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Theory of mind and autism: a review

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A theory of mind remains one of the quintessential abilities that makes us human (Whiten, 1993). By theory of mind we mean being able to infer the full range of mental states (beliefs, desires, intentions, imagination, emotions, etc.) that cause action. In brief, having a theory of mind is to be able to reflect on the contents of one's own and other's minds. This ability has been extensively studied in both normal and abnormal development (Astington, 1994; Astington, Harris & Olson, 1988; Baron-Cohen, 1995; Baron-Cohen, Tager-Flusberg & Cohen, 1993; Mitchell & Lewis, 1995; Moore & Dunham, 1996; Perner, 1991; Wellman, 1990; Whiten, 1991).

Difficulty in understanding other minds is a core cognitive feature of autism spectrum conditions. Two other cognitive features are weak central coherence¹ (Happe, 1994), and executive dysfunction² (Russell, 1997). The theory of mind difficulties seem to be universal among such individuals. This chapter describes some of the manifestations of this abnormality, and emphasizes how developmentally appropriate tests are needed in order to reveal it. The review is of work from 1985 to the present. Whilst this is not exhaustive, it gives a good flavour of the studies from this time, summarizing many different experiments that are listed in Table 1. Throughout the chapter, the terms 'theory of mind', 'mindreading', and 'understanding other minds' are used synonymously.

¹ Central coherence is the ability to integrate information in context (Frith, 1989). Individuals with autism are said to have weak central coherence and thus to be poor at using context but superior at local-detail perception (Happe, 1996; Jolliffe & Baron-Cohen, 1997; Jolliffe & Baron-Cohen, 1999; Plaisted, O'Riordan & Baron-Cohen, 1998a; Plaisted, O'Riordan & Baron-Cohen, 1998b; Shah & Frith, 1983; Shah & Frith, 1993).

² Executive function refers to the processes underlying action control (including attentional control). People with autism have been found to show executive dysfunction on a number of tasks (Hughes, Russell

insert Table 1 here

& Robbins, 1994; Ozonoff, Pennington & Rogers, 1991; Russell, 1997). These are assumed to reflect prefrontal cortical abnormalities (Shallice, 1988).

The mental-physical distinction

I start this review with the mental-physical distinction since many consider that this distinction is a fundamental cornerstone of our theory of mind, and one that is not explicitly taught by parents or teachers. The test for this distinction involves the child listening to stories in which one character is having a mental experience (e.g., thinking about a dog) whilst a second character is having a physical experience (e.g., holding a dog). The experimenter then asks the subject to judge which operations the two characters can perform (e.g., which character can stroke the dog?). Whilst 3-4 year old normal children can easily make these judgments, thereby demonstrating their good grasp of the ontological distinction between mental and physical entities and events (Wellman & Estes, 1986), children with classic autism have been found to be significantly impaired at making such judgments (Baron-Cohen, 1989a). This is despite having a mental age at least equivalent to a 4 year old level.

Understanding of the functions of the brain

This test was also originally devised by Wellman and Estes, and involves asking the child what the brain is for. They found that normal 3-4 year olds already know that the brain has a set of mental functions, such as dreaming, wanting, thinking, keeping secrets, etc., Some also knew it had physical functions (such as making you move, or helping you stay alive, etc.). In contrast, children with autism (but who again had a mental age above a 4 year old level) appear to know about the physical functions, but

typically fail to mention any mental function of the brain (Baron-Cohen, 1989a). In these studies, mental age is usually assessed in terms of verbal abilities, since non-verbal mental age tends, if anything, to be higher than verbal mental age. In this way, one is able to check that the deficit is not due to insufficient mental age.

The appearance-reality distinction

Flavell and colleagues (Flavell, Green & Flavell, 1986) found that children from about the age of 4 years old normally are able to distinguish between appearance and reality, that is, they can talk about objects which have misleading appearances. For example, they may say, when presented with a candle fashioned in the shape of an apple, that it looks like an apple but is really a candle. Children with autism, presented with the same sorts of tests, tend to commit errors of realism, saying the object really is an apple, or really is a candle, but do not capture the object's dual identity in their spontaneous descriptions (Baron-Cohen, 1989a). Given that to do this requires being able to simultaneously keep track of what an object looks like, versus what it actually is - how you perceive or think about it subjectively, versus how it is objectively - it is an additional clue that in autism there is a deficit in the development of a theory of mind. Note that alternative interpretations of this deficit are certainly possible, since this task relies on quite complex language skills.

First-order false belief tasks

These tasks relate to the understanding that different people can have different thoughts about the same situation. They are called first-order tests because they only involve inferring one person's mental state. (See below for discussion of second-order tests). Normal 4 year olds can keep track of how different people might think different things about the world (Wimmer & Perner, 1983). We have similarly found that, when interpreting well-known stories such as Little Red Riding Hood or Snow White, even 4 year olds will say things like "Little Red Riding Hood *thinks* that it's her grandmother in the bed, but really it's the wicked wolf!"; or "Snow White *thinks* the old woman is giving her a nice juicy apple. She doesn't *know* that it's really her wicked step-mother all dressed up, and that the apple is poisoned!". A large number of studies have demonstrated that children with autism have difficulties in shifting their perspective to judge what someone else might think, instead simply reporting what they themselves know (Baron-Cohen, Leslie & Frith, 1985; Baron-Cohen, Leslie & Frith, 1986; Leekam & Perner, 1991; Perner, Frith, Leslie & Leekam, 1989; Reed & Peterson, 1990; Swettenham, 1996; Swettenham, Baron-Cohen, Gomez & Walsh, 1996).

"Seeing leads to knowing" tests

Another corner stone of typically developing children's theory of mind is understanding where knowledge comes from, so that they can work out who knows what, and more importantly, who doesn't know what. This is a key development simply

because it underpins appropriate communication, telling people what they don't know - informing others - rather than telling them what they already know (Grice, 1975/1957). It also underpins an understanding of deception, which depends on being able to work out a person might know about. (We will return to discuss deception later).

Typically developing 3 year olds can understand the seeing-leads-to-knowing principle, in that when given a story about 2 characters, one of whom looks into a box and the other of whom touches a box, they can infer that the one who looked, will know what's in the box, whilst the other one will not (Pratt & Bryant, 1990). In contrast, children with autism are virtually at chance on this test, as likely to indicate one character as the other when asked "Which one knows what's in the box?" (Baron-Cohen & Goodhart, 1994; Leslie & Frith, 1988).

Tests of recognizing mental state words

By 4 years old, normally developing children can also pick out words from a word list that refer to what goes on in the mind, or what the mind can do. These words include "think", "know", "dream", "pretend", "hope", "wish", and "imagine". These are easily distinguished from other kinds of (non-mental) verbs like "jump", "eat", or "move". Children with autism have much more difficulty in making this judgment (Baron-Cohen et al., 1994). Note that this is really a test of their mental lexicon, rather than their ability to infer the contents of a mental state, but their deficient mental state lexicon may well be an indicator that conceptual development in this domain is also less

well developed than would be expected for the child's general mental age. Other aspects of their lexicon are not impaired relative to their verbal mental age.

Tests of production of the same range of mental state words in their spontaneous speech

The previous finding dovetails with reports that children with autism produce fewer mental state words in their spontaneous descriptions of picture stories involving action and deception, and in their conversational discourse, compared to their normal counterparts (Baron-Cohen et al., 1986; Tager-Flusberg, 1992). All the usual caveats regarding what we can infer from speech alone apply to these studies (i.e., does production reflect competence?), but when taken together with the other experimental evidence summarized here, the likelihood is that this reflects delays or deficits in comprehension of mental state concepts, or at the very least, reduced attention to such phenomena.

Tests of the production of spontaneous pretend play

Many studies have reported a lower frequency of pretend play in the spontaneous play of children with autism (Baron-Cohen, 1987; Lewis & Boucher, 1988; Ungerer & Sigman, 1981; Wing, Gould, Yeates & Brierley, 1977). This is interpreted in various ways (Leavers & Harris, 1998). For example, it might reflect a failure to reflect on one's own imagination - a mindreading deficit (Leslie, 1987). Or it might reflect a failure to

switch attention flexibly from ‘reality mode’ to ‘pretend mode’, as a result of some aspect of executive function (Russell, 1997). Or both. Note that the executive account strains a bit to explain why the normal 24 month old child should find such switching so easy (and fun) during pretence, whilst at the same age being largely incapable of many other executive switching tasks, such as solving the Detour Reaching Task (Diamond, 1991). This suggests that pretend play may be a function of early-developing mindreading mechanisms rather than slower-developing executive systems.

Tests of understanding more complex causes of emotion (such as beliefs)

Emotions can be caused by situations (such as falling over causes you to cry, or being given a present causes you to feel happy). But emotions can also be caused by mental states such as desires and beliefs (Harris, Johnson, Hutton, Andrews & Cooke, 1989). Thus, you can be happy because you got what you wanted, or because you think you are getting what you wanted. Harris and colleagues found that normal 4-6 year olds understand all 3 types of emotional causation. In contrast, studies show that children with autism with this mental age have difficulty with mental states as causes of emotion (Baron-Cohen, 1991; Baron-Cohen, Spitz & Cross, 1993). As with all of the previous studies, the deficits in autism are typically demonstrated relative to a comparison group of children without autism but with general developmental delay, suggesting that the deficit is autism-specific.

Tests of inferring from gaze-direction when a person is thinking, or what a person might want

Why do we spend so much time looking at people's eyes? Why not at their ears, chins, or elbows? The question may strike you as odd, because it makes no intuitive sense that these other parts of the body should contain any information that we might find important. But until recently, it was not clear what the information around someone's eyes conveyed to another person. We now know that from gaze-direction, children as young as 4 years old can work out when someone is thinking about something (e.g., gaze directed upwards and away, at nothing in particular, strongly signifies the person is thinking (Baron-Cohen & Cross, 1992)). Gaze-direction also allows young normal children to work out which of several objects a person wants, or might be interested in, or might be referring to (Baldwin, 1991; Bruner, 1983; Butterworth & Jarrett, 1991). Children with autism, in contrast, are relatively blind to such information from gaze-direction, even though they can answer the explicit question "What is Charlie looking at?" (Baron-Cohen, 1989c; Baron-Cohen, Baldwin & Crowson, 1997; Baron-Cohen, Campbell, Karmiloff-Smith, Grant & Walker, 1995; Baron-Cohen & Cross, 1992; Hobson, 1984; Leekam, Baron-Cohen, Brown, Perrett & Milders, 1997). Mentalistic interpretation of the eyes of another person does not seem to come naturally to them.

Tests of being able to monitor one's own intentions

We have covered a number of tests of understanding other people's thoughts, but another important class of mental states is intentions. Working out why people behave as they do is all about keeping track of people's intentions, since tracking actions alone gives a description of what people do, but not why they do it. In a novel test of this, 4 year old normal children were asked to shoot a toy gun at one of six targets, stating their intended target. Then, unbeknownst to the child the outcome was manipulated by the experimenter, such that sometimes the child hits their chosen target, and sometimes they did not. Normally developing 4 year olds could correctly answer the question "Which one did you mean to hit?", even when they did not get what they intended, but children with autism often made the error of answering by reference to the actual outcome (Phillips, Baron-Cohen & Rutter, 1998).

Tests of deception

Deception is relevant to understanding other minds simply because it involves trying to make someone else believe that something is true when in fact it is false. In other words, it is all about trying to change someone else's mind. Clearly, it must involve knowing that there are such things as beliefs, and that beliefs can be true or false; but it also involves knowing that beliefs are manipulable, that people will form their beliefs on the basis of what they know about, either through what they have directly witnessed or what they have heard about. Finally, deception requires motivation: recognizing that there might be some pay-off to making someone else believe something to be the case, even when this does not match reality.

We tend to think of deception as morally reprehensible, which in many cases it is. Society, and communication, is rightly predicated on the basis that we are all being truthful to each other, since otherwise we would never be able to trust each other's actions or communications as genuine or sincere. Some kinds of deception of course are morally less clear cut than this (such as saying out of politeness how much you like someone's haircut, when you don't, or how much you like a gift you've received, when you don't), since in these cases it may be worse to hurt someone else's feelings by telling the truth, than to lie. Being able to distinguish such white lies from others is all part of developing social skill and social cognition in the normal case.

A number of studies show that by the age of 4 years old the normally developing child is showing both an interest in deception, and beginning to practice it (Sodian, Taylor, Harris & Perner, 1992). Leaving the moral aspects aside, such signs of deception can be taken as a yardstick that the child is aware of all of these aspects of understanding other minds. Of course, early attempts at deception may be clumsy and ineffective, such as the young child claiming that he did not take the chocolate cookies, whilst the tell-tale evidence is all over all over his face; or the young child in a game of hide-and-seek, calling out from her hiding place behind the curtains to "come and find me!". In these instances, the child is arguably trying to deceive, but is not keeping track of the clues that would lead the other person to know the truth. Most workers in this area would code a behaviour as deception (1) when it is effective (i.e., excluding these two cases, since they do not clearly demonstrate an understanding of the need to conceal the essential

information), and (2) when there are multiple examples of it (i.e., excluding one-off cases which could always be explained through the learning of some rule, as in “go behind the curtain and stay quiet”). When there are many examples for which there is no single underlying rule, then the more parsimonious explanation is that the child understands what deception is.

Children with autism, when studied under experimental conditions, have been shown to have difficulties both in production of deception, but also in understanding when someone else is deceiving them (Baron-Cohen, 1992; Sodian & Frith, 1992; Yirmiya, Solomonica-Levi & Shulman, 1996). An example of one test is the “penny-hiding game”, where the aim of the game is to not reveal the hand which you have hidden a penny in. Young children with autism, despite having a mental age of above a 4 year old level, often make errors in this game, which suggest they do not understand how to deceive very well. Examples of their errors include hiding the penny in one hand, but leaving the other hand open; or between trials, transferring the penny from one closed fist, to the other; or putting the penny out of sight, and then telling the other person “it’s in here!”, etc., (Baron-Cohen, 1992).

Tests of understanding metaphor, sarcasm, jokes, and irony

Some studies have tested if children with autism understand figurative speech through story comprehension. Figurative speech requires an understanding of the speaker’s intentions, in order to move beyond the literal level of simply mapping words

onto their referents. Examples of figurative language include sarcasm (“How clean your room looks today!”, uttered by an exasperated parent to her child), and metaphor (“she’s got a sharp tongue!”). Results suggest that this more advanced mindreading test (pitched at the level of a normal 8 year old) reveals the subtle mindreading deficits in individuals with high-functioning autism. They may confuse the intentions of the speaker (Happé, 1994). A similar finding using a simpler test comes from a study of normal preschoolers based on testing if they can understand someone’s intention to joke. Children as young as 3 years old heard utterances like “This is a shoe”, spoken by the experimenter whilst pointing at a cup, and were asked why the experimenter said that. Whereas even normal children referred to the speaker “joking” and “pretending”, in their explanation, children with autism tended to refer to the speaker having got it wrong (“it’s not a shoe, it’s a cup” etc.) (Baron-Cohen, 1997).

Tests of pragmatics

Understanding figurative speech and humour is just a subset of pragmatics, or the use of language appropriate to the social context. Aspects of language in autism are considered in more detail elsewhere (Tager-Flusberg, 1993), but pragmatics includes at least the following:

- tailoring one’s speech to a particular listener;
- adapting the content of one’s speech to what your listener already knows or needs to know;

- respecting conversational maxims (Grice, 1975/1957) such as being truthful, relevant, concise, and polite;
- turn-taking appropriately so that there is space for both participants in the dialogue;
- being sensitive to the other person's contribution to the conversation;
- recognizing what is the wrong or right thing to say in a particular context;
- staying on topic; and
- appropriately helping your listener to follow when a topic change is occurring.

Almost every aspect of pragmatics involves sensitivity to speaker and listener mental states, and hence mindreading, though it is important to note that pragmatics also involves using context. This means that a deficit in pragmatics could occur for at least two different reasons: some degree of mindblindness, or some degree of weak central coherence (use of context). Two experimental studies of pragmatics in children with autism have included (1) a test of whether the Gricean maxims of conversational relevance can be recognized (Baron-Cohen, 1988; Tager-Flusberg, 1993), and a test of recognizing when someone said the wrong thing (faux pas) (Baron-Cohen, O'Riordan, Jones, Stone & Plaisted, in press). In the first task, the child has to work out which of two possible replies would be an inappropriate answer to a question. In the second study, the child has to identify if anyone said anything they should not have said, based on hearing a short story. Both studies suggest that children with autism have difficulties in this area (Surian, Baron-Cohen & Van der Lely, 1996).

Tests of imagination

We discussed the relevance of pretend play earlier, and this is one possible way that imagination can be expressed. More broadly, imagination is relevant to theory of mind since it involves an unreal world that exists purely in your mind, and being able to reflect on this virtual world. The virtual world is the content of one's mental state of imagining. One study of children with autism investigated the ability to draw pictures of unreal or impossible objects (such as two-headed people), and found that children with autism were either reluctant or less able to produce such drawings (Scott & Baron-Cohen, 1996). A recent study suggests that this may be due to executive function factors (the need to suppress routine approaches to drawing, and override these with novel approaches), and reports some evidence to show that when the task is simplified sufficiently to eliminate such executive factors, no deficit in autism is seen (Leevers & Harris, 1998).

However, Craig has gathered fresh evidence for persisting imagination impairments in both children with autism and Asperger Syndrome. He used a range of tasks including drawing, story telling, and standard creativity measures, for which an executive dysfunction explanation is not the most parsimonious account (Craig, 1997). His results were better accounted for by positing a basic deficit in the use of the imagination per se. This experimental evidence is clearly in line with the clinical descriptions of impaired imagination in people with an autism spectrum condition, and as specified in most diagnostic classification (APA, 1994).

Correlation with real-life social skills

One might raise the concern that theory of mind tasks simply measure aspects of social cognition under laboratory conditions, and as such have no relevance to social impairment in the real world. For this reason, Frith and colleagues have examined the correlation of theory of mind skills in children with autism in relation to real-world behaviour, as measured by a modified version of the Vineland Adaptive Behaviour Scale (Frith, Happe & Siddons, 1994). They report that these are indeed significantly correlated, providing some measure of validity of the tests.

Second-order false belief tests

The universality of theory of mind deficits in autism have been questioned simply because a proportion of children with autism or the related condition of Asperger Syndrome pass first-order tests. First-order tests, including most of those reviewed above, involve simply inferring one person's mental state, e.g., what John thinks. Happe points out that this need not challenge the universality claim, since there are no reported cases of autism spectrum disorder who pass first order theory of mind tests at the right mental age. Thus, an individual with high-functioning autism or Asperger Syndrome, who by definition has normal intelligence, should be able to pass such tests at 3-4 years of age. Typically however, they are older than this when they pass such tests. In children with autism, Happe finds that on average a verbal mental age of 9 years old is needed before

passing of such tests is seen, and that the youngest mental age of an individual with autism passing such tests is 5.5 years (Happe, 1995).

As one might expect, as a result of a delay in acquiring first-order theory of mind competence, these individuals often fail second-order false belief tests (Baron-Cohen, 1989b). Second-order tests involve considering embedded mental states, e.g., what John thinks that Mary thinks. Whereas first-order tests correspond to a 4 year old mental age level, second-order tests correspond to a 6 year old mental age level. Second-order tests can be another way of revealing if there is a *specific developmental delay* in theory of mind at a later point in development. However, some individuals with high-functioning autism or Asperger Syndrome may pass even second-order false belief tests by their teens (Bowler, 1992; Happe, 1993; Ozonoff et al., 1991). Those who can pass such second-order tests however may have difficulties on the more advanced theory of mind tests described earlier, such as inferring bluff and double bluff in story characters - an 8 year mental age level test - (Happe, 1994), or in decoding complex mental states from the expression in the eye-region of the face (Baron-Cohen, Jolliffe, Mortimore & Robertson, 1997; Baron-Cohen, Wheelwright & Jolliffe, 1997).

Specificity issues

It is important for readers not to take home the message that deficits on theory of mind tests are in any way diagnostic. This is because a child might fail such tests for a variety of reasons. In a recent meta-analysis, children with learning difficulties (or what

in the US is termed mental retardation) but without autism were also shown to often fail such tests (Yirmiya, Erel, Shaked & Solomonical-Levi, 1998). Although many studies also show that performance in theory of mind is in line with mental age levels in such groups (Baron-Cohen et al., 1985; Baron-Cohen et al., 1986; Perner et al., 1989), it is possible that a variety of types of comprehension problem might interfere with success on these tasks. Such children may also have equivalent difficulty on ‘control’ tasks such as the False Photograph task³ (Charman & Baron-Cohen, 1995; Leekam & Perner, 1991; Leslie & Thaiss, 1992) whilst children with autism may show a specific deficit only on the theory of mind task. The same point can be made in relation to deaf or blind children, whose development in theory of mind may be slowed down presumably for reasons to do with not receiving enough of the right perceptual input (Brown, Hobson, Lee & Stevenson, 1997; Peterson & Siegal, 1997). Interestingly, in the case of the deaf, this deficit is not seen when children have been taught signing by signing parents (Peterson & Siegal, 1997), the implication being that communication problems are in their case interfering with task performance.

People with autism-spectrum conditions are clearly having mentalizing difficulties for different reasons to those seen in people with learning difficulties or those who are blind or deaf, since a deficit can be revealed even in the highest functioning individuals with an autism spectrum condition in whom general comprehension problems can be ruled out. For example, adults with Asperger syndrome or high-functioning autism show reduced performance on the Reading the Mind in the Eyes Task (Baron-Cohen et

³ This task involves working out the content of pictorial representations (photos) that do not match reality.

al., 1997). An even more dramatic demonstration of this is the deficit on this task reported in an Oxbridge University Mathematics Professor with Asperger syndrome, who had won the equivalent of the Nobel Prize (the Field Medal) (Baron-Cohen, Wheelwright, Stone & Rutherford, in press). Mentalizing deficits in such 'pure' cases of Asperger syndrome may seem strongly diagnostic, especially given their highly specific nature (such individuals having no identifiable deficits in any other domain). However, caution is still needed in not treating such tests as diagnostic, since adults with schizophrenia can also fail such tests (Corcoran & Frith, 1997), albeit with a much later age of onset.

Conclusions

Mindreading deficits in autism spectrum conditions appear to be early occurring (from at least the end of the first year of life, if one includes joint attention⁴ deficits) and universal (if one tests for these either at the right point in development, or in the case of high-functioning, older subjects by using sensitive, age-appropriate tests). Parents of children with autism spectrum conditions, may also show difficulties in attributing mental states when just the eye-region of the face is available (Baron-Cohen & Hammer, 1997), suggesting that for genetic reasons, mild degrees of mindblindness may be one aspect of the broader cognitive phenotype.

This is a good control task for the false belief task.

⁴ Joint attention involves monitoring what you and another person are simultaneously attending to. It is discussed elsewhere (Baron-Cohen, 1989c; Leekam et al., 1997).

The brain basis of the theory of mind deficit in autism is being investigated using both functional neuroimaging and studies of acquired brain damage (Baron-Cohen et al., 1999; Happe et al., 1996; Stone, Baron-Cohen & Knight, 1999; Stone, Baron-Cohen, Young & Calder, 1998). These suggest that key neural regions for normal mindreading are the amygdala, orbito-frontal cortex, and medial frontal cortex. It is hoped that future research in this area will refine both the techniques for studying this skill across the lifespan, and make further headway in understanding the underlying mechanisms essential for mindreading. Finally, much of the basic research in this field may have clinical applications in the areas of either intervention or early diagnosis (Baron-Cohen et al., 1996; Hadwin, Baron-Cohen, Howlin & Hill, 1996; Howlin, Baron-Cohen & Hadwin, 1998)⁵. This is a potentially fruitful avenue for future research.

⁵ This recent book reports materials used in a study to train mindreading skills, using explicit methods, in children with autism. Results show training does improve performance, but with limited generalisation.

Table 1: Some tests of theory of mind in people with autism

1. the mental-physical distinction (Baron-Cohen, 1989a);
2. understanding of the functions of the mind (*ibid*);
3. the appearance-reality distinction (*ibid*),
4. first-order false belief tasks, (Baron-Cohen et al., 1985; Baron-Cohen et al., 1986; Leekam & Perner, 1991; Perner et al., 1989; Reed & Peterson, 1990; Swettenham, 1996; Swettenham et al., 1996);
5. "seeing leads to knowing" tests (Baron-Cohen & Goodhart, 1994; Leslie & Frith, 1988);
6. tests of recognizing mental state words (like "think", "know", and "imagine") in a wordlist (Baron-Cohen et al., 1994).
7. Tests of production of the same range of mental state words in their spontaneous speech (Baron-Cohen et al., 1986; Tager-Flusberg, 1992);
8. Tests of the production of spontaneous pretend play (Baron-Cohen, 1987; Lewis & Boucher, 1988; Ungerer & Sigman, 1981; Wing et al., 1977);
9. Tests of understanding more complex causes of emotion (such as beliefs) (Baron-Cohen, 1991; Baron-Cohen et al., 1993).
10. Tests of recognizing the eye-region of the face as indicating when a person is thinking and what a person might want (Baron-Cohen et al., 1995; Baron-Cohen & Cross, 1992);
11. Tests of being able to monitor their own intentions (Phillips et al., 1998);
12. Tests of deception (Baron-Cohen, 1992; Sodian & Frith, 1992; Yirmiya et al., 1996);

13. Tests of understanding metaphor, sarcasm, and irony;
14. Tests of pragmatics in their speech (Baron-Cohen, 1988; Tager-Flusberg, 1993);
15. Tests of recognition of violations of pragmatic rules (Surian et al., 1996);
16. Tests of imagination (Scott & Baron-Cohen, 1996).
17. Correlation with real-life social skills, as measured by a modified version of the Vineland Adaptive Behaviour Scale (Frith et al., 1994).
18. Second-order false belief tests (Baron-Cohen, 1989b; Bowler, 1992; Happe, 1993; Ozonoff et al., 1991).
19. Understanding stories in which characters are motivated by complex mental states such as bluff and double bluff (Happe, 1994).
20. Decoding complex mental states from the expression in the eye-region of the face (Baron-Cohen & Hammer, 1997; Baron-Cohen et al., 1997; Baron-Cohen et al., 1997).

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