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Brief report

Impaired theory of mind but intact decision-making in Asperger syndrome: Implications for the relationship between these cognitive domains

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ABSTRACT

The relationship between decision making and theory of mind (TOM) has been hardly investigated in patients with Asperger Syndrome (AS). Here, we show that the AS group ($n=25$) exhibited deficits on a complex TOM task, yet were unimpaired in a decision-making test. No association was found between these two domains.

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1. Introduction

Individuals with Asperger syndrome (AS) display a symptom pattern characterized by qualitative impairment in reciprocal social interaction as manifested by marked deficits in the use of multiple non-verbal behaviors that regulate social interaction, and restricted repetitive and stereotyped patterns of behavior, interests and activities. It is widely recognized that impairments in social reciprocity, failure to develop and maintain peer relationships, deficient theory of mind (TOM) and problems in detecting emotions all contribute to social dysfunction in AS (Baron-Cohen et al., 2001a, 2001b; Flood et al., 2011). TOM is the ability to infer thoughts, beliefs, intentions, and desires in other people's minds. Impaired TOM usually underlies AS patients' unusual social behavior and propensity to commit "faux pas", as they have difficulties to understand subtle jokes and/or ironies, make social attributions (Shimoni et al., 2012) or read in between the lines (Happé, 1994; Baron-Cohen et al., 2001a, 2001b). Another capacity that is central for healthy social behavior is decision-making (DM). Although widely studied in neurodegenerative disease (Gleichgerrcht et al., 2010), only a few studies have looked at DM in AS. An interesting study by Luke et al. (2011) demonstrated, using a novel questionnaire and a decision-making inventory, that adults with autism spectrum conditions experienced several problems in DM especially reporting an avoiding style. In the same line, De Martino et al. (2008) demonstrated insensitivity to contextual frame in the DM process. Some of the brain regions thought to be affected in AS have shown to be involved in DM, namely the prefrontal cortex (PFC, including its dorsal section) and the amygdala, which plays a central role in this complex process. Another clinical group featuring evident involvement of the PFC is the behavioral variant frontotemporal dementia. Among these patients, performance on both ToM and DM tasks is impaired, yet these cognitive domains have been shown to be dissociated (Torralva et al., 2007), suggesting that whilst similar prefrontal circuitry may be implicated in ToM and DM tasks, these cognitive domains may be independent from each other. Based on these previous dissociations we hypothesized that TOM deficits associated with AS would not be related to the DM domain. Accordingly, the main goal of the present study was to examine DM and TOM tasks in a group of AS patients and to further understand the relationship between these two cognitive domains in this condition.

2. Methods

2.1. Participants

Twenty-five adults [72% male; mean age=33.9 (S.D.=11.1); mean years of education=14.8 (S.D.=4.2)] with a clinical diagnosis of Asperger Syndrome (AS) according to DSM-IV criteria (2000) and 36 healthy control [60% male; mean

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age=36.4 (S.D.=9.9); mean years of education=15.8 (S.D.=2.8)] were recruited from the Institute of Cognitive Neurology (INECO, Argentina) as part of a broader study on cognition in AS. Diagnosis was based on thorough clinical evaluation following of participants and information gathered from their parents. Diagnostic features were further confirmed using screening questionnaires, including the Childhood Asperger Syndrome Test (CAST; Scott et al., 2002) and the Autism Spectrum Quotient for adults (AQ; Baron-Cohen et al., 2001b). The groups were comparable in terms of age ($t_{48}=0.86$, $p=0.39$), gender ($\chi^2=0.80$, $p=0.37$, $df=1$), and education ($t_{48}=0.75$, $p=0.46$).

2.2. Procedure

Subjects were administered a standard neuropsychological battery which included the following: forward digit span (Wechsler, 1997) and the trail making test (part A) were used to assess attention and concentration. Verbal memory was assessed using the Rey auditory verbal learning test (RAVLT; Rey, 1941), and non-verbal memory with the Rey Complex Figure test (Rey, 1941); naming using the Boston naming test (adapted version) (Kaplan et al., 1983) and verbal fluency was tested using timed generation of words starting with the letter "P". Executive or frontal function was evaluated the digit span backwards, the trail making test (part B) (Partington and Leiter, 1949) and the Wisconsin card sorting t est (WCST), modified version (Nelson, 1976). Three experimental tasks were included:

Theory of mind tests:

- The Mind in the Eyes Test (MIE): This computerized task consists of 17 photographs of the eye region of faces. The subject is required to make a choice between two words that best describe what the individual in the picture is thinking or feeling (Baron-Cohen et al., 1997).
- Faux Pas: In this test the subject is read a story that may or may not contain a social faux pas (Stone et al., 1998). The subjects are shown ten stories with a faux pas and ten stories without a faux pas. After each story, the subject is asked whether something inappropriate was said and if so why. When a faux pas was correctly identified, participants were asked two additional questions: the first measuring intentionality—that is, recognizing that the person committing the faux pas was unaware that they had said something inappropriate, and other measuring emotional attribution, in which participants are expected to recognize that the person hearing the faux pas might have felt hurt or insulted. These components tap on cognitive and affective aspects of ToM, respectively.

Decision making test:

- Iowa Gambling Task (IGT): The computerized version of IGT involves continuous card selection from four separate decks (A, B, C and D) completed after 100 selections. Card choices from decks A and B lead to overall debt on the task whereas decks C and D yield a profit. The task is divided into five blocks, each of 20 consecutive card choices, in order to quantify the change in decision-making across the course of the task (Bechara et al., 1994).

2.3. Statistical analysis

Categorical variables were compared between groups using independent χ^2 tests. Ordinal variables were analyzed using independent samples t tests. Pearson correlations were calculated between IGT and TOM. The α value for all statistical tests was set at 0.05, two-tailed.

3. Results

Performance results are shown in Table 1.

3.1. Neuropsychological comparison between groups

A significant difference between groups was found on the neuropsychological battery for the recognition phase of the verbal memory task, as well as on attention and executive functioning tasks, including forward digit span, Trail Making Test Part B, and the Wisconsin Card Sorting test.

Table 1
Performance score for neuropsychological, theory of mind, and decision making tasks of healthy controls (CTR) and Asperger syndrome (AS) patients.

	CTR, $n=25$		AS, $n=25$		$t=$	$p=$
Cognitive tests	*Mean*	S.D.	*Mean*	S.D.		
RAVLT						
Learning	52.7	9.2	46.3	10.5	1.78	0.08
Delayed	11.7	3.3	10.5	2.4	1.20	0.24
Recognition	14.4	1.2	13.2	2.0	2.33	**0.03**
ROFC						
Delayed	22.0	8.2	21.1	8.9	0.32	0.75
Recognition	75% correct		80% correct		$\chi^2=0.12$	0.73
Digit span forward	5.8	0.8	6.8	1.4	2.57	**0.02**
TMT-A	26.2	7.8	30.8	15.3	0.98	0.34
Boston Naming Test	19.9	0.3	19.3	1.3	1.60	0.12
Semantic fluency	21.2	5.2	20.6	4.6	0.36	0.72
ROFC copy	35.6	0.8	35.5	1.2	0.34	0.74
Phonological fluency	17.1	4.8	15.2	5.1	1.08	0.29
Digit span backward	5.9	1.7	5.4	1.4	0.95	0.35
TMT-B	56.6	16.9	73.6	30.0	2.20	**0.04**
WCST	6.0	0.0	5.2	1.6	2.49	**0.02**
Mind in the eyes	14.2	1.1	13.6	2.1	1.25	0.61
Faux Pas						
Total score	18.8	1.1	16.0	2.7	4.85	$<$ **0.001**
Hits	9.2	0.3	5.8	2.6	6.18	$<$ **0.001**
Rejects	9.7	0.5	9.4	1.0	1.34	0.19
Intentionality	9.4	0.8	4.4	2.3	10.3	$<$ **0.001**
Emotion	9.1	0.7	4.1	2.3	10.4	$<$ **0.001**
Iowa Gambling Test						
Block 1	-3.1	6.6	−3.0	5.4	0.08	0.94
Block 2	3.0	6.3	3.7	7.7	0.36	0.72
Block 3	3.7	6.6	2.5	7.7	0.58	0.57
Block 4	7.6	8.5	3.4	8.5	1.67	0.10
Block 5	6.9	10.4	6.7	10.3	0.05	0.97
Net score	13.6	27.0	12.9	25.3	0.08	0.93

RAVLT, Rey Auditory Verbal Learning Test; ROFC, Rey–Osterreith Figure Copy; TMT, Trailing Making Test; WCST, Wisconsin Card Sorting Test.

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3.2. Theory of mind

While the groups did not differ on their ability to infer other people's feelings from the eyes' region of faces, AS were significantly worse at inferring the thoughts and intentions of others, as revealed by their significantly worse performance on the Faux Pas total score, as well as the hits, intentionality, and emotion subscores.

3.3. Decision-making

No significant differences were found between the groups on any of the IGT 20-card blocks, nor on the total net score of the task.

3.4. Relationship between theory of mind and decision-making

A significant, positive correlation was found between the total score of both TOM tasks ($r=0.40$, $p<0.01$), yet neither of these tasks correlated significantly with the net score on the IGT (MIE: $r=-0.1$, $p=0.50$; Faux Pas: $r=0.22$, $p=0.12$). No other correlations were found between TOM variables and any of the variables derived from the IGT (*all* $p>0.25$). The same pattern was observed when correlations were analyzed independently within each group.

4. Discussion

This study is, to the best of our knowledge, the first to examine the IGT in this group of patients in combination with measures of TOM. We found no significant differences between the AS and the control groups on any of the measures of the IGT. These results are in line with the study published by Johnson et al. (2006) showing no group differences on this particular task, demonstrating, however, that the AS group showed a distinct pattern of DM characterized by frequent shifts between the four IGT decks. Moreover, as expected, differences with controls arose in TOM measures, particularly on the ability to infer thoughts and intentions of others, as reflected in the Faux Pas and as previously reported by several studies (Baron-Cohen et al., 1999; Moran et al., 2011; Gleichgerrcht et al., in press). As well, we were interested in examining the relationship between DM and TOM in AS patients. Previous studies have suggested that TOM is an independent, separate cognitive module (Happe et al., 1999; Bird et al., 2004); however, little attention has been paid to its relation with DM, another cognitive domain that shares its neural basis. The main finding of the present investigation was related to the lack of association between the performance on TOM and DM tasks, despite the acknowledged involvement of the orbito-frontal cortex in both tasks. Scores on the two ToM tasks were, nonetheless, closely correlated. This is in line with previous dissociations found between DM and TOM among patients with frontotemporal dementia (Torralva et al., 2007). This convergent result may suggest that although sharing similar prefrontal circuitry, TOM and DM function independently from each other, probably having distinct but additive effects upon the development of social behavior. These findings also highlight the possibility that AS patients may find it more challenging to perform tasks requiring complex implicit processing, e.g. Faux Pas, relative to tasks that rely on abstract information that becomes clearer as the task progresses, as it occurs on the IGT (Dunn et al., 2006).

Difficulties in social skills, low social perception and disregulation in social interaction are prominent in individuals with AS. A better understanding of these cognitive processes, critical to social behavior, both related to the prefrontal cortex function, may lead to the design of better assessment methods and therefore allow for new cognitive rehabilitation strategies specifically related to the development of social knowledge and better social responses in patients with neuropsychiatric diseases, particularly AS.

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