apply this understanding in practice. Tackling this problem, a task was designed where participants are asked to retell a story about an interaction between two people. The HFASD group showed a diminished tendency to represent the social interactions in mentalistic terms. Second, participants were tested in a direct perspective-taking task. Both the typically developing and HFASD participants performed at similar—though quite poor—levels on this task. Apparently, even structured interactions are filled with perspective-taking errors, including in normal adults. Interestingly, the performance was positively correlated to chronological and mental age in the HFASD group only. Therefore, their ToM skills are probably not systematically deficient but may depend on cognitive abilities, suggesting different processing styles in typically developing individuals and HFASD.

The role of intelligence in the performance on ToM tasks likely indicates that individuals with HFASD use more cognitive, rule-based strategies in social situations. While this may be helpful in highly structured situations, the more dynamic social reality in daily life interactions often presents unexpected situations, which can result in sudden failures in perspective taking that are often highly confusing to others. Typically developing individuals, on the other hand, seem to employ more intuitive or heuristic approaches, which provide them with the ability to improvise and respond in a more flexible way to changing environments.

Indeed, the clear structure of many traditional false-belief-type tasks may have overestimated the performance of the HFASD individuals. This argument is closely related to the rationale of the contribution of Roeyers and Demurie, who review various approaches to advancing ToM measures, specifically for adolescents and adults with HFASD. A first series of tasks presented static social stimuli to infer mental states, but varied the modality of the stimuli by using voices or parts of faces. This provided widely varying results. For instance, the use of eye-region pictures to infer their mental states has yielded mixed results with respect to group differences between HFASD participants versus matched controls. A second series has aimed to approach the dynamics of real-life interactions using film fragments. This approach has indicated limitations of individuals with HFASD, though large individual differences were found. Interestingly, the performance of HFASD individuals improved when the interaction was more structured (i.e., involving a well-known situation such as getting acquainted). The roles of structure and the ability of HFASD individuals to use explicit social scripts in well-known situations are further discussed. Both Roeyers et al. and Begeer et al. (2010 this issue) note that in real-life situations structure may help HFASD individuals to use of ToM skills.

Geurts, Broeders, and Nieuwland provide a wider perspective on ToM by highlighting the link with two related domains of functioning: executive functioning and pragmatic language abilities. Executive functioning provides a clear explanatory framework for ToM functioning. Executive functions, defined as the cognitive control processes that enable us to monitor behaviour in a dynamically changing environment, can be said to fundamentally underlie ToM in pragmatic language use. Alternatively, deficits in ToM and executive functioning could be caused by another cognitive deficit. This hypothesis is investigated by reviewing the evidence for ToM deficits in children with a disorder known to be related to impaired executive functioning: AD/HD.

While the bottom line of the empirical findings is that children with AD/HD are overwhelmingly impaired in executive functioning, limitations in ToM are not convincingly found, suggesting that impairments in executive functions do not automatically result in ToM deficits. When considering the

relation of both capacities with pragmatic language use, the relatively unimpaired ToM abilities of children with AD/HD can be contrasted with their poor pragmatic language skills. Interestingly, the task discussed as measuring pragmatic language use, the strange stories task, is also often put forward as an advanced ToM task (Roeyers et al., 2010 this issue), showing the need for a better conceptualization of the construct of ToM. In short, the Geurts et al. paper shows that the research on ToM will benefit from a longitudinal focus on multiple domains in multiple disorders to disentangle why some children develop impairments in specific aspects of their social cognitive functioning.

DO CURRENT CONTRIBUTIONS SUGGEST SPECIALIZED CAPACITY OR EMERGENT PROPERTY?

Perspectives from non-human development (Dally et al., 2010 this issue; Koski & Sterck, 2010 this issue) give credence to the interpretation that animal ToM consists of multiple constituting capacities. Both chimpanzees (Call & Tomasello 2008) and scrub jays (Dally et al., 2010 this issue) entertain mental representations of other's knowledge, goals, desires and intentions. However, chimpanzees do not seem to entertain mental representations of false beliefs (Kaminski et al., 2008), a capacity not tested in scrub jays. In particular the chimpanzee data suggest that entertaining one type of mental representation does not automatically imply that other mental representations are formed, indicating a gradual emergence of ToM. Animal research, however, does not provide information on whether ToM is mandatory to use once present, since research aims at investigating whether it is actually present, not whether it is present and is not employed.

Perspectives from human development also seem to suggest a gradual emergence, differentiating between various different tools (Malle, 2005) that ToM is comprised of, in keeping with the emergent property hypothesis. Children show a gradually increased awareness of their own mental representations (Mitchell et al., 2010 this issue) and an increasing ability to pass ToM tasks (Ketelaars et al., 2010 this issue) with age. Also, the waning of the initial confusion about who has most access to one's own mental states during development is inconsistent with ToM as a mandatory process (Mitchell et al., 2010 this issue). Moreover, the evidence for perspective-taking failures in normal adults is in full contrast with the idea that ToM is a capacity that will be used when present in an individual (Begeer et al., 2010 this issue). In addition, Ketelaars et al. (2010 this issue) highlight the large individual variance in children's performance on a range of tasks related to ToM skills. Their evidence for a correspondence between belief reasoning and emotion understanding emphasizes ToM as a dynamic

construct, suggesting separate but connected skills that broaden over time to later insights. Furthermore, following Geurts et al. (2010 this issue), it could be argued that cognitive flexibility and inhibitory control are skills that are required for passing ToM tasks, on both conceptual and applied levels.

Perspectives from pathological development show even more strongly that the idea of ToM as one specialized capacity is not tenable when considering more able and older human individuals, whether typically developing or with autism. Different outcomes of ToM tasks using different methodology, whether conceptual versus practical, or unstructured versus explicit and structured tasks, suggest a strong context dependency in the performance. Moreover, the findings that normal adults often fail to act according to ToM, despite the fact that they have been found to pass every single method of measuring ToM in its official definition, shows that there may not be a specialized capacity that we can define as ToM (Begeer et al., 2010 this issue), but rather a variety of situated capacities that may allow us to deal with other minds, if applied in the adequate way.

It is intriguing to contrast the rule-based, theoretical approach of ToM of individuals with HFASD with the strict criteria from studies in non-human species that prohibit training animals on ToM. In behavioural biology, the possibility that an animal's behaviour relies on rule-based, associative learning disallows this behaviour to be considered ToM. The criteria for using rule-based responses in human studies are less clear. These contrasting approaches raise the question of whether flexibility and spontaneity of behaviour should be considered necessary and sufficient components of ToM, and whether overly learned or rule-based responses should be excluded.

Language skills have been considered mandatory for ToM (Astington & Jenkins, 1999). While Ketelaars et al. (2010 this issue) indeed found a relationship between language skills and performance in ToM tasks in normally developing children, Geurts et al. (2010 this issue) found that AD/HD children with poor language skills performed well on ToM tasks. Moreover, animals lack language (Pinker, 1994), but show some aspects of ToM. This gives rise to the question of whether language is required for ToM. Tomasello et al. (2005) argued for the idea that language is an important by-product of ToM, rather than a necessary ingredient. The studies on animals suggest that language may not be an essential constituent part of ToM, but a critical view of the limited results with regard to animal ToM skills do leave the option that language is indeed a necessary ingredient to form particular mental representations or to put them to particular use.

This finding can also have a bearing on how ToM is tested in humans. Psychological measures of ToM usually rely heavily on language skills (see Ketelaars et al.; Begeer et al.; Roeyers et al., all this issue). The inconsistent findings with these measures regarding autism may show that—IQ independent—non-verbal or behavioural assessments may provide a closer

account of the core problems of ToM skills of adults with HFASD (Senju et al., 2009). Altogether, the precise role of language skills in employing ToM remains to be investigated.

In conclusion, the data are more consistent with the view that ToM is an emergent capacity than the view that it is a special capacity. Therefore, whether an individual has a ToM cannot be answered with yes or no, as this concept is not a dichotomous one. The employment of ToM appears to depend on the functioning of its constituting capacities, the type and level of represented mental states and context factors. To determine what allows its use in particular situations is the challenge for the future. We hope this introduction and the contributions to this special issue have peaked interest in not just testing whether ToM is present according to some criterion, but that the focus will be on the ingredients that contribute to and allow (or prevent) the expression and employment of ToM in a particular setting. Only this will allow us to start understanding when and how individuals deal with the minds of others.

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