Pragmatics, Cognitive Flexibility and Autism Spectrum Disorders

MIKHAIL KISSINE

Abstract: Pragmatic deficits of persons with autism spectrum disorders [ASDs] are often traced back to a dysfunction in Theory of Mind. However, the exact nature of the link between pragmatics and mindreading in autism is unclear. Pragmatic deficits in ASDs are not homogenous: in particular, while inter-subjective dimensions are affected, some other pragmatic capacities seem to be relatively preserved. Moreover, failure on classical false-belief tasks stems from executive problems that go beyond belief attribution; false-belief tasks require taking an alternative perspective on the reality. While this capacity is functional in typically developing young children, it is impaired in ASDs. Typically developing children are capable of taking their interlocutor's perspective into account when communicating, whereas poor cognitive flexibility makes it difficult for persons with ASDs to grasp the inter-subjective character of communicative stimuli. This analysis predicts that those pragmatic processes that amount to merely taking into account salient contextual facts during utterance interpretation, without necessarily adopting the interlocutor's perspective, may be preserved in ASDs.

1. Introduction

There is a pervasive body of evidence showing that persons with autism spectrum disorders (ASDs) present important pragmatic deficits, the most striking of which are difficulties in understanding metaphor, irony and jokes, inability to adjust one's conversational contribution and prosodic contour to conversational expectations, difficulties to construct a coherent narrative discourse, non-adherence to Gricean maxims, and problems with the detection and avoidance of faux-pas (e.g. Baron-Cohen, 1988; 2000 p. 15, Baron-Cohen *et al*., 1999; Kaland *et al*., 2002; Lord and Paul, 1997; Surian *et al*., 1996; Wearing and Blair, 2005; Tager-Flusberg, 1992, 1993, 2000; Happé, 1993). Other aspects of linguistic competence, such as syntax and phonology, are relatively preserved (provided that language develops at all). This linguistic profile seems unique and peculiar to patients suffering from ASDs (Tager-Flusberg, 2000).

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Address for correspondence: Université Libre de Bruxelles, CP 175, 50 av. F.D. Roosevelt, 1050 Bruxelles, Belgium.
Email: mkissine@ulb.ac.be

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Many researchers trace the pragmatic deficits observed in people with ASDs back to a more general mindreading deficit (e.g. Perner *et al*., 1989; Happé, 1993; Capps *et al*., 1998). Indeed, a well-documented characteristic of persons with ASDs is their difficulty to attribute beliefs to other people (e.g. Baron-Cohen *et al*., 1985; Baron-Cohen, 1995, 2000; Perner *et al*., 1989).

Classically, this mindreading competence is measured by the 'false-belief' task (Wimmer and Perner, 1983). The most standard setting, 'Sally-Ann', is the following. The participant watches a scene where a first personage (Sally) puts some object in $location_1$, and then leaves. Next, a second personage (Ann) comes in and changes the location of the object to $location_2$. The participant is then asked in which location Sally will look for the object. Roughly, before three years and eight months typically developing children fail the task, answering that Sally will look in $location_2$ (cf. Wellman *et al*., 2001 for a meta-analysis). This has been taken as evidence that before the age of three years and eight months, children's 'Theory of Mind' is not fully operational. In a repeated and consistent way, children and adults with ASDs (and with a mental age above four) have also been shown to fail the false-belief task (e.g. Baron-Cohen *et al*., 1985; Baron-Cohen, 2000, pp. 5-7; Yirmiya *et al*., 1998).[1]

Belief-attribution—and, accordingly, the false-belief task—occupies such a central place because people with ASDs do not seem to have problems with the attribution of desires and intentions. Persons with autism are as good as control groups in detecting other people's desires (in a picture sequencing task, Baron-Cohen *et al*., 1986). Children with autism can predict emotional states from the target's desires or link them to situations in the world (even though they are often unable to understand that emotions may be caused by beliefs) (Baron-Cohen, 1995, p. 79).[2] Russell and Hill (2001) found that children with autism are good at monitoring basic actions and distinguishing, both from first-person and from third-person perspective, between an outcome of an action that has been intended and a fortuitously successful (viz. unintended) outcome.[3] Young children with autism—exactly like typical eighteen-month-olds (Meltzoff, 1995)—are also capable of imitating an action, even when they are observing an experimenter who

[1] In an alternative setting of the false-belief task the participant is presented with a tube of Smarties (candies) and asked what she is expecting to find in it. Contrary to standard expectation (viz. to find Smarties) the tube contains a pencil. Next, a second experimenter gets in, and the participant is asked what this experimenter expects to find in the tube. Using this alternative paradigm Perner *et al*. (1989) obtained results similar to the standard 'Sally-Ann' task: while children with autism mainly answered 'a pencil' to the second question, children with specific language impairments gave the correct answer 'Smarties'.

[2] Along the same line of thought, although children with ASDs hardly talk about epistemic and attentional states in everyday conversation, they make at least as much reference to volitional states as children with Down syndrome (Tager-Flusberg, 1992, 1993).

[3] Regarding the capacity to monitor the success of one's own intention, Russell and Hill's results contradict the conclusions of an earlier study by Phillips *et al*. (1998). Russell and Hill suggest that this discrepancy could be due to the lower verbal IQ of participants in Phillips's *et al*. study.

attempts to perform this action without success, i.e. even when imitation takes place on the basis of intention attribution only (Carpenter *et al*., 2001).[4]

However, the link between belief attribution and pragmatics in ASDs is not as clear as it may seem. On the one hand, it is debatable—to say the least—that false-belief tasks really tap belief attribution. On the other hand, it appears increasingly clear that pragmatic deficits in ASDs are not homogenous: while inter-subjective dimensions are clearly affected, some other pragmatic skills seem to be relatively preserved. My working hypothesis in this paper will thus be that the classical false-belief task involves a cognitive capacity that is deficient in ASDs. This same dysfunction causes deficits on the inter-subjective pragmatic dimension, without necessarily having an impact on other pragmatic capacities. Such an analysis must also be able to explain why typically developing children below four do not experience the same pragmatic problems as people with ASDs, while both populations fail the classical belief-task. One possibility—the one I will pursue below—is that typically developing children and persons with ASDs do not (or not always) fail classical false-belief tasks for the same reasons: whereas in ASDs the executive skills required for succeeding are impaired, in young children these skills are simply insufficiently mature.

In the following Section, I will review evidence for the claim that performance on false-belief tasks is improved when the participant's attention is focused on the protagonist's perspective. In Section 3, we will see that false-belief tasks require the participant to be able to shift from one perspective to another—which is an executive skill that is deficient in ASD. In Section 4, I will borrow Nichols and Stich's (2003) idea that mindreading requires a 'Possible World Box' (PWB), also exploited in counter-factual reasoning and pretence play. We will see mechanisms involving the PWB are already operational (albeit not at the adult level) in typically developing children below four, while they are dysfunctional in ASD. In Section 5, data will be reviewed that show that the PWB allows typically developing children to envisage communicative stimuli from a perspective different from their own. By contrast, persons with ASDs struggle with this inter-subjective aspect of language use, as predicted by the hypothesis of a cognitive flexibility dysfunction. Finally, in Section 6, I will argue that this analysis accounts for the selectively impaired pragmatic profile of people with ASDs.

2. Varieties of False-Belief Tasks

There is a growing consensus in the literature on the idea that failure on classical, Sally-Ann type false-belief tasks (cf. Introduction) does not necessarily reveal

[4] Phillips *et al*. (1995) argue that children with autism do not understand more complex 'representational' features of desirability. However, the tests the authors used—inferring target's desire without information about the goal, and inferring desire change on the basis of new information—require building a model of the target's beliefs (Nichols and Stich, 2003, pp. 129-30), which is precisely the cognitive skill that is impaired in autism (see below).

incapacity to attribute epistemic states. Performance on false-belief tasks can be improved by several factors that are not (directly) related to mindreading (e.g. Bloom and German, 2000). For reasons that should become apparent soon, I will focus on one of these factors—salience of the protagonist's perspective.

The performance of children below four on classical 'Sally-Ann' tasks improves considerably when the question is framed in more explicit terms: 'Where do you think that Sally will be looking for *o first*?' (Siegal and Beattie, 1991). The impact of this explicit wording with the term *first* on persons with ASDs is not entirely clear. On the one hand, Surian and Leslie (1999) replicated the facilitation effect on typically developing children below three, but observed no improvement for older children with autism. On the other hand, Eisenmajer and Prior (1991) report that half of their participants with ASDs who failed the false-belief task succeeded with the *first* wording. In any event, it is very plausible the addition of *first* renders the protagonist's false belief temporally salient: the participant focuses on the immediate belief of the protagonist's, and not on what the protagonist should or will eventually do.

Wellman and Bartsch (1988) devised three kinds of false-belief tasks. In the first, *Inferred Belief*, the participant has to predict a character's action on the basis of an inferred belief. (For example, 'This morning Jane saw her coloured pencils on the desk, not on the shelf. Now Jane wants her coloured pencils. Where will she look for them?') In the second, *Not Own Belief*, the participant has to predict a character's behaviour on the basis of a belief discrepant with her own. (For example, 'Sam wants to find his puppy. It might be hiding in the house or in the garden. Where do you think Sam's puppy is hiding? [Child answers, e.g. 'In the house'.] That's a good guess. Sam thinks his puppy is in the garden. Where will Sam look for his puppy?') In the third, *Explicit False Belief*, the action must be predicted on basis of an explicitly false belief. (For example, 'Mary wants to find her kitten. Mary's kitten is in the bedroom. Mary thinks her kitten is in the kitchen. Where will Mary look for her kitten?') Wellman and Bartsch found that three-year-olds succeed on the first two types of tasks—*Inferred Belief* and *Not-Own Belief*—but perform below chance level at the *Explicit Belief* task. One possible explanation for this pattern is that on the two first tasks the participant's focusing on the target's belief is not blocked by her own true belief. Consistent with this analysis is the fact that three-year-old performance improves when the real location is invisible—hence when their true belief is less salient—(Zaitchik, 1991). By contrast, in the *Explicit Belief*, although the protagonist's false belief is brought to prominence, it still stands in contradiction with the participant's own true belief.

As for persons with ASDs, they have been shown to succeed in all three tasks designed by Wellman and Bartsch (Sparrevohn and Howie, 1995; Grant *et al.*, 2004). It has to be noted, however, that while the typically developing children who failed the *Explicit False Belief* task in Wellman and Bartsch's study were younger than 3:5 years, in both Sparrevohn and Howie's and Grant *et al.*'s studies, the verbal age of participants with ASDs who passed the *Explicit False Belief* task was above seven. Moreover, Sparrevohn and Howie's results strongly suggest, first, that

Explicit False Belief requires higher verbal age than *Inferred Belief* and *Not Own Belief*, and, second, that standard false-belief task requires higher verbal age than *Explicit False Belief*. This is consistent with the assumption that a minimal verbal mental age is required to pass false-belief tasks, even though this minimal verbal age is higher for people with ASDs than for typically developing children (Eisenmajer and Prior, 1991; Happé, 1995; Yirmiya *et al*., 1998; Milligan *et al*., 2007). Furthermore, Grant *et al*. (2004) also report that passing standard false-belief tasks can still prove difficult even for those participants with ASDs who have no difficulties with *Explicit False Belief*.

Despite the complexity of the data one can conclude that classical false-belief tasks involve certain cognitive demands that are distinct from belief attribution proper. Making more explicit the difference between the participant's own belief and the protagonist's belief—either by raising the prominence of the protagonist's belief or by rendering the participant's belief less salient—improves typically developing children's performance on false-belief tasks (although the developmental trend still subsists, cf. Wellman *et al*., 2001). Rendering the mindreading target's perspective more salient can also improve the performance of people with ASDs on false-belief tasks. It is hard to decide whether facilitating classical false-belief tasks has the same effect on typically developing children and on people with ASDs, and, accordingly, whether both populations employ the same cognitive resources when they succeed on classical and/or modified false-belief tasks. For now, the important point is that false-belief tasks are made easier when an alternative perspective—that of the protagonist—is brought into focus.

3. False-Belief Tasks and Cognitive Flexibility

The attribution of a false belief to another person involves a rather specific executive demand: to build up a model of the world based on information she takes to be wrong, and then to predict action on the basis of this model (see Russell, 1997; Russell, Saltmarsh *et al*., 1999; also Bloom and German, 2000). Failure on false-belief tasks could thus be partly due to a difficulty in conceiving an alternative model of reality or in assessing, from the perspective of one model, the conclusions arrived at within another one. This is in line with what we saw in the previous section: performance on false-belief tasks may improve when the protagonist's perspective is made salient. I will now invoke several independent reasons to assume that people with ASDs who fail on false-belief tasks do so (at least in part) because of difficulties in reasoning with alternative models of reality.

A good starting point is the fact that persons with autism or Asperger syndrome appear to have selective executive dysfunction, which is revealed by tasks that require sustaining a flexible strategy or shifting from one arbitrary rule to another, such as the Wisconsin Card Test and the Tower of Hanoi Test (e.g. Prior and Hoffmann, 1990; Hughes and Russell, 1993; Frye, 1999). For persons with high-functioning autism, the performance on these tasks is, furthermore, correlated with

first-order and second-order belief attribution (Ozonoff *et al*., 1991). By contrast, the capacity to focus attention on a less salient aspect of a stimulus, such as that tapped by the Stroop task, seems to be preserved in ASDs (e.g. Ozonoff, 1997; Adams and Jarrold, 2009; also Zandt *et al*., 2009; Bramham *et al*., 2009).

Such executive difficulties are consistent with the hypothesis that persons with ASDs experience problems in cancelling rules they acquired and conclusions that they have already drawn (Russell, 2002). Hughes and Russell (1993) report that children with autism (mental age around 6:5) experience difficulties to disengage from a habitual motor sequence and to conform to an arbitrary motor rule, like throwing a switch before reaching for a marble. Joseph and Tager-Flusberg (2004) found that a structurally similar *Knock-Tap* task—where the participant must withhold a salient motor response in order to follow an arbitrary rule—correlated (independently from verbal and mental age) with performance on Theory of Mind tasks in a population of children with ASDs. By contrast, children with autism succeed in executive tasks that are not rule-bound (Hughes and Russell, 1993).[5]

Crucially, the studies cited in the previous two paragraphs strongly suggest that it is not the capacity to 'shift' from one action pattern or from one aspect of the stimulus to another one that is impaired *per se*. The problem seems restricted to shifting from one rule to another one. Even more precisely, what proves problematic in rule-bound tasks, such as Hughes and Russell's (1993) box-switch or the *Knock/Tap*, is not so much the arbitrariness of the rule to be learnt, as the fact that this rule contradicts a salient schema of action. And yet, the difficulty is not an inhibitory one, since, as we have seen, inhibiting a salient verbal response or focusing attention on a salient aspect of the stimuli does not seem problematic for persons with ASDs.

A promising take on the data adduced so far is that the rule-bound tasks at hand require changing one's perspective on the world. Such an interpretation receives support from the Dimension Change Card Sorting (DCCS) task. In the DCCS task the participant is first told to sort a deck of cards along one dimension (e.g. card colour); after a while, she is instructed to change the sorting rule, and to sort the remaining cards along another dimension (e.g. the animal pictured on the card). Zelazo *et al*. (2002) and Colvert *et al*. (2002) found that performance on the DCCS test is a strong predictor for the performance on Theory of Mind tasks within groups of children with ASDs.[6] Although the DCCS is a rule-bound task, it is

[5] Intriguingly, children and adolescents with ASDs have no problems with inhibiting a salient verbal response in the *Day/Night* task, where the participant is required to answer *day* to a picture of the moon and the stars, and *night* to a picture of the sun (Russell, Jarrold *et al*., 1999; Joseph and Tager-Flusberg, 2004). This difference might be due to the verbal nature of the task; for instance, it is possible that dissociating a word from its meaning is particularly easy for people with ASDs (at least, this seems to be the case in reading, cf. Adams and Jarrold, 2009), and thus does not amount to a perspective shift.

[6] Furthermore, while the performance on DCC has been found to be comparable in ten-year-olds with high functioning autism and in a typically developing control group, in the

also plausible to consider that shifting from one sorting rule to another amounts to switching from one perspective on the card to another (e.g. Perner and Lang, 2002). Under such an analysis, DCCS tasks require that the participants construct two conflicting models of reality: one where the card is a shape and another one where the card is a colour. Note that very similar cognitive demands underlie false-belief tasks: the participant has to construct two conflicting models of reality—one where the object is in *location*$_1$, and another one where the object is in *location*$_2$.

Support for this analysis of rule-bound tasks that pose problem for participants with ASDs can be drawn from similar data on typically developing young children. Good performance on the DCCS task—the capacity to shift from one sorting rule to another one—also predicts typically developing children's performance on false-belief tasks (Frye *et al*., 1994; Müller *et al*., 2005). As may be expected from the foregoing, this correlation is unrelated to the parallel development of inhibitory control (Perner *et al*., 2002). Importantly, young children's performance on the DCCS task improves when rule switching does not entail change in perspective (Perner and Lang, 2002; Kloo and Perner, 2003). One such variation runs as follows. In the initial phase, the participant sorts the cards according to the preferences of two characters (e.g. Donald likes all the green cards, and Minnie all the yellow cards); in the switch phase, the change of sorting rule corresponds to a change in characters' preferences (e.g. now Donald wants all the yellow cards, and Minnie all the green ones). In such a version of the task, the child does not have to change her own perspective on the world; she has only to accommodate new information about a character's preferences. The significant facilitation effect indicates that it is not as much the rule-bound character of the DCCS task that is difficult, as the fact that in the original version the rule shift entails a perspective shift. Likewise, performance improves when the cards are sorted along only one dimension, e.g. shape (for instance, in the first phase all the horses go to the horse-box, and all the rabbits to the rabbit-box; in the switch phase, the rabbits go the horse-box, and the horses to the rabbit-box). Again, switching the rule in such a task does not require viewing the card under another dimension—the card still corresponds to a shape. Kloo and Perner (2003) also found that training children on the standard DCCS task, explicitly drawing their attention to the dimension change, improved performance on the false-belief task. Moreover, training young children on the false-belief task, putting emphasis on the fact that mental representations can differ from reality, also improves their performance on the DCCS task. Along the same line of thought, Perner *et al*. (2007) cogently argue that young children's difficulties with tracking the same referent through alternative names, with counterfactual reasoning and with false-belief tasks should all be traced back to a common cause. Leaving the details aside, their proposal is that the three types of tasks entail switching from one perspective to another (see also Nilsen and Graham, 2008).

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former group longer reaction times were elicited when the sorting rule was shifted to another dimension (Dichter *et al*., 2010).

Let me summarise the argument so far. We have seen that persons with ASDs often experience difficulties to shift from one strategy to another one. These difficulties cannot be explained in terms of lack of inhibitory control, and are restricted to rule-bound tasks where rule-shifting entails a shift between different perspectives on reality. This latter kind of process is also required to succeed in false-belief tasks (also Perner *et al*., 2007).

Envisaging reality under different aspects, that is, building and using alternative models of reality is what I will refer to under the term '*cognitive flexibility*'. Although some inconsistencies subsist in the literature,[7] difficulties in cognitive flexibility thus understood (not necessarily related to inhibitory control nor to working memory) emerge as being *the* executive dysfunction associated with ASDs (Hill, 2004; Ozonoff *et al*., 2005).[8] It is also extremely plausible that failure on false-belief tasks can be partly explained, in the ASDs population, by a deficit at the level of cognitive flexibility. (This, of course, does not rule out that compensatory strategies—dependant, for instance, on high verbal capacity—can be employed to overcome these difficulties, nor that cognitive flexibility cannot be partly preserved.)

It has to be acknowledged that as it stands this hypothesis remains ambiguous to a certain extent: a deficit in cognitive flexibility—as I am using the term here—may correspond either to incapacity to *construct* alternative models of reality or to incapacity to *use* such models. I do not think that the currently available evidence allows us to decide between these two (non-mutually exclusive) alternatives. Fortunately, this does not affect the central claim of this paper, viz. that lack of cognitive flexibility explains the pragmatic profile of people with ASDs: trivially, unimpaired cognitive flexibility requires both the representational capacity to construct alternative models of reality and the procedural capacity to use them.

Before concluding this section, let me point at a supplementary reason for thinking that failure on standard false-belief tasks reflects difficulties in constructing alternative models of the world. Recall that desire detection appears to be intact in ASDs (cf. Introduction). Likewise, desire detection does not pose any problem to typically developing children below four (e.g. Astington, 1993). Now, there exist 'conflicting-desire' analogues of 'false-belief' tasks. A 'conflicting-desire' task has the same structure as classical false-belief tasks in that it requires the participant

[7] For instance, while Rumsey (1985) tested adults with high-functioning autism and found that poor performance on Wisconsin Card Test was unrelated to verbal and non-verbal IQ, Liss *et al*. (2001) present data indicating that difficulty with the Wisconsin Card Test is not universal among children with high-functioning autism, and is correlated with verbal IQ. See Geurts *et al*., 2009 for a review.

[8] Reasoning in non-monotonic way also presupposes the capacity to shift from one model of reality to another—to suspend or to cancel the conclusions previously held true. While in persons with high-functioning autism and Asperger syndrome performance in tasks involving logical monotonic reasoning is similar—and even superior (Morsanyi *et al*., 2010)—to that of typical adults, handling exceptions during reasoning appears to be somehow problematic (van Lambalgen and Smid, 2004; Stenning and van Lambalgen, 2007; Pijnacker, Geurts *et al*., 2009).

to attribute someone else a desire that is directly conflicting with the participant's current desire. If false-belief tasks were just tapping the attribution of representational epistemic states—and, accordingly, conflicting-desire tasks that of volitive states—one should expect no correlation between performances on each type of task. Yet, typically developing children below the critical age of three years and eight months, as well as participants with ASDs face almost the same difficulties with a conflicting-desire task as with a standard false-belief task (Moore *et al.*, 1995; Russell, Saltmarsh *et al.*, 1999). Such a correlation is expected from the standpoint adopted here: both false-belief and conflicting desires tasks have an identical executive component—they require adopting different perspectives on the world.[9]

In the previous Section, we have seen that standard false-belief tasks are made easier when the protagonist's perspective on the world is made more salient. In this section, I have argued that difficulties with standard false-belief tasks can be, at least in part, explained by difficulties to shift from one perspective on the world to another. Expectedly, adopting an alternative perspective is easier when this perspective is more prominent. I will now present a central component of the model of mindreading developed by Nichols and Stich (2003) that helps think of the picture sketched so far in more precise terms.

4. 'Possible World Box'

The model of mindreading defended by Nichols and Stich (2003) postulates that belief attribution is handled by a cognitive mechanism whose essential component is the 'Possible World Box' (PWB). The PWB makes any proposition, be it the content of a belief or not, available to the same inferential processes as those that operate on belief contents. However, the contents of the PWB do not necessarily integrate the 'Belief Box': while the inferential steps are the same as in classical 'truth-preserving' reasoning, here the premises are not necessarily being taken as true. The PWB is not specifically dedicated to belief-attribution; it is used in any cognitive process that involves an alternative model of reality. As a starting point of any such process, a representation is placed—'clamped'—within the PWB. Next, some contents of the 'Belief Box' are transferred to the PWB. However, this transfer is subject to filtering by the 'updater', which ensures that the transferred information is consistent with the clamped premise. (The updater also ensures

[9] Children with autism also present difficulties to satisfy someone else's desire when this desire is based on a representation of reality they know to be mistaken (Mitchell and Isaacs, 1994). Importantly, failure on this latter kind of task is not due to incapacity to inhibit a proponent response (Mitchell *et al.*, 1997). Yet, *pace* Martin and MacDonald (2003), this does not undermine the possibility to trace difficulties with belief attribution back to an executive problem. Failure on both false-belief tasks and conflicting-desire tasks stems from executive problems related to flexibility, not from an inhibitory deficit.

that the Belief Box contains no contradictory information, and triggers a process of belief revision and elimination when a newly acquired piece of information contradicts some previously held beliefs.) Inferential processes can then operate on the representations encapsulated within the PWB. Unless they are allowed by the updater to get into the Belief Box, the conclusions drawn in such a way will not be taken as representing the world, but only as holding in a particular model of reality.

Under the view developed here, it makes sense to assume that young children below four use a primitive form of mindreading, which consists in predicting the behaviour of other people by importing the contents of one's own beliefs into the PWB. Note that such a cognitive process does not suffice to pass false-belief tasks. Take the 'Sally-Ann' paradigm. The child begins by 'clamping' within the PWB the proposition [Sally wants the object o]. Next, she builds up a model of Sally's beliefs by transferring within the PWB the contents of her own beliefs, among which the information that o is in location l_2. Inferential processes operating within the PWB will thus yield the wrong conclusion [Sally will look in l_2].

In order to explain the facilitation effects mentioned in Section 2, it is reasonable to surmise that when explicit information, like 'Sally thinks that o is in l_1', is provided, instead of the content of child's own belief about the location of o, the premise that is clamped in the PWB is [o is located in l_1]. Since this premise contradicts the content of the child's own belief [o is in location l_2], the updater prevents the latter from being transferred to the PWB. Therefore, this time, the model of Sally's behaviour will be constructed on the basis of the contents of Sally's beliefs. A plausible explanation of the facilitation effects, discussed in Section 2, is thus that performance on false-belief tasks improves when the child is prompted to dissociate her own perspective on the world from the one modelled within the PWB.

This analysis of young children's mindreading is supported by developmental data. First, there seems to be a close link between counterfactual reasoning and mindreading (see also Proust, 2002). Riggs *et al*. (1998) observe that, in a group of children between three and four, success on false-belief tasks is strongly correlated with the capacity to reason from counterfactual premises (viz. from premises that contradict child's own beliefs). Furthermore, whereas counterfactual reasoning proves difficult, these children have fewer problems to reason about a hypothetical future state of the world. The difficulty seems to be with assessing the result of a reasoning conducted within the PWB from the perspective of what the child takes to actually be the case (i.e. from the Belief Box).[10]

None of this implies that young children cannot use the PWB altogether. We saw that PWB is at work in simplified belief-attribution processes. Likewise young children can engage in counterfactual reasoning to a limited extent. Three-year-olds'

[10] In this connection, it has been shown by Harris *et al*. (1991) that young children fail to discern the unreal character of imaginary situations. As argued by Proust (2002), confusions of this kind can be due to the fact that children are unable to apprehend a pretence simulation as such from the vintage point of the actual world.

performance improves on counterfactual reasoning if the false premise is made salient (Leevers and Harris, 2000), if the causal relation between the false premise and its outcome is conspicuous (Harris *et al*., 1996) or if this causal chain is kept short (German and Nichols, 2003). Moreover, three-year-olds imagine counterfactual situations in order to provide causal explanations (Harris *et al*., 1996).

Pretence provides another strong indication of an early functioning of the PWB. From the age of eighteen months, typically developing children display spontaneous pretend play (e.g. Astington, 1993). In Nichols and Stich's (2003, pp. 28-35) model, pretence is accounted for as follows. In pretend play the initial representation—e.g. [this banana is a telephone]—is 'clamped' within the PWB, so that it lies out of the scope of the 'updater'. All that the 'updater' does then is to ensure that only those contents that are compatible with the clamped representation are transferred from the Belief Box to the PWB. Once this transfer is achieved, inferential processes can operate within the PWB yielding further developments of the pretend play. The link between the PWB and pretend play is all the more plausible since it is equally around eighteen months—when pretend play appears—that children begin to imagine solutions to new problems by projection, without getting through an actual trial-error sequence (Astington, 1993; see also Carruthers, 2006 on the link between pretend play and creative problem solving).

Several symptoms associated with ASDs can be explained by postulating impairment at the level of the PWB (Nichols and Stich, 2003, pp. 128-31). Recall that persons with ASDs have problems with those executive tasks that involve cognitive flexibility. Problems to employ PWB (partially) deprive one from resources needed to reason with alternative models of the world. Accordingly, impairment at the PWB level would also explain why people with ASDs experience difficulties with classical false-belief tasks. Noteworthy, not only do people with ASDs have difficulties with counterfactual reasoning (Leevers and Harris, 2000)—which involve the PWB, these difficulties also correlate with low success on classical false-belief task (Grant *et al*., 2004).[11]

We just saw how the PWB accounted for the pretence play in typically developing children. Children with ASDs engage in spontaneous pretend play significantly less than control groups, and when they do, their play is much more stereotyped and repetitive (e.g. Jarrold *et al*., 1993). While the exact relationship between pretend play in ASDs and executive functions has not yet been thoroughly researched, it is extremely plausible that deficits in pretend play are related to difficulties to generate new behaviours (cf. Moore *et al*., 1995; Rutherford and Rogers, 2003; Rogers *et al*., 2005). Such an explanation is entirely consistent both with the idea that pretence is carried out within the PWB, and that impairment at the level of the PWB is characteristic of ASDs.

[11] Scott *et al*. (1999) claim that people with ASDs do manage counterfactual reasoning. However, as noted by Leevers and Harris (2000), they employed stimuli that allowed the participant to arrive at the correct response using context-free syllogistic reasoning.

To echo the caveat made in Section 3, it is unclear, as things stand today, whether impairment at the level of the PWB should be thought of as a lack of a certain representational format (no PWB) or in terms of a processing deficiency (no use of the PWB). Furthermore, saying that success on any task involving the PWB is out of the reach of every person with ASDs would be too crude a claim. For instance, we saw in Section 2 that performance on false-belief tasks of some persons with ASDs can be improved. This suggests either that some functioning of the PWB is preserved or that an alternative strategy is employed (for instance by individuals with a higher verbal age). None the less, I also presented, in the previous Section, extensive empirical evidence that ASDs are characterised by a selective executive impairment at the level of cognitive flexibility, which entails problems in perspective shifting. Together with the facts just mentioned, this provides solid grounds for claiming that an important proportion of the population affected by ASDs suffer from impairment at the level of the PWB. By contrast, PWB is functioning in typically developing young children. For this reason, typically developing children are capable, from a very young age, to take a perspective on the world different from their own, while this proves hard for people with ASDs.

5. Perspective-Shifting and Communication

At the age of 2:11, children show implicit understanding of false-belief, revealed by their preferential look at the correct location in traditional false-belief tasks (Clements and Perner, 1994). Examining anticipatory look, Southgate *et al*. (2007) showed that two-year-olds correctly predict action from false-belief attribution. Fifteen-month-old infants are surprised—and thus look for a longer period—if the adult who has a false belief about the location of a toy searches for it in its real location (Onishi and Baillargeon, 2005). Findings of this kind confirm that a cognitive mechanism allowing the construction of an alternative perspective on reality emerges very early in typical development (for a review, see Baillargeon *et al*., 2010).

In the previous Section we saw that there are good reasons for believing that persons with ASDs have difficulties in using PWB. If so, one should expect young infants and children with ASDs to differ relative to implicit belief attribution. Using the same paradigm as Southgate *et al*. (2007), Senju *et al*. (2010) found that, unlike typically developing two-year-olds, children with ASDs fail to anticipate actions based on false beliefs.

Another area where the capacity to adopt an alternative perspective plays a prominent role is joint attention. In order to share attention with you about an external entity, I must be able to monitor your perspective on the world. In order to have motivation to draw your attention to a certain object or event, I must be able to understand that you are (or can be) unaware of it.

Typical infants gesture in order to share attention with the adult about some outside entity, and monitor joint attention (for a review, see Tomasello and

Camaioni, 1997). By contrast, children with ASDs are known to have difficulties to establish joint attention. For instance, in their naturalistic study, Stone and Caro-Martinez (1990) observed almost no attention seeking verbal or non-verbal acts. Behaviours revealing the failure of children with autism to establish mutual attention have been massively attested in parental reports (Stone and Lemanek, 1990; Clifford and Dissanayake, 2008), in retrospective study of home video tapes (Osterling and Dawson, 1994; Guidetti *et al*., 2004), and in analyses of naturalistic or semi-structured interactions (e.g. Loveland and Landry, 1988; Capps *et al*., 1998; Camaioni *et al*., 1997; Camaioni *et al*., 2003).[12]

Not only are typically developing infants able to take someone else's perspective on the world from a very early age, they also employ this perspective shifting in communication. Using the same type of preferential look procedure as Onishi and Baillargeon (2005), Song *et al*. (2008) showed that infants expect false beliefs to be corrected by verbal or non-verbal indication of the correct location of the object. Likewise, twelve- and eighteen-month-olds point to inform the adult about the location of a lost object—even though they have no interest in this object (Liszkowski *et al*., 2006; Liszkowski *et al*., 2008). Further evidence of belief attribution skills in young children's communication includes the observation that two-year-olds adopt their requests to their parent's knowledge (O'Neill, 1996).

In other words, the capacity to build a model of the world different from one's own—to use the PWB—is recruited very early in order to exchange information. Infants construe a conversational frame within which utterances have an informative and cooperative function (for an extensive discussion, see Tomasello, 2008, chapter 4). They are able to envisage communicative behaviour with respect to a model of their interlocutor's beliefs. That is, because they are capable of constructing an alternative model of the reality, young infants apprehend communicative stimuli as inter-subjective information vehicles.

Now, if, as I contend, there is a link between the PWB and such communicative skills, one should expect people with ASDs—who, as we have seen, present impairment at the PWB level—to have problems with grasping the information-sharing function of communicative behaviour. An experiment by Roth and Leslie (1991) proves very illustrative here. These authors presented a group of typically developing children around five, a group of typically developing below 3:8 years, and a group of children with autism with the following variation on the classical false-belief task. Sally and Ann are playing outside. Sally places the object *o* at $location_1$, and leaves the scene. While she is absent, Ann displaces *o* to $location_2$. When she is back, Sally asks Ann where is *o*. Ann answers that *o* is at a third $location_3$. The participant was then asked (*a*) 'Where does Sally think that *o* is?' and

[12] The acquisition of joint attention skills is seen by some as an essential factor for the cognitive and linguistic development of children with ASDs (Mundy and Crowson, 1997). These skills also correlate (along with imitation capacities) with cooperation abilities in autism (Colombi *et al*., 2009).

(*b*) 'Where does Ann think that *o* is?'. Children around five provided the correct answer to both questions—*location*$_3$, *location*$_2$.[13] The majority of the children below 3:8 answered *location*$_3$ to both questions. (For similar results, see also Zaitchik, 1991.) However, they also answered—correctly—that the actual location of the object was *location*$_2$. We thus see that children below 3:8 understand the informative function of utterances, even though they fail to distinguish between Ann's and Sally's cognitive states. In other words, they do not process linguistic stimuli as mere representations of states of the world: Ann's utterance cannot be understood as a mere distal sign, since the corresponding state of affairs is known to be inexistent.[14] By contrast, participants with ASDs answered *location*$_2$ to both questions, thus failing to understand that a false assertion still has informational content for a third party.

Evidence coming from gestural communication provides further indication that individuals with ASDs have problems to view communicative behaviour as information sharing. At the pre-linguistic and early linguistic stages, children with ASDs show an abnormal predominance of proto-imperative behaviour over informative gestures and vocalising (Wether by and Prutting, 1984; Mundy *et al*., 1993). The fact that children with ASDs do not exhibit declarative gestures (e.g. Mundy *et al*., 1993; Tomasello and Camaioni, 1997; Camaioni *et al*., 1997; Guidetti *et al*., 2004) suggests that they attribute an exclusively instrumental function to language, thus using linguistic utterances only as means towards the satisfaction of their desires (Gómez *et al*., 1993).[15]

It is important, at this point, to distinguish between 'instrumental' imperative behaviour and 'cooperative' requests. Instrumental imperatives amount to acting on the addressee directly, using her as tool to reach a certain end. By contrast, cooperative requests provide the addressee with an independent reason to perform some action (for an extensive discussion of this distinction, see Tomasello, 2008: chapters 2-4, passim; on requests as reasons to act, see Kissine, 2009). Typically developing infants exhibit the latter, cooperative kind of imperative behaviour. To quote a particularly striking piece of evidence: Shwe and Markman (1997) show that, around thirty months, children react to an adult who conveys misunderstanding of their request even though they are handed the requested object (see also Golinkoff,

[13] Note that, at this age, children are most probably unable to attribute second-order beliefs (cf. Perner and Winner, 1985). A plausible interpretation is that children around five construct a (dispositional) model of Sally's mind, and manage to isolate this simulation from the model of Ann's mind (which coincides with their own beliefs).

[14] These children probably perform the same kind of simulation as their elders (cf. footnote 13), but do not distinguish between the conclusion drawn within the model of Sally's mind and the conclusion drawn within the model of Ann's mind. In this connection, it is worth mentioning that children who fail the false-belief tasks are nevertheless able to assess the ignorance state of other persons (Hografe *et al*., 1986).

[15] Somewhat surprisingly, in their naturalistic observation of infants with autism Clifford *et al*. (2007) detected a deficit of proto-declarative showing, but not of proto-declarative pointing and gaze monitoring.

1986, 1993). The fact that they attempt to correct the adult's misunderstanding in spite of their desire being satisfied demonstrates that, even for such young children, a request is more than a simple instrumental means; it is a genuine reason to act.

By contrast, it is often reported that when producing requests, children with ASDs conceive of the addressee as a tool to attain a certain goal (cf. Phillips *et al*., 1995; Gómez *et al*., 1993). In producing non-verbal requests in order to reach an object, children with autism tend to favour contact gestures—in contrast to mentally handicapped and typical children, who massively use distal gesticulation, schematic pointing and joint attention (at an age as early as thirteen months, cf. Bates, 1976, p. 55; also Dore, 1974). In addition, children with ASDs make significantly more attempts to attain the object without seeking any help (Landry and Loveland, 1988; Loveland and Landry, 1988; Phillips *et al*., 1995). Imperative behaviour by autistic children also comprises lesser eye contact than that of controls; absence of gaze coordination and low amount of positive affects during requests is even seen as a reliable cue in order to detect autism in two-year-olds (Lord, 1993; Mundy *et al*., 1993). On the comprehension side, Loveland *et al*. (1988) report that, in comparison to control groups, children with autism are more likely to respond instrumentally to requests—that is by performing the requested action without continuing the interaction.

6. Pragmatics in ASDs

In the previous section I argued that because they are affected by a deficit at the level of the PWB, children and adults with ASDs do not take the perspective of their interlocutors into account when communicating. Several pragmatic deficits characteristic of ASDs support the picture drawn so far. Persons with ASDs commonly fail to realise that the content of an utterance must be new, informative and relevant with respect to the preceding discourse (Baltaxe, 1977; Paul, 1987; Perner *et al*., 1989; Surian *et al*., 1996). As their language develops, children with autism do not acquire the capacity to respond in a topically related way (Tager-Flusberg and Anderson, 1991). In the same vein, children (Surian *et al*., 1996) and adults (Eales, 1993) with autism fail to recognise the inappropriateness of a message that is redundant, obviously false or unrelated to the topic of the conversation. Conversational contributions of individuals with autism also show an abnormal prevalence of utterances concerned with the immediate physical context and with their own volitive states relative to utterances that involve an intra-personal interaction (Ziatas *et al*., 2003; Capps *et al*., 1998). Stone and Caro-Martinez's (1990) and Chiang and Lin's (2008) naturalistic observations revealed a negative correlation between the severity of autism and the amount of verbal or non-verbal acts that aim at commenting or informing. Likewise, Ruble (2001) reports that boys with autism are twice less likely to respond to someone, and three times less likely to attract attention to themselves than a control group of boys with Down syndrome. Capps *et al*. (1998) observed that, relative to a control group of

children with developmental disorders, children with ASDs are less likely to answer a comment or a query, or to extend conversation by providing new or relevant information (also Loveland *et al*., 1988).

As such, the pragmatic difficulties just enumerated are compatible with the hypothesis that in autism pragmatic functioning is impaired altogether, independently from a putative lack of cognitive flexibility. Pragmatic problems—would the objection go—are not directly related to the PWB, but stem from the fact that persons with autism rely exclusively on the literal, linguistic meaning, and do not take context into account. Yet, there is some evidence that persons with ASDs understand the contextual dependence of communicative stimuli. Baltaxe and D'Angiola (1992) report that children with autism tend to produce less coherent discourse strings than control groups. However, their study also shows that these children do use cohesive devices, like pronouns, whose reference is to be found either in the surrounding discourse or in the exterior context. Likewise, persons with high-functioning autism and with Asperger syndrome employ cohesive markers; the way they are used, however, is not tuned to the interlocutor's needs, nor to the flow of the conversation (Fine *et al*., 1994; de Villiers, 2005; see also Capps *et al*., 1998). Such data are fully compatible with the view defended here. What the PWB—cognitive flexibility—contributes to language use is the capacity to assess the utterance with respect to a perspective different from one's own. That such a capacity is deficient—as seems to be the case in ASDs—does not entail that language interpretation and use do not rely on context. What is predicted, by contrast, is that poor cognitive flexibility limits the context taken into account to one's own perspective on the world.

In line with this idea, de Villiers *et al*. (2007) claim that some of the pragmatic determinants of the literal content are preserved in the conversation of persons with high-functioning autism and Asperger syndrome. Among these, they report the resolution of accidental homonymy (e.g. *mummy* as 'mummified body' and not as 'female parent'), appropriate understanding of an unspoken domain of quantification (e.g. as in *I cleaned the whole place up* for some part of it), appropriate understanding of an implicit comparison class (e.g. for adjectives like *small*), the correct identification of a contextually salient entity/property (e.g. *hard* as 'difficult' and not as 'rigid'), and the use of indexical pronouns (*he, she, his,* etc.) and demonstratives (*this, those, now, here*, etc.). Comprehension studies are needed to confirm these results, but it is very plausible that such pragmatic components of utterance meaning can be grasped by considering solely what is salient from one's own point of view (cf. Recanati, 2004). It is worth mentioning that utterances that require pragmatic enrichment are sometimes difficult to grasp when produced by persons with ASDs because the contextual contribution is not made (easily) accessible to the addressee (de Villiers *et al*., forthcoming). Again this is compatible with the idea that difficulties at the PWB level do not preclude using language in a context-dependent way, although they prevent the speaker from taking the interlocutor's perspective into account.

I hasten to stress that I *do not* claim that *all* pragmatic difficulties associated with ASDs are explainable by a deficit at the PWB level. What I do claim is that

problems with grasping the inter-subjective property of communicative stimuli are linked to a deficit of cognitive flexibility. This account leaves open the possibility for any other pragmatic competence to be preserved in persons with ASDs, so long as disengaging from one's perspective on the world is not required.

Before concluding, let me merely enumerate some of such potentially preserved pragmatic skills. Adults and adolescents with high-functioning autism and Asperger syndrome are good at deriving some 'scalar' implicatures—non-logical, hence non-literal, readings of *some* and *or* (Pijnacker, Hagoort *et al*., 2009; Chevallier *et al*., 2010). Likewise, Dennis *et al*. (2001) report that children with high-level autism successfully resolve lexical ambiguity on the basis of contextual information. Metonymy comprehension has also been shown to be more preserved than metaphor and to be reliably predicted by receptive vocabulary (Rundblad and Annaz, 2010).[16] Finally, an observational study by Kissine *et al*. (forthcoming) revealed that children with low-level autism go beyond the utterance's literal meaning in order to interpret it as a request. It is plausible that none of these pragmatic processes requires taking an alternative perspective on the world, although, of course, a more elaborate argument is needed to settle this issue.

7. Conclusion

The relationship between belief-attribution and pragmatics is far from being straightforward. False-belief tasks require shifting from one's own perspective to another one. While both for children below four and for persons with ASDs performance on such tasks may improve when the protagonist's perspective is brought into salience, it is unclear whether such facilitation procedures have identical effects in both populations. In any event, young children are capable of conceiving alternative models of reality, whereas persons with ASDs have problems getting beyond their own model of the world. For this reason, while young children take their interlocutor's perspective while communicating, it is difficult for persons with ASDs to grasp the inter-subjective character of communicative stimuli. However, pragmatic processes that amount to taking into account salient contextual facts during utterance interpretation, without necessarily adopting the interlocutor's perspective, may be preserved in ASDs.

It should be noted that the construction by young children of a model of their interlocutor's beliefs does not reach the adult level until quite late. Proper understanding of irony is quite revealing in this respect. In order to distinguish lies from ironical speech, one has to interpret utterances with respect to a model

[16] The status of metaphor comprehension in ASDs is less clear. While Happé (1993) claims that persons with ASDs do not understand metaphors unless they pass first-order false-belief tasks, Norbury (2005) claims that it is semantic competence that is the key predictor for metaphor understanding. See Wearing (2010) for a recent discussion.

constructed on the basis of what is *mutually* accepted to be true. In both cases—lie and irony—S communicates information she believes to be false; but when she is lying, S assumes that A does not know this, whereas irony and jokes involve just the opposite assumption. In order to conceive a background based on shared assumptions, one has, at least, to be able to attribute second-order beliefs like 'S knows that A knows that the literal content is false' or, 'S does not know whether or not A knows that the literal content is false'. Winner and Leekam (1991) observed that typically developing children between five and seven can distinguish lies from jokes only if they can make hypotheses about what the speaker wanted the hearer to believe. Similar results emerge for children and adults with ASDs (Leekam and Prior, 1994; Happé, 1993; Martin and McDonald, 2004).[17]

This being said, young children's pragmatic performances show that being able to conceive of an alternative model of reality suffices to use language as an inter-subjective communicative device. Unlike many contemporary theories, the account defended here does not make appeal to the attribution of multi-layered Gricean communicative intentions. However, it is still possible that constructing an alternative model of reality amounts to engaging in a meta-representational process and/or in genuine belief attribution. I leave the discussion of this indubitably crucial question for another article.

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[17] Another limitation of the capacity of young infants to establish shared attention frames is brought to light by Moll *et al*.'s (2007) study which shows that in order to build up a shared model of conversation, infants need to be directly involved with the addressee.

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