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Brief report

The relationship between theory of mind and autobiographical memory in high-functioning autism and Asperger syndrome

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ABSTRACT

The relationship between theory of mind (ToM) and autobiographical memory (AM) in high-functioning autism (HFA) and Asperger syndrome (AS) has never been investigated. Here, we show that ToM abilities could be predicted by levels of AM in HFA and AS as compared to controls, suggesting that difficulties in AM are closely related to ToM impairments in HFA and AS.

1. Introduction

Several proposals have been offered to account for the social impairment observed in autism spectrum disorders (ASDs). Among these, the suggestion that failure to understand other people's mental states — the ability termed "theory of mind" (ToM) — has been studied most widely. The "mind blindness" hypothesis of autism (originally proposed by Baron-Cohen et al. (1985)) argued that if the social impairment in autism arises from a failure of the 'mentalizing' mechanism, then children with autism should be unable to represent mental states such as beliefs and desires (Leslie and Frith, 1987). Indeed it has been repeatedly demonstrated that individuals with autism show ToM impairments (Baron-Cohen et al., 1999). Furthermore, while some individuals with high-functioning autism (HFA) and Asperger syndrome (AS) have been shown to pass second-order ToM tasks, they were significantly impaired on more advanced tasks of ToM, such as the Strange Stories task (Happé, 1994) and reading the mind in the eyes task (Baron-Cohen et al., 2001).

It has been recently suggested that in the process of understanding another's mental state we may rely on our autobiographical memories (AMs) in order to retrieve analogous event from the past that might help to disambiguate a social scenario (Corcoran and Frith, 2003). This formulation is similar to the simulation theory proposed by Harris (1992), which postulates that the ability to relate to another's mental state is related to our ability to put ourselves "in their shoes". In accordance with this concept, Corcoran and Frith (2003) reported significant correlations between ToM abilities and measurement of AM in patients with schizophrenia.

Furthermore, it has been shown that individuals with HFA and AS show deficits in tasks that involve components of recalling personal past experiences (Klein et al., 1999).

Taken together, it is possible that impairments in ToM abilities reported in HFA and AS could be accounted for by impaired AM abilities. To further examine this hypothesis, we compared the performance of individuals with HFA and AS with that of normally developing individuals on measures of ToM and AM and examined the relationship between these measurements.

2. Methods

2.1. Participants

The HFA and AS group comprised 16 adolescents and young adults (15 males) with formal diagnosis of AS and HFA according to international criteria (APA, 1994). The group mean age was 21.87 (S.D. = 4. 75) and the mean number of years of education was 11.91 (S.D. = 1.44). The HFA and AS participants were recruited to the study through a patient support group center. All had received the diagnosis prior to the study from at least two senior psychiatrists based on the International Classification of Diseases (ICD)-10 or Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) criteria.

Control participants ($n = 21$) were matched with the experimental group on the basis of age (mean = 22.90, S.D. = 4.62), years of education (mean = 12.71, S.D. = 2.17), and gender (20 males and one female).

All groups were tested for intellectual abilities using selected subscales from the Wechsler Adult Intelligence Scale (WAIS)-III Heb (similarities, block design, and digit span).

2.2. ToM tasks

Happé (1994) Strange Stories: The task consisted of 10 short vignettes followed by questions designed to test the comprehension of the story and the intension of the

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character. Four additional vignettes were used as a physical control measure, to verify basic comprehension.

The Baron-Cohen et al. (2001) Reading the Mind in the Eyes task (RMET) was used to assess aspects of ToM that do not involve story comprehension or working memory.

2.3. AM task

A modified version of the Personality Trait Questionnaire (PTQ) (Klein et al., 1999) was administred twice. In the first session and 4 weeks later (second session), each participant was asked to rate 10 personality traits that describe him the most. In a third session, the subjects were asked to provide an autobiographical example to the traits they rated high on the PTQ. Each example was scored based on three dimensions:

1. Self-reference dimension — relating to the self (1 point) or not relating to the self (0 point).
2. Location dimension — relating to location of the event (1 point) and no relation to location of behavior (0 point).
3. Time dimension — indicating the specific time of the event (1 point to 0) from the most specific estimation to no time estimation at all. Reliability between judges was high (Cronbach's alpha = 0.76).

2.4. General memory task

In order to assess general delayed recall abilities, the Rey Auditory–Verbal Learning Test (RAVLT) (Spreen and Strauss, 1998) was used.

3. Results

Independent samples t-test revealed no effects of age [$t(35) = 0.66$, n.s.] or education [$t(34) = 1.36$, n.s.]. We did find differences between the groups in the similarities [$t(35) = 3.87$, $P < 0.001$] and the block design [$t(35) = 3.86$, $P < 0.001$] subscales but not in the digit span subscale [$t(35) = 1.97$, n.s.] task. The skewness of the distributions of ToM and AM tasks is close to normal. For example, skewness of the Strange Stories task was −0.57 and the AM task was −0.91. Furthermore, Q–Q plot analysis confirmed that the measurements were normally distributed.

3.1. ToM abilities

As illustrated in Fig. 1, a one-way analysis of variance (ANOVA) indicated a significant difference between the groups in the ToM conditions in the Strange Stories task [$F(1,35) = 23.47$, $P < 0.001$] but not in the physical conditions [$F(1,35) = 2.52$, n.s.]. Furthermore, in the RMET, the difference between groups was significant [$F(1,35) = 4.66$, $P < 0.05$]. Since there were group differences in the similarities and block design subscales, these variables were further used as covariates.

Tests of analysis of covariance (ANCOVA) indicated that the differences between groups remained significant in the Strange Stories task after covarying for both WAIS-III Heb subscales: similarities [$F(1,34) = 15.88$, $P < 0.001$] and block design [$F(1,34) = 18.82$, $P < 0.001$].

In the RMET, the differences approached significance when the similarities subscale was used as a covariate [$F(1,34) = 3.36$, $P = 0.076$] as well as when the block design was used [$F(1,34) = 2.91$, $P = 0.097$].

3.2. Autobiographical memory

In the AM task, we found significant group difference in the total score of the task [$F(1,35) = 13.68$, $P < 0.01$] as well as in the time dimension [$F(1,35) = 25.43$, $P < 0.001$]. The HFA and AS group ($M = 4.53$, S.D. = 1.56) responded with less specific time referrals than the control group ($M = 7.07$, S.D. = 1.49). No differences were found in the self-reference dimension [$F(1,35) = 1.12$, n.s.] or the location dimension [$F(1,35) = 0.05$, n.s.], although the scores of the HFA and AS group were lower in these measurements.

Tests of ANCOVA indicated that the differences between groups remained significant in the total score of the task after covarying for both WAIS-III Heb subscales: similarities [$F(1,34) = 9.48$, $P < 0.01$] and block design [$F(1,34) = 12.14$, $P < 0.01$]. In the time dimension, the significance also remained after covarying for both WAIS-III Heb subscales: similarities [$F(1,34) = 24.46$, $P < 0.001$] and block design [$F(1,34) = 32.53$, $P < 0.001$].

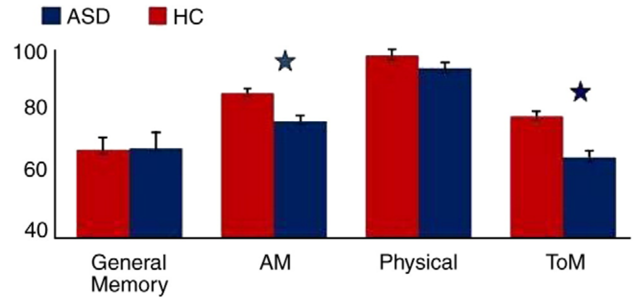

Fig. 1. The figure shows significant differences between groups in the ToM and the AM measures but not in the physical or general memory measure.

3.3. General memory abilities

A univariate ANOVA indicated no significant differences in delayed recall measured by the RAVLT [$F(1, 35) = 0.94$, n.s.].

3.4. The relationship between ToM abilities and AM

A correlation analysis was conducted to examine the relationship between the AM total score, the Strange Stories task and the RMET. A significant correlation was found between the AM total score and the RMET in the HFA and AS group ($r = 0.46$, $P < 0.05$) but not in the HC group ($r = -0.20$, $P = 0.20$) and a significant correlation between the AM total score and the Strange Stories task was evident in the HC group ($r = 0.55$, $P < 0.01$) but not in the HFA and AS group ($r = 0.31$, $P = 0.13$).

In order to investigate whether AM can explain differences in ToM abilities, we performed regression analyses, which indicated that in the HFA and AS group AM can explain 16% of the variance in the RMET task [$F(1,14) = 3.80$, $P = 0.07$], while in the HC group AM can explain 26% of the variance in the strange stories task [$F(1,19) = 8.17$, $P < 0.05$].

In order to investigate other possible factors that could explain the AM–ToM relationship that was found, correlations between ToM tasks, the physical tasks, the WAIS-III subscales, and RAVLT were computed. All correlations failed to reach significance.

4. Discussion

Recently, a common brain network has been proposed to underlie a number of different processes, including AM, prospection, navigation, self-reflection, and ToM (Buckner and Carroll, 2007). Nonetheless, to date, no systematic neuropsychological evidence for this common network has been presented. In a recent case report Rosenbaum et al. (2007) reported that in two individuals who suffered brain injury involving impairments in AM, ToM abilities remained intact. In the present study, we focused on a different population that involves developmental (rather than acquired) difficulties in ToM. We hypothesized that ToM deficits that are associated with a developmental disorder such as HFA and AS could be accounted for by impaired AM. In accordance with this hypothesis, both abilities were impaired in these individuals while they showed intact performance on control tasks. Interestingly, our results indicated that ToM correlated with AM in the HC group only in the Strange Stories task, whereas a positive correlation was found between AM and the RMET in the AS/HFA group. This dissociation in the correlations may point to different mechanisms that underlie the contribution of AM to ToM in HFA and AS, one that involves a visual-dependent mechanism. Based on a theoretical model suggested by Tager-Flusberg (2001), Sabbagh (2004) described two functionally and anatomically distinct neural mechanisms for ToM, the right medial–temporal circuit involved in decoding others' mental states based on immediate information (such as eye expression), and the left medial frontal circuit implicated in complex reasoning about those mental states (such as prediction of the behavior of a character in a story). Based on Sabbagh's hypothesis, it could be speculated that the contribution of AM to ToM in autism is based on the visual decoding mechanisms, whereas HC use their AM when complex reasoning mechanisms are required.

Several limitations of the study need to be acknowledged. First, the small number of participants limits the statistical power of the results. Additionally, the assumption regarding causality should be treated with caution as this study examined only correlations. For example, a different hypothesis may suggest that AM relies on autonoetic consciousness, such that a deficit in this process can account for the deficit in both TOM and AM.

Another concern is the clinical diagnosis of the HFA and AS group which was based on Diagnostic and Statistical Manual of Mental Disorders (DSM) or International Classification of Diseases (ICD) criteria and not by using acceptable methods such as the Autism Diagnostic Interview, Revised (ADI-R) or Autism Diagnostic Observation Schedule (ADOS).

Nevertheless, the finding that in the HFA and AS group a relationship between ToM and AM deficits is evident further indicates that these abilities are interwoven in HFA and AS and may be critical to human social behavior.

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