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Social and pragmatic impairments in individuals with Autism Spectrum Disorder. A lack of Theory of Mind?

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Abstract

Individuals affected by Autism Spectrum Disorder (ASD) are impaired in the domains of social interaction and communication. This paper aims at reviewing the pertinent literature to offer a better understanding of the theoretical debate on the social and linguistic impairments experienced by individuals with autism.

The available literature was revised up to March 2014. Data were extracted pertaining to the following categories related to ASD: pragmatic impairments, metaphor, social interaction, Theory of Mind.

The results show that, although little uncertainty remains that individuals with ASD have difficulty in tasks involving mentalizing, not all Authors agree that this deficit is the consequence of impairment in the capacity to represent the mental states of others (Theory of Mind).

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difficulties in understanding non-literal linguistic expressions such as irony or metaphor also do not understand how signals in general modulate goal-directed behaviors. Future research in order to gain a clearer picture on the mechanisms underlying the pragmatic and social impairments in individuals with ASD might investigate to what extent these problems are the results of how signals, rather than mental states, modulate the significance of meaning.

Keywords: Autism; Theory of Mind; Pragmatic disorders; Social interactions.

1. Introduction

According to several Authors (e.g. Frith, 2003) the ability to represent the mental states of others in order to understand and interpret their behavior is called "mentalizing", "mindreading" or "Theory of Mind" (ToM).

A considerable amount of evidence is now available which suggests that individuals with Autism Spectrum Disorder (ASD) experience difficulties in the domain of mentalizing (Baron-Cohen, 2000; Brent, Rios, Happé, & Charman, 2004). The strongest indication of this stems from the so-called False-Belief (FB) tasks in which children are asked to predict the behavior of a character who holds a false belief about reality. For instance, in the well-known Sally-Anne task (Baron-Cohen, Leslie, & Frith, 1985), children are presented with a scenario in which a doll named Sally places a marble in a basket and then leaves the scene. In Sally's absence, another doll named Anne removes the marble from the basket, places it in a box and leaves as well. When Sally returns, the children are asked where she will look for her marble. The idea is that children can only predict Sally's behavior correctly if they attribute the FB to her that the marble will still be in the basket where she had originally left it.

Most typically developing (TD) children correctly predict Sally's behavior (e.g. that she will look in the basket) around the age of 4 but the majority of children with ASD fail the task by indicating that Sally will look in the box (e.g. Baron-Cohen *et al*., 1985). This means that they do not have a first-order ToM which requires the ability to predict the behavior of a character who holds a FB about the world.

Perner and Wimmer (1985) created other kinds of tasks to test a higher order reasoning, called second-order ToM. These tasks require the attribution of FBs about beliefs. In the ice cream van task (Perner & Wimmer, 1985), two dolls, John and Mary, see an ice cream van in a park. While John goes home to get some money Mary sees the ice cream van move to the church. On his way home, John happens to notice the ice-cream van at the church (so his belief about the van's position remains true). Mary looks for John, whom she is told has gone for an ice cream. At this point children are asked where Mary thinks John has gone to buy his ice cream. The correct answer is "the park" as Mary has a FB (John knows that the van is in the park) about John's belief, which is actually true (John knows the van moved to the church).

Recent studies have also shown that individuals with ASD are affected by pragmatic difficulties in both language comprehension and expression (e.g.

Paul, Orlovski, Marcinko, & Volkmar, 2009). They have problems in detecting ambiguity which is an important aspect of what a person must know in order to comprehend language (Le Sourn-Bissaoui, Caillies, Gierski, & Motte, 2011) and experience more difficulties than TD controls in inferring the speaker's intention from emotional prosody when embedded in a discrepant context (Le Sourn-Bissaoui, Aguert, Girard, Chevreuil, & Laval, 2013). There is also some empirical evidence for the hypothesis that individuals with ASD experience not only impairments in theory of mind and pragmatic abilities but also, more broadly, social deficits. Tager-Flusberg (2001), assessing a quite large number of subjects with ASD by the means of a diverse theory of mind tasks, showed a significant association between theory of mind abilities and social competence. However, not all researchers agree that these difficulties are the result of an impairment in the ability to represent the mental states of others. Klin, Volkmar, and Sparrow (1992) found that the social dysfunction in autism affects very basic and early emerging social behaviors, such as showing anticipation of being picked up by the caregiver, which are typically present prior to the time at which even the earliest precursors of a ToM apparently emerge (before the 8-12th month of life). Moreover, the existence of autistic individuals who consistently pass false-belief tasks suggests that it may be necessary to hypothesize an additional cognitive abnormality. Peterson (2014) found that even children with ASD who passed false belief tasks scored lower in empathy than TD who failed false-belief tasks. According to the Weak Central Coherence (WCC) model (Frith, 1989), persons with autism experience impairments in social and pragmatic competencies because they tend to process information locally rather than globally, which would have negative consequences on their capacity to extract higher-level meaning from the context. The WCC has been investigated in two different domains: visuo-spatial constructional coherence and verbal-semantic coherence (e.g. Rajendran & Mitchell, 2007).

The initial works focused on perceptual mechanisms and measured central coherence with visuo-spatial tests. Some studies (e.g. Jolliffe & Baron-Cohen, 1997; Happe´, 1999) showed that autistic individuals performed tasks where a design or a figure had to be divided into their component parts faster than controls.

In the verbal area, central coherence theory is aimed at exploring contextual integration and linguistic processing. For instance, Jolliffe and Baron-Cohen (1999) by utilizing methodological variations (i.e. providing the context-appropriate pronunciation of a homograph, drawing a bridging

inference to make a situation and outcome coherent and using context to interpret a verbally presented ambiguous sentence), demonstrated that individuals with autism have problems in integrating linguistic material to create meaning. Other Authors attributed the pragmatic difficulties experienced by individuals with ASD, such us the inability to access the less salient literal meaning of the idiomatic expressions (Giora, 1999), to a difficulty in inhibiting the figurative meaning. The findings are explained in the light of a multiple deficits account and call into question the role of the Executive Functions (EF), those higher-order processes, strictly associated with the prefrontal cortex, which are necessary for controlling and regulating thoughts and actions. Difficulties in the domain of EF can manifest as paying attention to insignificant details, but failing to see how these details make sense into a bigger picture. Other EF difficulties relate to complex thinking that requires holding more than one perspective at the same time. According to Pellicano (2012) differences in the growth trajectories of autistic children's EF skills could account not only for pragmatic difficulty, but also for some of the impairments in children's social outcomes, adaptive behavior, and willingness to learn in school.

This study is an attempt to gain insight into the mechanisms underlying the social and pragmatic deficits found in ASD. In particular, we will focus on previous studies aimed at analyzing the ASD individuals' difficulty to comprehend figurative language (i.e. metaphor, irony, sarcasm), differentiate between physical and social causality, process human stimuli and understand deception. The topic of this paper is both important and timely as according to the revised criteria in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) for diagnosing ASD, a percentage of ASD children would switch to a new diagnosis of social communication disorder (SCD). SCD describes individuals who have social and communication difficulties without the repetitive behaviors or restrictive interests typical of autism. In addition, the DSM-5 combined earlier subtypes of autism into one diagnosis of ASD (American Psychiatric Association, 2013). According to Hoogenhout and Malcom-Smith (2014) what captures the difference between the subtypes of autism doesn't relate to factors leading to social and pragmatic impairments (i.e. ToM), but lies beyond the influence of intellectual functioning. Thus, while a single new ASD category doesn't conceptually change much from the previous situation, new insight in the field would be useful to identify treatment guidelines for the new category of SCD that would apply to around 10

percent of children who previously would have received a diagnosis of autism.

2. Methods

The first Author (AP) performed a systematic search of the following online databases: Pubmed, Psychinfo, Google Scholar, Scopus. We initiated our literature search by using the word autism in combination with the following keywords: pragmatic impairments, metaphor, social interaction, Theory of Mind. Search of the databases and reference lists were made until March 2014. Articles were selected if they had shed light on the reasons why individuals with ASD experience social and/or pragmatic difficulty; moreover, we took into consideration only peer-reviewed journal articles in English.

Because our search included all studies where the keywords were mentioned in the abstract, title or keyword list, a considerable number of studies were excluded on the basis of reading the abstracts. The most common exclusion reasons were related to the fact that the search terms were only present in the abstract, while the study did not focus on the topics we were interested in. Finally, 60 published papers were considered in this review.

3. Results

This section examines the studies showing a relationship between ASD and factors leading to difficulty in social and pragmatic areas (e.g. interpretation of causality, attention to human stimuli, comprehension of non-literal expressions).

3.1. ToM and pragmatic abilities in ASD

The correct interpretation of the meaning of other's intentions and beliefs related to the context (Hampton, Passanisi, & Jonsson, 2011) is essential in order to gain pragmatic and communication skills. Happe´'s studies (Happe´, 1993; 1995) on the understanding of figurative language in ASD were the starting point for experimental research on this subject.

Based on the evidence regarding mentalizing difficulties in ASD, Happé (1993) suggested that individuals with ASD should experience difficulty understanding certain nonliteral uses of language, such as irony or metaphor,

since these rely on the ability to attribute mental states to others. Happe´(1993) tested 18 individuals with autism between the ages of 9-28. The sentence completion task included questions involving metaphors, similes, synonyms and irony. Participants were divided into three groups of six participants based on their successes or failures in first and second-order ToM tasks. The no-ToM group (age range: 10-28; VIQ: 52-76) failed in both tasks; the first-order ToM group (age range: 9-25; VIQ: 64-100) passed the first-order tasks only; the second-order ToM group (age range: 11-26; VIQ: 58-100) performed most successfully in the second-order tasks. A control group of individuals with moderate learning difficulties (MLD) was also tested. The control group was matched with the no-ToM group for verbal IQ (VIQ). The no-ToM group was significantly less successful than both the first- and second-order ToM groups and the MLD controls on the metaphor condition. These findings suggest that the no-ToM autistic subjects' failure with metaphors was not simply due to a general lack of verbal ability.

While examining data concerning both TD children and children with language impairments, Norbury (2005) disputed Happe´'s conclusions that an understanding of ToM is necessary in order to comprehend metaphors. Norbury observed that TD children pass first-order FB tasks around the age of four while an understanding of metaphors increases throughout adolescence and young adulthood. In addition, she observed that children with specific language impairments are deficient in understanding metaphorical language despite having relatively intact ToM abilities (Highnam, Wegmann, & Woods, 1999; Rinaldi, 2000). Based on these findings, Norbury concluded that ToM abilities are a necessity in understanding metaphors but on their own they are insufficient. She studied 94 children between the ages of 8-15 who suffered from communication impairments. They were divided into three groups based on language ability, autistic symptoms and ToM performance. They completed a Test of Work Knowledge (ToWK, Wiig & Secord, 1992) as well as a ToM and a metaphor task, which was adapted from Happe´ (1993). The results showed that only children with language impairments had difficulty in the metaphor tasks, regardless of concurrent autistic symptoms. Semantic knowledge, as measured by the ToWK and as shown by a hierarchical regression analysis, was the strongest predictor of metaphor comprehension. Interestingly, Norbury's study (2005) showed that age was the second most important predictor in the regression analysis and it was far more important than vocabulary knowledge, ToM and autism measures.

These findings emphasize the importance of using a developmental approach when studying the relationship between ASD and metaphors or between ASD and figurative language. Based on this developmental perspective, Rundblad and Annaz (2010) conducted an original study on the mechanisms underlying metaphors and metonymies in 11 children with ASD between the ages of 5.4-11.4; 17 TD children were used as the control group. According to the Authors, the comprehension of both metaphor and metonymy evolves at different rates during typical childhood development, with metonymy having better results than metaphors at younger ages. In their opinion, because it is cognitively and linguistically simpler to understand metonymy than it is to understand metaphors, this rubric should also apply to atypical children. Based on this understanding, Rundblad and Annaz (2010) studied metaphor and metonymy comprehension in autistic children. Their study focused on the following results: performance; onset and rate of development in relation to chronological and mental age; severity of autism, as measured by the Childhood Autism Rating Scale (CARS, Schopler, Reichler, & Renner, 1986); Social Communication Questionnaire (SCQ, Rutter, Bailey, & Lord, 2003); ToM ability, as measured by the Sally and Ann task (Baron-Cohen *et al*., 1985); and weak central coherence, as measured by the Children's Embedded Figures Test (CEFT, Witkin, Oltman, Raskin, & Karp, 1971). The Authors used a task comprising 10 metonymies and 10 metaphors, both lexicalized and incorporated into picture stories, to assess children's comprehension of figures of speech. The autistic group performed significantly worse on both figures of speech compared to the chronologically matched TD children. There were no correlations between the metonymy or metaphor tasks in regards to CEFT, ToM, CARS and SCQ. The lack of relationship between CEFT and ToM is in direct contrast to an explanation of the figurative language difficulties experienced by children with ASD that is based on theory of WCC or on the lack of ToM.

Adachi, Koeda, Hirabayashi, Maeoka, Shiota, Wright *et al*. (2004) studied a group of children with ASD between the ages of 7-14 (Total IQ and VIQ 70), in comparison with two other groups: one with ADHD and the other with TD children. The subjects were given several tasks including metaphor and sarcasm comprehension and ToM tasks, which were tested using a task adapted from the Box of Smarties (Perner, Frith, Leslie, & Leekam, 1989). The Authors developed the Metaphor and Sarcasm Scenario Test (MSST) which comprises 10 items, half of which measures metaphor comprehension and the other half measures sarcasm comprehension through

multiple-choice responses to a short story. Results showed that in all groups sarcasm comprehension was more problematic than metaphors. Particularly in the ASD group, increased sarcasm comprehension was strongly correlated with success in the ToM task, which in turn did not correlate with the metaphor comprehension score.

3.2. Interpretation of physical and social causality in ASD

Some Authors (Bowler & Thommen, 2000; Congiu, Schlottmann, & Ray, 2009) hypothesized that difficulty in every day social interaction, social description and communication experienced by subjects with autism may relate to impairments in the differentiation between physical and social causality.

Bowler and Thommen (2000) used launch and reaction events developed by Michotte (1946) and Kanizsa and Vicario (1968) to represent and test prototypical physical and social interactions (i.e., elastic collisions with transfer of momentum and chase/escape sequences with contingent motion-at-a-distance).

Three groups of ten children were involved in this experiment: one group with autism (Chronological Age - CA range: 86-187 months; Verbal Mental Age - VMA range: 63-132 months) and two groups of TD children whose CAs were matched individually with either the CAs of the children with autism or with their VMA (respectively: CA range: 85-183 months; VMA range: 63-132). Participants were asked to watch a screen and to describe what they saw happening after each film was presented. Results showed that both children with autism and TD children were equally able to describe both mechanical and intentional causality. This result suggests that perception of causality at a distance is not directly related to social or mental state reasoning, as it is well-established that individuals with ASD experience difficulty in every day social interactions (Klin, 2000; Bowler, & Thommen, 2000). However, when faced with more complex stimuli in a richer context that unfolds over time, their performance declines.

Bowler and Thommen (2000) found evidence of this in a second experiment using the movie of animated geometric shapes developed by Heider and Simmel (1944). In this movie, two triangles and a circle perform a series of movements in relation to each other and to a rectangle. The triangles and circle are capable of independent movement, whereas the rectangle moves only when acted upon. Four groups of eleven children took part in the experiment: one group of children with autism and three groups

of TD children matched with either the CAs or the VMAs of the children with autism (mean of CA: 127.5 months; mean of VMA: 94.7 months; mean of IQ: 81.1). The children with autism made fewer propositions describing actions between animates than CA and VMA controls.

In accordance with Bowler and Thommen (2000), Congiu *et al*. (2009) found that children with autism were not impaired in perception of causality. Forty-one children participated in the study: 19 children with High Functioning Autism (HFA) (CA range: 8.2-18.7; VIQ range: 45-111) and 22 TD children matched for VMA (CA range: 8.10-9.10; VIQ range: 97-143). The stimuli included launch and reaction events as well as their delayed non-causal equivalents with and without contact, all with both rigid and non-rigid agents. As a measure of perceptual animacy children were asked to describe the non-rigid stimuli (i.e. Michotte's caterpillar). Although the high functioning children with autism perceived physical and causal events as well as matched TD children, they misidentified Michotte's caterpillar as animate, compared to TD children with the same VIQ. According to the Authors, the impairment experienced by children with autism may be due to the difficulty in finding an appropriate verbal description for the unfamiliar non-rigid stimuli presented.

3.3. Attention to human stimuli and memory awareness in ASD

Most learning occurs through social interactions with significant others, such as parents. This kind of learning, which is responsible for the healthy development of personality (McAdams, 1989; Baldwin, 1992; Schimmenti, Passanisi, Gervasi, Manzella, & Famà, 2013; Schimmenti, Passanisi, Pace, Manzella, Di Carlo, & Caretti, 2014; Schimmenti, Passanisi, & Caretti, 2014) relies on specific cognitive and attentional biases that lead children to preferentially pay attention to social stimuli and to experience exchanges in social context (Legerstee, Anderson, & Schaffer, 1998).

Colombi, Vivanti, and Rogers (2011) found that people with autism perform relatively better in imitating goal-directed actions than gestural and facial movements. According to Vivanti and Rogers (2011) these impairments may be due to the failure to fully learn skills that are central to cognitive development and adaptive behavior. Unlike TD children, those with ASD do not tend to receive the same number of social rewards usually related to social stimuli, and/or they would not be able to discriminate between them.

On this basis Wilkinson, Best, Minshew, and Strauss (2010) assessed

memory awareness during a facial recognition task. This study involved 18 high-functioning children (mean of CA: 13.1 years) and 16 adults (mean of CA: 27.5 years) with autism matched with 13 TD children (mean of CA: 14.3 years) and 15 TD adults (mean of CA: 26.9 years). After looking at 24 color photographs of adult female faces, participants had to recognize them among 48 color photographs of adult female faces. After each memory test, participants were also asked whether their responses were "certain", "somewhat certain" or "guessing". Results showed that, in general, face recognition accuracy reflected greater certainty. However, children with autism reported less precise memory awareness for faces and less reliable discrimination between their confidence ratings compared to TD children. The differences between adults with autism and their controls were subtler. Results suggest that individuals with autism may have broader meta-cognitive deficits, potentially leading to more general impairments in social interactions. These findings support the idea expressed by Adler, Nadler, Eviatar, and Shamay-Tsoory (2010) that impairments in ToM abilities reported in HFA could due to impaired autobiographical memory (AM) skills.

In the process of understanding another's mental state, people may use their AMs in order to retrieve analogous occurrences from the past that might help them understand a social scenario (Corcoran & Frith, 2003). Wilkinson *et al.* (2010) compared 16 high-functioning adolescents and young adults (mean of CA: 21.87) with HFA or Asperger syndrome (AS) with 21 matched control participants (mean of CA: 22.90). All participants were tested for ToM, AM and general memory. In particular ToM tasks consisted of Happé (1994) Strange Stories in which participants answered questions regarding their comprehension of the story and the intention of the character described in 10 short vignettes. In order to assess aspects of ToM not involving story comprehension or working memory, participants were also administered the Reading the Mind in the Eyes Task (RMET, Baron-Cohen, Wheelwright, & Hill 2001). AM was tested by means of a modified version of the Personality Trait Questionnaire (PTQ, Klein, Chan, & Loftus, 1999). In the first session each participant rated how much 10 personality traits best described them. Then subjects were asked to provide an autobiographical example of the traits they rated high on the PTQ. Each example was scored based on the following: self-reference dimension – whether it relates to the self (1 point) or not (0 point); location dimension – relating to the location of the event (1 point) and no relation to location of behavior (0 point); time dimension – indicating the exact time of the event

(1 point to 0) from the most detailed estimation to no time estimation at all. In order to assess general memory, the Rey Auditory Verbal Learning Test (RAVLT, Spreen & Strauss, 1998) was used. Individuals with HFA/AS performed as well as controls in general memory but not as well in the ToM and AM measures.

Interestingly, ToM correlated with AM in the control group only in the Strange Stories task, whereas a positive correlation was found between AM and the RMET in the HFA/AS group.

This dissociation in the correlations may suggest different mechanisms explaining the contribution of AM to ToM in individuals with autism. According to Tager-Flusberg (2001) and Sabbagh (2004), the right medial-temporal circuit is involved in decoding others' mental states based on immediate information (such as stimuli of RMET), and the left medial-frontal circuit is recalled in complex reasoning about those mental states (such as prediction of the behavior of a character in a story). Thus, it could be speculated that the contribution of AM to ToM in autism relies on visual decoding mechanisms, whereas controls use their AM when complex reasoning mechanisms are needed.

3.4. Ability to deceive and ToM

The difficulties experienced by autistics (e.g. the ability to deceive) seem to be partially due to a lack of ToM (Leekam & Prior, 1994). To test this hypothesis, Li, Kelley, Evans, and Lee, K. (2011) investigated whether the propensity to lie (e.g., denying peeking at a toy) and the ability to feign ignorance of a toy's identity (semantic leakage control) were related to first-order FB reasoning. Nineteen autistic (CA: 6.17-12.83; VMA: 3.50-10.48) and 30 TD children (CA: 6.00-10.25; VMA: 5.53-11.79) were administered a battery of standard first-order and second order FB tests. To investigate both antisocial and white lie-telling, all participants were given two tasks based on the temptation resistance paradigm (Talwar & Lee, 2002) and on the undesirable gift paradigm (Talwar, Murphy, & Lee, 2007). In the antisocial lie-telling propensity task, children were asked whether they looked at a covered toy while the researcher was absent despite being asked not to do so (antisocial lie question); they were also asked what they thought the toy was (semantic leakage control question). As for the white telling propensity task, children were given an unattractive prize (i.e. a bar of soap) for winning a game and they were asked whether they liked the prize. Contrary to expectations, the results showed that children with ASD were

able to deceive others. However, children with ASD experienced more difficulty than TD children in maintaining consistency between their statements during deception (semantic leakage control). The Authors also found that the propensity to tell antisocial lies does not significantly correlate with FB understanding in children with or without ASD, while TD children, who exercise semantic leakage control, had better second-order FB understanding. In contrast, this correlation was not found in children with ASD. This finding suggests that children can tell antisocial lies without necessarily exhibiting a conscious will to instill a FB in another. Interestingly, antisocial lie-telling propensity was related to white lie telling propensity (in politeness settings) in the ASD group but not in the TD group. It is speculated that children with ASD may have learned to act in such a way to avoid getting into trouble with the person they lied to. In other words, this study suggests that both antisocial and white lies told by autistic children reflect scripted knowledge rather than ToM.

It is reasonable to deduce that children with ASD may have difficulty showing skepticism towards what others say in light of the specific difficulty that these children have when engaging in deception and manipulating others' beliefs. Compared to children with TD, ASD children may be more likely and willing to believe whatever they are told. For this reason, Yi, Pan, Fan, Zou, Wang and Lee (2013) examined the indiscriminate trust tendency of 22 ASD children (CA range: 5.1-8.9) compared to 27 age-matched (CA range: 5.1-8.7) and 26 ability-matched (CA range: 4.1-7.10) TD children. The Authors specifically studied whether an indiscriminate trust bias would be expressed more by ASD children than their TD peers when a complete adult stranger gives them information. To test this, a simple trust game was used, which had been adapted from Couillard and Woodward paradigms (1999). During this game, an adult with whom the children have never interacted before, either places a marker or points on one of three boxes to indicate that a desirable item was hidden in that box. Children either trusted the adult by looking in the indicated box or they went to a different one. Those who did the latter may not have trusted the information given by the adult. According to the results, although young school-aged children with ASD did not blindly trust the information provided by the unfamiliar adult, they seemed to trust the adult more than their age- and ability matched TD peers.

These results are consistent with findings about the difficulty that ASD children experience when engaging in deliberate deception (Russell, Mauthner, Sharpe, & Tidswell, 1991; Baron-Cohen, 1992; Sodian & Frith,

1992). In order to decide whether to trust or mistrust somebody, one must realise that a person may not only have deceptive intentions but also that they may be capable of forming them. To deceive another person, one must understand and be able to form deceptive intentions. For this reason, trust and deception may be two ways of looking at the same thing. It has been well-established that deception is closely linked to the understanding of ToM in general and to FB understanding specifically (Chandler, Fritz, & Hala, 1989; Talwar & Lee, 2008). By definition, deception involves instilling FBs into another's mind. Consequently, the understanding and manipulation of beliefs is necessary in the deployment of deception as well as in the detection of deception in others in order to avoid being fooled.

According to Pellicano and Burr (2012), children with ASD are less likely than TD children to be influenced by or to rely on previous experiences. For this reason, ASD children were not as likely to learn from their past experiences of lying adults which could explain their bias to trust others, as evidenced in Yi *et al.*'s study (2013). However, just like TD children, those with ASD may be able to learn from their prior experiences, but these experiences may have involved reliable adults.

3.5. ToM or signal-dependent, goal-directed system?

In order to demonstrate that difficulties experienced by subjects with autism are not merely the result of an impairment in the ability to represent the mental states of others, Bowler, Briskman, Gurvidi, and Fornells-Ambrojo (2005) carried out two experiments on children with autism (CA: 71-213 months; VMA: 35-156), TD children (CA: 41-57 months; VMA: 30-67) and children with intellectual difficulties (CA: 103-213 months; VMA: 40-92). The latter group was included to control for the fact that children with autism have a lower IQ than TD children. In all groups, irrespective of their diagnosis, performance on the classic Sally-Anne FB task (which implies a ToM) was found to correlate with a non-mentalistic analogue called the Train Task. In this task a driverless train is located in front of a tunnel that hides a bifurcation of the track, with one arm of the track leading out of the tunnel terminating at a blue landing pad and the other at a yellow landing pad. In front of the tunnel is a signal with a blue and yellow light; children are taught that if a plane lands on the blue landing pad, the blue signal light turns on and the train sets off for the blue platform (and vice versa for yellow). After a few demonstrations of the typical sequence (i.e. plane lands, appropriate signal light turns on, train follows the signal light to

the appropriate platform), the test scenario is presented. This time, a bird lands on one of the platforms triggering the same-colored signal light. The plane is now forced to land on the other platform resulting in a mismatch between the location of the plane and the color of the signal. Bowler *et al*. (2005) showed that children who failed the Sally-Anne task (e.g. Sally will look where the marble really is) indicated that the train will head to the platform where the plane landed rather than the platform indicated by the signal. Children who passed the Sally-Anne task, by contrast, indicated that the train will head to the platform indicated by the signal. Thus, the Authors concluded that it is not the attribution of mental states *per se* that presents difficulties for individuals with ASD but rather the understanding of how a signal (whether a mental state or an explicit signal such as in the Train Task) modulates goal-directed behaviors.

The findings of Bowler *et al.* (2005) were based on the comparisons of two control groups that had the same VMA as the ASD group. However, they were measured by independent vocabulary tests which failed to measure the exact incidental cognitive demands of the tasks. For this reason, it is possible that the ASD and control groups' ability to meet the incidental cognitive demands of the tasks was different. Consequently, it is of upmost importance to investigate whether ASD children have difficulty in understanding mental and non-mental representations, regardless of their deficits in language and EF.

Iao and Leekam (2014) tried to re-examine the non-specificity claim of ToM. This study involved 18 children with ASD (CA range: 70-133; VMA range: 51-119) and as controls, 18 matched TD children (CA range 52-88; VMA range: 53-98). Participants were administered FB tasks (Wimmer & Perner, 1983) and their performance on these was compared with their performance in non-mental tasks sharing similar structural features. The "False" Photograph (FP) task (Leekam & Perner, 1991; Leslie & Thaiss, 1992; Apperly, Samson, Chiavarino, Bickerton, & Humphreys, 2007) involves a character taking a photograph of an object in Location A with a Polaroid camera, after which the object is moved to Location B. Previous research (Leekam & Perner, 1991; Leslie & Thaiss, 1992; Charman & Baron-Cohen, 1992) has shown that TD children and children with ASD failed the FB task but passed the FP task. These results confirmed Baron-Cohen *et al.*'s original suggestion of a ToM deficit in individuals with ASD (1985). It has been argued that these tasks differ conceptually: a FB is a misrepresentation of its intended idea (Leekam & Perner, 1991) while a photograph is a true representation of the situation at the time it was taken.

Thus, since the FP task may not be an appropriate non-mental comparison to the FB task, to adequately test the domain specificity debate, Iao and Leekam (2014) also administered the false-sign (FS) task to participants. In this task, subjects are shown a signpost that indicates an object in Location A, after which it is moved to Location B. For this reason, the signpost becomes a false sign. Afterwards the subjects are asked where the object is, based on the indications provided by the signpost. Results showed that children with ASD performed worse on the false representation test of the FB and FS tasks than on the FP task just like TD children. When performance on the FP task was taken out, the association between the FB and FS tasks remained.

These findings suggest that both groups process mental and non-mental representations by means of an underlying conceptual capacity for representational understanding rather than a specific deficit in understanding mental representations related to ToM in ASD.

4. Discussion and conclusions

All of the studies described give insight into the cognitive mechanisms that underlie the pragmatic and social difficulty experienced by individuals with ASD. Not all researchers agree that this difficulty is the result of impairment in the ability to represent the mental states of others.

Norbury (2005) has found evidence that children's metaphor comprehension is due to language impairments instead of a lack of ToM. Furthermore, Congiu *et al.* (2009) have suggested that children with autism, instead of lacking ToM, have a basic deficiency finding appropriate words to explain the unusual animate stimuli presented. Finally, according to others (Wilkinson *et al*., 2010; Colombi *et al*., 2011; Vivanti & Rogers, 2011) impairments in attention, memorization and the imitation of human stimuli are the main factors that affect ASD children's ability to succeed in the areas of social interaction and communication with others.

Thus, a broader view is needed to grasp the complexity of language and communication problems in ASD population. It seems that central coherence represents a theory with a wider perspective as evidenced by its opportunities to conceptualize the difficulty of language and communication in ASD in relation to problems in the meaning perception, also known as "sense-making". Persons with ASD would experience social and pragmatic difficulty because of a weakness of central coherence. Nevertheless, Rundblad and Annaz (2010) found no correlation between the metonymy or

metaphor tasks in regards to WCC.

Pragmatic impairments in ASD might be due to other factors. Bowler *et al.* (2005) have demonstrated that children with ASD who fail the classic Sally-Anne FB task (which implies the capacity to mentalize) also fail the non-mentalistic analogue called the Train Task. This finding–raises the possibility that children with ASD have difficulty in understanding non-literal linguistic constructs, such as irony or metaphor, because they do not understand how signals in general (rather than mental states specifically) modulate the significance of meaning. According to Iao and Leekam (2014), the main concept that underpins mental and non-mental representations is most likely representational understanding, which provides additional evidence for ToM's non-specificity claim. In addition, the Authors suggested that individuals with autism do not experience impairments in social domain because of their language deficit, or because they lack EF. In fact the nonverbal reality-unknown tasks, which were used to assess children's understanding of representation and found to correlate with performance on FB in the study, do not require sophisticated language and cognitive inhibition skills.

In order to shed light on the mechanisms underlying the pragmatic and social impairments in individuals with ASD future research might investigate to what extent the performance of individuals with and without an ASD diagnosis correlates amongst pragmatic language tasks (i.e. metaphor, metonymy, irony tasks), mentalizing tasks (i.e. RMET) and tasks assessing the understanding of how signals modulate goal-directed behaviors (i.e. train and FS tasks).

This would be useful to understand whether individuals' own goal-directed behavior in a linguistic context is modulated according to a signal or whether their behavior in such a context is only determined by the goal. Finally, these new research outcomes could help to individuate the treatment guidelines for the newly defined disorder of SCD that have not been yet identified, diminishing consequently the widespread concern and the negative emotions associated with decreased quality of life (Passanisi, Leanza, & Leanza, 2013) among many families dealing with these problems.

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