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Broader Autism Phenotype in Parents of Autistic Children: Reality or Myth?

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Abstract The finding that relatives of individuals with autism show mild autistic traits is referred to as the broader autism phenotype (BAP). In the current study, 25 parents with a child with high-functioning autism and 25 parents with typically developed children were compared on: (1) the Block Design Test, (2) the Autism-Spectrum Quotient (AQ), and (3) a reaction time task to examine reflexive covert visual orienting to social (eyes) and non-social (arrows) cues. The parent groups were scored similar on the Block Design Test and the AQ. However, fathers with an autistic child demonstrated a different reaction time pattern and responded slower on the social cues than control fathers. These results partly support and further elaborate on the BAP in parents with an autistic child.

Keywords Broader autism phenotype · Autism · Parents · Visual orienting · Reaction times

Introduction

Autism is a strongly genetically determined developmental disorder characterized by a triad of problems, namely social impairments, communication impairments, and restricted and stereotyped patterns of behavior, interests, and activities (American Psychological Association, 1994). There exists considerable agreement that autism is not a single gene disorder, yet, it is still unclear how many and which particular genes are involved (e.g., Pickles et al., 1995). A direct method to study the genetic basis of autism is to examine DNA. An indirect and less intrusive method to gain information about the genetics of autism is to examine family patterns of autism and mild autistic traits. Monozygotic twins have shown a concordance rate for mild autistic traits as high as 90%, which is considerably higher than the concordance rate for the full blown autistic syndrome (Bailey, Palferman, Heavey, & Le Couteur, 1998). This suggests a genetic liability to a milder variant of autism. It also implies that rather than being an 'all-or-nothing phenomenon,' autism lies at the extreme of a continuum of autistic traits. It is therefore not surprising that several researchers have looked at autistic traits in parents of autistic children. The expression of mild, non-pathological autistic characteristics among relatives of autistic people is referred to as the broader autism phenotype (BAP).

The BAP cannot be defined as a fixed pattern of specific mild autistic traits. As yet, it is not entirely clear which traits make up the BAP. Most studies have focused on the triad of problems observed in autism. Deviant social behavior has been found in parents of autistic children in that they reported a lower quantity and quality of friendships when compared to parents of children with Down syndrome (Piven et al., 1997; Santangelo & Folstein, 1995). They also appear to have worse social conversational skills and a preference for less social activities and behaviors (Briskman, Happé, & Frith, 2001; Landa et al., 1992). Furthermore, personality of parents of autistic children has been found to be more schizoïd, aloof, untactful, undemonstrative, hypersensitive to criticism, anxious, and rigid (Piven et al., 1994, 1997; Wolff, Narayan, & Moyes, 1988). Findings regarding communication impairments in parents of autistic children have been

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somewhat equivocal. In several studies with a direct assessment of verbal capacities no significant differences between parents of autistic children and parents of children with Down syndrome were obtained (Leboyer, Plumet, Goldblum, Perez-Diaz, & Marchaland, 1995; Plumet, Goldblum, & Leboyer, 1995; Szatmari et al., 1993). Some studies have hinted at the presence of restricted and stereotyped behaviors in parents of autistic children. Obsessive Compulsive Disorder, which can be viewed as an extreme form of restricted and stereotyped behavior, appears to be more common among autism relatives (Bolton, Pickles, Murphy, Rutter, 1998). Executive dysfunction has been put forward as the underlying factor of restricted and stereotyped behavior seen in autistic children and their parents. In line with this hypothesis, parents of autistic children have been found to perform worse than both parents of typically developing children and parents of learning disabled children on tasks assessing executive functions (Hughes, Leboyer, & Bouvard, 1997).

According to Briskman et al. (2001) 'weak central coherence' is also one of the elements of the BAP. Central coherence is 'the everyday tendency to process incoming information in its context—that is, pulling information together for higher-level meaning—often at the expense of memory for detail' (Happé, 1999). Hence, people with a weak central coherence have the tendency to process information in bits and pieces instead of a meaningful whole. Two visuospatial tests where a weak central coherence benefits task performance are the Embedded Figures Test and the Block Design Test. Individuals with autism tend to show a superior performance on the Embedded Figures Test and the Block Design Test when compared to controls (Jolliffe & Baron-Cohen, 1997; Morgan, Mayberry, Durkin, 2003; Shah & Frith, 1993; Van Lang, Bouma, Sytema, Kraijer, & Minderaa, 2005). These findings support the idea that individuals with autism process information more in a detailed, local way instead of a more global way than controls do.

Although some studies did not find parents with an autistic child do better on the Block Design Test (Fombonne, Bolton, Prior, Jordan, & Rutter, 1997; Piven & Palmer, 1997; Happé, Briskman, & Frith, 2001) found fathers with an autistic child to do notably better on the Block Design Test than fathers with dyslexic children or normally developed children. No significant difference was found between the groups of mothers. It is interesting to note that Happé et al. (2001) were not the first to find stronger evidence of the BAP within fathers than mothers. Hughes et al. (1997) for example found fathers with an autistic child to perform worse on a spatial memory task than fathers with typically developed children, whereas groups of mothers performed similarly. Results that point to more pronounced BAP characteristics among fathers than mothers suggest gender may be an important factor in the manifestation of the BAP.

Whereas the Block Design Test emphasizes a positive aspect of individuals with autism as they are assumed to show superior performance on this task, do typical tests for autism usually aim at shortcomings such as social abnormalities. In this line, Baron-Cohen, Wheelwright, Skinner, Martin, and Clubley (2001) developed the Autism-Spectrum Quotient (AQ). This questionnaire evaluates the presence of mild autistic traits in adults with normal intelligence. To test the validity of the AQ, Baron-Cohen et al. (2001) gave the AQ to different groups of people. As would be expected, the group of adults with Asperger's syndrome and high-functioning autism scored significantly higher on the AQ than randomly picked controls. In fact, while 80% of the autism group reached a total score of 32 or higher, only 2% of the controls reached such a high score. Furthermore, among the controls men scored slightly, but significantly higher than women. Also, science students were found to score substantially higher than students in the field of humanities and social sciences.

Although several studies have addressed the BAP, to date no study has been done into gaze perception of parents of autistic children. This is surprising, since deviant gaze perception is one of the first manifesting characteristics of autism (Zwaigenbaum et al., 2005). In a study of Osterling and Dawson (1994), home videotapes of first birthday parties were used to examine spontaneous looking behavior of children who developed normally and children who were later diagnosed with autism. One year old later diagnosed with autism looked substantially less at other people's faces. In fact, failure to direct attention to people's faces was found to be the single best predictor of later diagnosis of autism. Many other studies have reported sort-a-like abnormalities in the spontaneous looking behavior of autistic children, adolescents, and young adults (Klin, Jones, Schultz, Volkmar, & Cohen, 2002; Willemsen-Swinkels, Buitelaar, Weijnen, & Van Engeland, 1998; Yirmiya, Pilowsky, Solomonica-Levi, & Shulman, 1999).

The ability to orient attention to social stimuli and the ability to share attention by looking where someone else is looking, do indeed seem to be linked in young autistic children (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998). However, it is important to keep in mind a correlation between two factors does not automatically imply any causality. Baron-Cohen (1995) is a defender of the theory that gaze perception is causally linked to the development of social understanding. He proposes people have a mindreading system that provides them insight into the mental states of others. Baron-Cohen (1995) claims this system is disrupted in autistic people. The mindreading system consists of several different components among which the Eye Direction Detector (EDD). The EDD detects the presence of eyes in the surrounding and ascertains in which direction they look. According to Baron-Cohen (1995) the EDD is of great importance to comprehend the mental state of someone. Findings from a study by Yirmiya et al. (1999) support the idea that impaired gaze perception is causally linked to impaired social understanding. They were able to discriminate autistic children who failed or passed a Theory of Mind task based on the time they looked at the eyes of the experimenters during the task. Children who looked less at the eyes, failed the Theory of Mind task. Nevertheless, care should be taken before equating deviant gaze perception with deviant social attention. It is also possible that more basal, non-social processes underlie the deviating gaze perception in autistic people. For example, autistic children may experience a general difficulty in the voluntary shift of their attention (Leekham, Hunnisett, & Moore, 1998).

Besides studies into spontaneous looking behavior, there have also been studies that examined more reflexive processes of visual attention in autistic children. By means of a modified version of the Posner cueing task it was tested whether autistic children, just like typically developing children, would show reflexive orienting of visual attention in response to centrally presented non-predictive social (eyes) and non-social (arrows) cues (Chawarska, Klin, & Volkmar, 2003; Kylliänen & Hietanen, 2004; Senju, Tojo, Dairoku, & Hasegawa, 2004). This reflexive orienting of visual attention is reflected by a faster reaction to targets preceded by a cue that correctly pointed to their location. Despite their deviant looking behavior in daily life, autistic children demonstrated to benefit from correct cueing of the target in the same way as control children did. Vlamings, Stauder, van Son, and Mottron (2005) also found that young adults with high-functioning autism, like the control group, showed a congruency effect, that is, they responded significantly faster when cues were directed at the location of the target than when the opposite location was cued. However, unlike the autistic adults, the control adults demonstrated a symmetrical congruency effect in response to the arrow cues, but an asymmetrical congruency effect in response to the eye cues. More specifically, control adults only showed a congruency effect when the eyes looked to the right side of the screen, while autistic adults showed a congruency effect both when the eyes looked to the right and to the left. The same pattern of congruency effects was also found when a subgroup of individuals with PDD-NOS was compared to the control group. Thus, even individuals who only partially met the criteria for a diagnosis of autism differed considerably from the group of controls.

In a study of Jarrold, Butler, Cottington, and Jimenez (2000) normal adults were given a central coherence test (Embedded Figures Test) as well as a Theory of Mind task (Eyes Task). Performances on these tasks were found to be negatively correlated, which means that people who were fast on the central coherence test, tended to do better on the Theory of Mind task. In another experiment Jarrold et al. (2000) tested autistic children and typically developing children on central coherence tests as well as Theory of Mind tasks. After accounting for differences in individual's mental ages, performance on both central coherence tests was significantly correlated with performance on Theory of Mind tasks. Findings from a later study performed by Morgan et al. (2003) argue against this association between central coherence and theory of mind. They found that a measure of joint attention, which presumably requires some degree of theory of mind, and a measure of central coherence (Embedded Figures Test) both reliably discriminated autistic children from typically developing children, but the correlation between both measures failed to reach significance.

The present study is the first to compare parents of autistic children to parents of typically developing children on the Block Design Test, the AQ, as well as a reaction time task that assesses reflexive covert shifts of visual attention in response to social and non-social cues. During the reaction time task automatic responses are evoked, this strongly reduces the chance of conscious manipulation of the results by the participant. Another advantage of the reaction time task is its high sensitivity. It is hypothesized that, in comparison to control parents, parents with a child with an autism spectrum disorder will show results that more closely correspond to an autistic profile. More specifically, it is expected that parents with an autistic child (1) perform better on the Block Design Test, (2) score higher (more autistic) on the AQ, and (3) show a stronger symmetry in their congruency effect in response to eye cues as compared to control parents. Furthermore, results from fathers and mothers will also be considered separately, since it is hypothesized that differences between both parent groups are more apparent among fathers than mothers.

Methods

Participants

Parents with a 6–16–year-old child with an autism spectrum disorder were addressed through the 'Instituut voor Orthopedagogisch Onderwijs' in Maastricht, a special school for children with an autism spectrum disorder. Fifty-four parents returned an application form to the University of Maastricht. As a result of this high response, it was not deemed necessary to test all parents. Because of practical reasons two-parent-families were favored above single-parent-families. Also, parents were less likely to be selected when they lived in areas that were difficult to reach by public transport. Ultimately, 20 mothers and 19 fathers were tested. For the control group two selection criteria were formulated. Only parents were included who (1) had no first or second degree family members with an autism spectrum disorder and (2) who had at least one normally developed child between the age of 6–16. Control parents were recruited in various ways. Some were contacted through Sint Oda, a regular primary school in Maastricht. Other control parents heard of the study via mouth-to-mouth advertisement by other participants or the experimenter. Twenty-nine control parents were tested, of which 15 mothers and 14 fathers.

A first analysis revealed that parents with an autistic child were significantly younger and lower educated than control parents. This obviously was problematic, since the Block Design Test is part of a standard IQ-test and intelligence is known to correlate with educational level. To remove the substantial difference between the groups of parents both groups were slimmed down to 25, each group consisting of 12 mothers and 13 fathers. Parents were excluded from further analysis based on age and educational level while keeping blind for task performances. The slimming down resulted in a mean age of 41 and 5 years for parents with an autistic child (SD 4 and 6 years) and 43 and 2 years for control parents (SD 5 and 3 years). Mean educational level for both groups was 5 from a possible range of 1 (primary school) to 8 (university—old style).

The group of children with an autism spectrum disorder whose parents belonged to the final selected group, consisted of 13 boys and 3 girls. Eight were diagnosed with autism, the others had received a diagnosis of syndrome of Asperger (2) or PDD-NOS (6). All children had been diagnosed according to DSM IV-criteria. Furthermore, because the IVOO only accepts children with an IQ above 70, this was a guarantee all children were of normal intelligence. The mean age of the children was 9 and 5 years, with the youngest child being 6 and 1 years and the oldest 14 and 4 years (SD 2 and 7 years).

Control children were without any serious medical or mental problems with the exception of one boy with cystic fibrosis. As cystic fibrosis is a physical disability with no relation with autism or level of intelligence, there was no reason to exclude the parents.

Tasks

The Block Design Test from the Dutch WAIS-III was used as an indicator of weak central coherence. The Block Design Test is a visuospatial test where one has to organize white and red cubes so that they make up a particular pattern. Time to make each pattern was measured and translated into a score ranging from 0 to 7. When all scores were added up, they produced a total score on the Block Design Test (Wechsler, 2004).

The AQ consists of 50 items that jointly cover five different domains wherein individuals with autism show deviations, namely social skills, attention switching, attention for detail, communication skills, and imagination. The AQ was translated into Dutch by someone who was master of the English language at a professional level. Items could be answered in the following matter: definitely agree, slightly agree, slightly disagree, or definitely disagree. Each item was scored on a range of 1–4. When scores of all 50 items were added up, a total AQ score was obtained. To receive a maximal score according to the autistic profile, half of the items had to be answered in a definitely positive way, while the other half had to be answered in a definitely negative way.

The computer task used in this study is identical to the detection task used by Vlamings et al. (2005). The detection task can be subdivided into two different tasks: a task where the cues are eyes (from now on referred to as eye task) and a task where the cues are arrows (from now on referred to as arrow task). Each trial on the eye task started with a 500 ms central presentation of a female face with eyes looking straight ahead (or in case of the arrow task: arrows pointing to both sides), followed by a presentation where the eyes would look to the right or left side for 400 ms (arrows point to the right or left). Then the (non-)target would appear on the left or right side of the screen and simultaneously the cue at the center of the screen would disappear. The task contained trials where the eyes (or arrows) cued the side where the target would appear (congruent trials) and as many trials where the eyes (or arrows) cued the opposite side (incongruent trials). Whether the participant pressed the button or not, the next trial always began after 1,500 ms. After a practice session of 16 trials the actual task began, which consisted of two blocks of 60 trials, split by one break after the first block. Chance of an 'A' appearing ('press the button') was twice as likely as an 'X' appearing ('do not press the button'). A Dell Latitude D600 with a 14-in. screen was used to run the task. Experimental Run Time System software was used to obtain reliable reaction times in milliseconds (Version 3.18, Beringer, 1996).

Procedure

For the assessment parents were visited in their homes. Due to practical restrictions it was not possible to keep the experimenter blind for group membership of the parents. Total time to test two parents was ~75 min. To control for task order, one half of the participants started with the reaction time task, either the eye task or the arrow task, followed by the Block Design Test, the remaining reaction time task and the AQ. The other half of the participants received the tasks in a reversed order. Men and women were equally assigned to each group.

The computer task was explained to the participant. The participant was instructed to press a designated button with his/her dominant hand as quickly as possible whenever an ‘A’ appeared and to refrain from pushing the button whenever an ‘X’ appeared. Furthermore, participants were informed that the direction of the eyes or arrows was non-predictive with regard to the location of the letter. Finally, it was emphasized to keep looking at the center of the screen during the whole task. During a practice session this was checked. In case of obvious eye shifts the participant was again reminded to keep focusing at the center of the screen.

After their performances parents were shortly debriefed about the expectations of the study. When all results of the study were analyzed, parents were sent a letter about the general findings of the study.

Data Analysis

With the help of independent samples *t*-tests group means on the AQ and Block Design Test were compared. The two groups of parents were compared by taking results from fathers and mothers together, as well as by contrasting the results of fathers and mothers separately. Also, the results of fathers and mothers were put side-by-side (regardless of group membership). As for the reaction time task: for each participant the average number of errors was ascertained on congruent as well as incongruent trials and in the eye task as well as in the arrow task. Reaction times on trials where parents correctly pressed the button were analyzed with the help of a four-way analysis of variance (ANOVA) with group (parents with an autistic child versus control parents) as between subject factor and repeated measures for task (eye task versus arrow task), cue direction (left versus right), and congruency (congruent versus incongruent). Separate ANOVA’s were run for fathers and mothers. Finally, correlations were calculated between the three chosen measures of the BAP, that is, between performance on the Block Design Test, AQ score and degree of asymmetry in the reflexive orienting response to eye cues.

Results

Block Design Test and AQ

It was hypothesized that parents with an autistic child would do better on the Block Design Test than control parents. An independent samples *t*-test did not support this hypothesis ($\alpha = 0.05$, two-sided). Also, it was hypothesized parents with an autistic child would score higher on the AQ than control parents. Again, no substantial differences were found between both groups of parents (see Table 1 for mean scores). When results from fathers and mothers were examined separately, a significant difference was found on the AQ component ‘attention to detail,’ where control mothers scored significantly higher than mothers with an autistic child [$t(22) = -2.214$ and $p = 0.037$].

Table 1 Results of fathers and mothers on the Block Design Test and the AQ

Group	Block Design Test		AQ	
	M	SD	M	SD
Fathers with autistic child	46.5	14.0	102.6	23.3
Control fathers	49.3	14.4	96.1	18.4
Mothers with autistic child	41.7	12.8	90.0	13.9
Control mothers	40.3	10.6	100.8	14.8

When independent samples *t*-tests compared AQ scores and Block Design Test performances of fathers with those of mothers, there was a trend for fathers to do better on the Block Design Test than mothers [$t(48) = 1.905$ and $p = 0.063$]. Also, a significant difference was found on the component ‘communication’ of the AQ: fathers had a higher score, hence responded more autistic than mothers [$t(48) = 2.323$ and $p = 0.024$).

Reaction Time Task

Because many parents made no or only a single error, results with regard to number of errors will not be further discussed. Examination of reaction times first revealed that parents were significantly faster on the arrow task as compared to the eye task (for results of the four-way ANOVA see Table 2). The mean reaction time on the arrow task was 24 ms faster than on the eye task. Second, a congruency effect was found, that is, parents were substantially faster on congruent trials as compared to incongruent trials. Reaction times on congruent trials were overall 12 ms faster than reaction times on incongruent trials. Furthermore, there was a trend for mothers to show a bigger congruency effect when the left side of the screen was cued. Paired samples-*t*-tests showed this trend was produced by the mothers with an autistic child. Finally, a task × cue direction × congruency × group effect was discovered within the group of fathers.

Separate ANOVA’s for parents with an autistic child and control parents revealed a significant task × cue direction × congruency effect within fathers and mothers with an autistic child [fathers: $F(1, 12) = 5.71$ and $p = 0.034$; mothers: $F(1, 11) = 6.94$ and $p = 0.023$].

Table 2 Results of four-way analysis of variance of reaction times

Effect	Fathers (n = 26)			Mothers (n = 24)		
	F	*df*	*p*	F	*df*	*p*
Task	34.11	24	0.000***	10.58	22	0.004***
Task × group	1.86	24	0.19	0.72	22	0.41
Cue direction	0.19	24	0.67	0.11	22	0.75
Cue direction × group	0.00	24	0.98	0.16	22	0.69
Congruency	19.00	24	0.000***	32.57	22	0.000***
Congruency × group	1.15	24	0.71	0.52	22	0.48
Task × cue direction	0.78	24	0.39	0.00	22	0.99
Task × cue direction × group	0.13	24	0.91	0.07	22	0.80
Task × congruency	1.98	24	0.17	0.42	22	0.52
Task × congruency × group	0.04	24	0.84	0.32	22	0.58
Cue direction × congruency	2.62	24	0.12	3.36	22	0.08
Cue direction × congruency × group	0.02	24	0.89	0.01	22	0.91
Task × cue direction × congruency	0.70	24	0.41	0.68	22	0.42
Task × cue direction × congruency × group	5.25	24	0.03*	1.81	22	0.19

* $p < .05$ and *** $p < .005$

With group (parents with an autistic child versus control parents) as between subject factor and repeated measures for task (eye task versus arrow task), cue direction (left versus right), and congruency (congruent versus incongruent)

Hence, parents with an autistic child showed a significantly differential reaction time pattern on the eye task and the arrow task (see also Figs. 1, 2). Paired samples t-tests revealed a considerable congruency effect on the eye task when the left side was cued for fathers as well as mothers with an autistic child [fathers: $t(12) = -3.583$ and $p = 0.004$; mothers: $t(11) = -4.775$ and $p = 0.001$]. For both fathers and mothers of this group, congruency effects

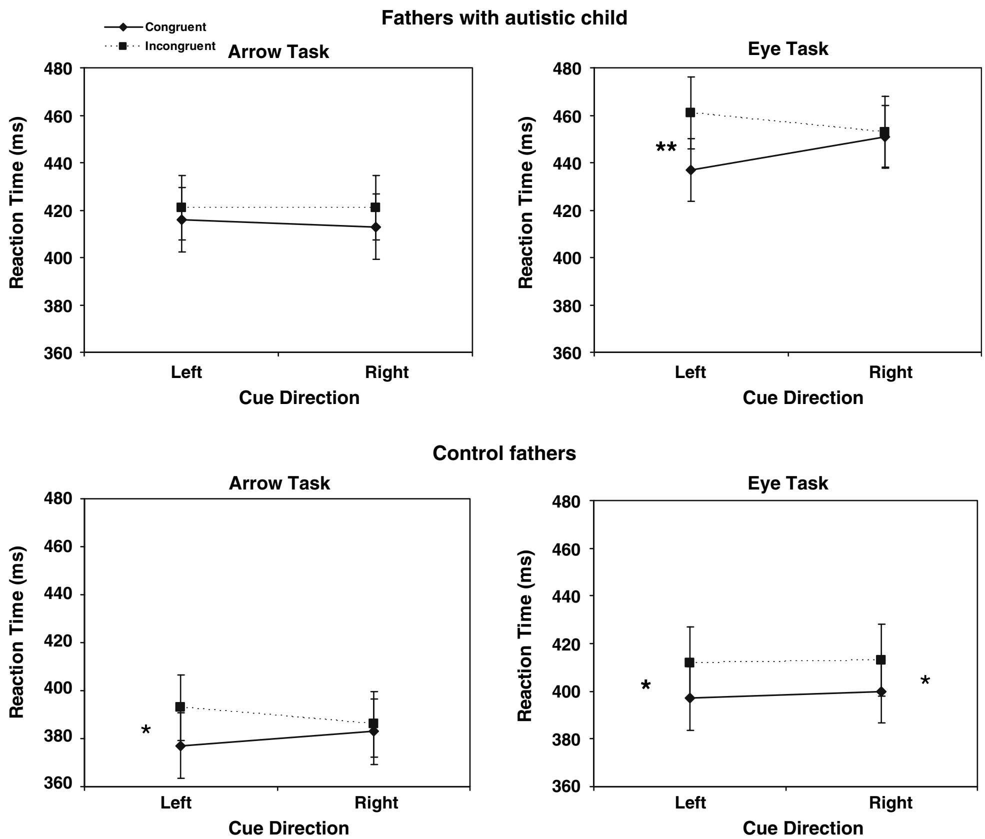

Fig. 1 Reaction times and standard errors on the eye and arrow task for fathers (*$p < 0.05$; **$p < 0.01$)

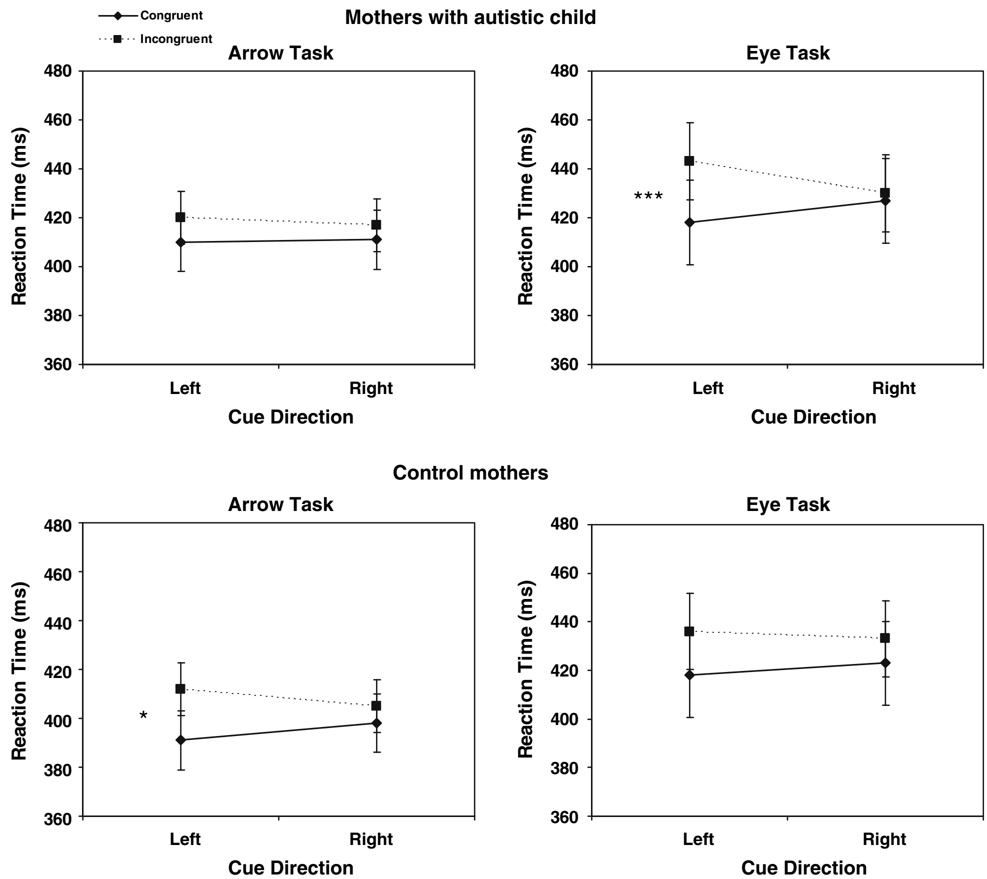

Fig. 2 Reaction times and standard errors on the eye and arrow task for mothers (* $p < 0.05$; *** $p < 0.001$)

on the arrow task were not significant. Within the group of control parents, fathers showed a significant congruency effect at the eye task when the left or right side was cued [left: $t(12) = -2.250$ and $p = 0.044$; right: $t(12) = -2.335$ and $p = 0.045$] and at the arrow task when the left side was cued [$t(12) = -2.616$ and $p = 0.023$]. Control mothers showed a nearby significant congruency effect in response to eyes cueing the left side of the screen [$t(11) = -2.077$ and $p = 0.062$] and a significant congruency effect in response to arrows cueing the left side [$t(11) = -2.584$ and $p = 0.025$].

Furthermore, mean reaction times of control parents were faster than those of parents with an autistic child. Independent *t*-tests revealed this speed difference was only produced by a substantial speed difference within the group of fathers (see also Fig. 3). Mean reaction time, that is reaction time averaged over task, cue direction and congruency, was 434 ms for fathers with a child with an autism spectrum disorder and 395 ms for control fathers. This difference in mean reaction time proved to be significant [$t(24) = 2.094$ and $p = 0.047$]. Control fathers reacted significantly faster than fathers with an autistic child on congruent trials [$t(24) = 2.216$ and $p = 0.036$] and the eye task [$t(24) = 2.278$ and $p = 0.032$]. Control fathers also tended to be faster on invalid trials [$t(24) = 1.949$ and

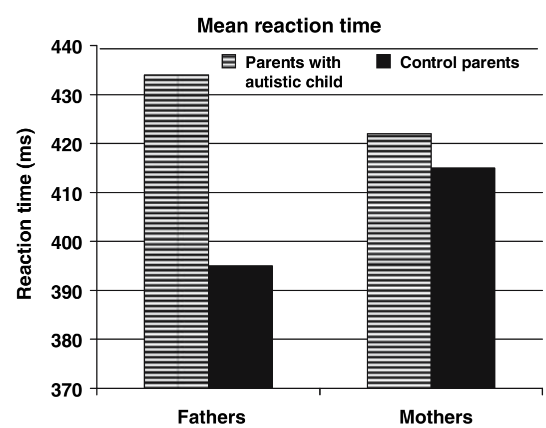

Fig. 3 Mean reaction time for fathers and mothers of both parent groups

$p = 0.063$] and the arrow task [$t(24) = 1.773$ and $p = 0.089$].

Finally, correlations were calculated between all measures for the group as a whole and also for both parent groups separately. Neither in the group of parents with an autistic child nor in the group of control parents the AQ and Block Design Test were significantly correlated. Within the group of parents with an autistic child a significant positive correlation was observed between educational level of the parent and performance on the Block Design Test ($r = 0.47$ and $p = 0.02$). Also, a negative correlation was found between a variable termed 'difference eye left time' and scores on the Block Design Test and the AQ (respectively, $r = -0.40$ and $p = 0.05$; $r = -0.46$ and $p = 0.02$). 'Difference eye left time' refers to the time difference between congruent and incongruent trials (time incongruent minus time congruent trials) on those trials where eyes cued the left side of the screen. Within the group of control parents a significant negative correlation was noted between educational level of the parent and mean reaction time ($r = -0.47$ and $p = 0.019$). For a graphical depiction of the significant correlations see Figs. 4–7.

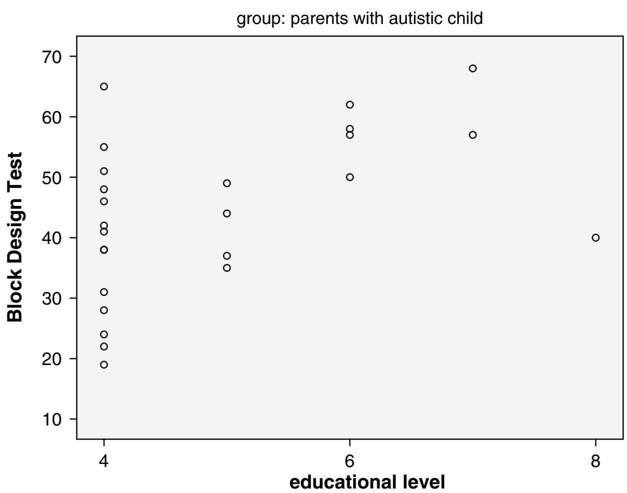

Fig. 4 Scores on the Block Design Test and educational level of each parent

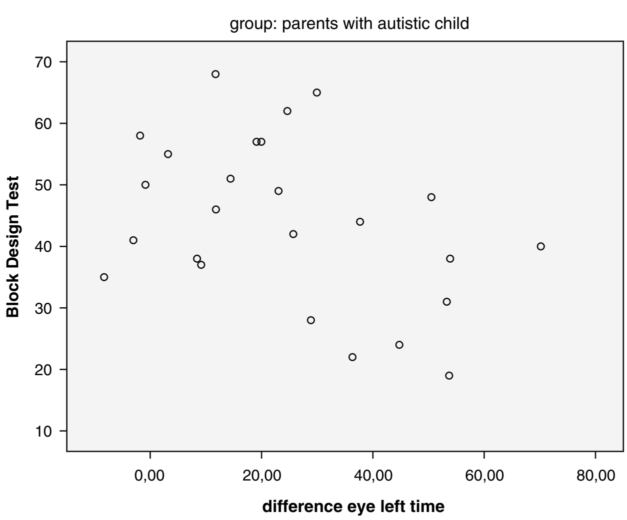

Fig. 5 Scores on the Block Design Test and 'difference eye left time' of each parent

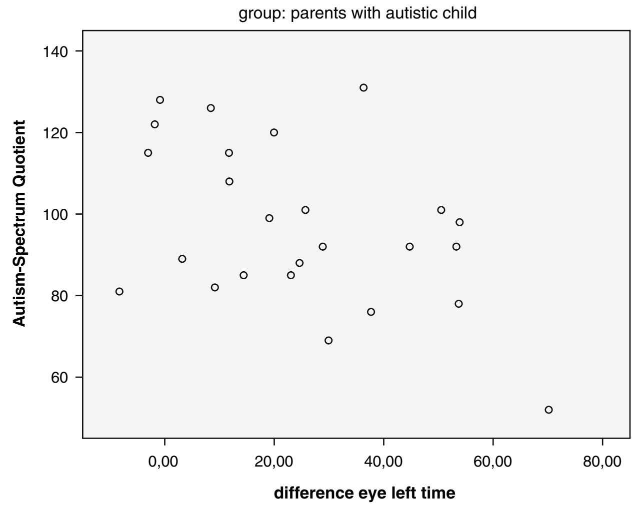

Fig. 6 Scores on the Autism-Spectrum Quotient and 'difference eye left time' of each parent

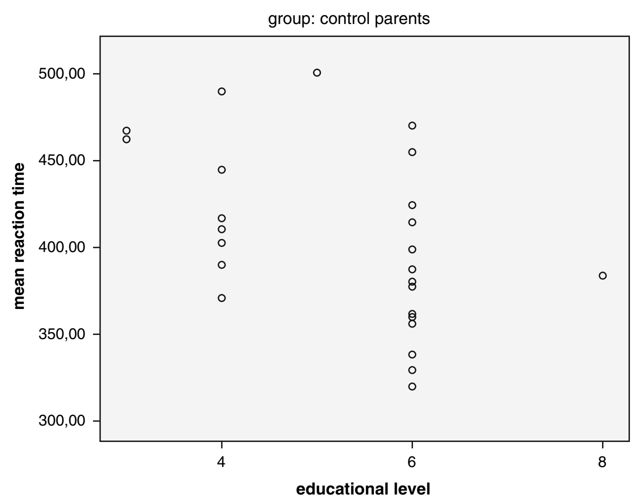

Fig. 7 Mean reaction time and educational level of each parent

Discussion

The present study compared parents with autistic children and parents with typically developed children on the Block Design Test, the AQ as well as a reaction time task that assessed covert shifts of attention in response to social and non-social cues. The performances on the Block Design Test and the AQ were largely the same for parents with an autistic child and control parents. As for the reaction time task, fathers with an autistic child demonstrated a significantly different reaction time pattern than control fathers. Furthermore, it was found that fathers with an autistic child responded significantly slower on the reaction time task than control fathers.

Results on the Block Design Test showed no significant difference in performance, neither when groups were compared as a whole nor when fathers and mothers were compared separately. Earlier studies found the same results (Fombonne et al., 1997; Piven & Palmer, 1997). One could therefore say that the Block Design Test is not sensitive enough to detect subtle differences in central coherence. Nevertheless, Happé et al. (2001) found fathers of a child with an autism spectrum disorder to perform substantially better on the Block Design Test than fathers of a dyslexic child or a normally developed child. The sensitivity of this test is also shown in the present study, since there was a nearby significant trend for fathers to do better on the Block Design Test than mothers.

A similar pattern of results was found on the AQ. Parents of autistic children did not ascribe more autistic traits to themselves than parents of typically developed children did. This is in obvious contradiction with the hypothesis and also challenges the idea of the BAP in parents of autistic children. Again, one could argue that the instrument used is simply not sensitive enough to detect subtle differences in autistic traits within the normal population. Yet, the AQ was designed to do just that. Besides, when AQ scores of fathers and mothers were contrasted, fathers generally scored higher on the AQ than mothers and this difference was significant with regard to the AQ component 'communication.' Hence, fathers judged themselves less willing and/or less able to communicate than mothers did. Earlier studies detected even more gender differences within a group of normal adults, where total AQ score and scores on several AQ components were significantly higher for men (Austin, 2005; Baron-Cohen et al., 2001). This suggests that the AQ is in fact sensitive enough to detect subtle differences in autistic traits within the normal population. However, it is important to keep in mind the AQ is subjected to the usual limitations of a paper–pencil-task. Hence, it could be that parents gave social desirable answers rather than answers that most closely resembled their personal beliefs and capabilities. It could be that parents with an autistic child felt the need to present themselves as non-autistic. This may have hidden a true difference in autistic characteristics between the groups. One possible way to overcome this problem in the future, is not to rely on self-reports alone, but also to include a version of the AQ where parents have to rate their spouse.

When AQ scores were considered for fathers and mothers separately, control mothers were found to score significantly higher on the component 'attention to detail' than mothers with an autistic child. Hence, contrary to expectancy, control mothers judged themselves more attentive to details than mothers of an autistic child. A possible explanation is that a high score on 'attention to detail' is not regarded as a shortcoming by control mothers, whereas high scores on all the other AQ components such as social skills are. On the other hand, mothers with an autistic child may very well recognize the trait 'attention to detail' as an autistic trait and therefore may be more reluctant to say they pay much attention to details. This could lead to the result of control mothers scoring higher on the AQ component 'attention to detail,' while in reality there is no such difference.

Results on the reaction time task showed several significant effects. First of all, a task effect was noticed. Parents were found to be considerably faster on the arrow task when compared to the eye task. This difference in reaction time can be explained by the fact that the face in the eye task was a far more complex cue than the arrows presented in the arrow task, consequently, it took participants more time to process the information presented on screen. Second, a significant congruency effect was found, that is, parents responded generally faster on congruent trials when compared to incongruent trials. Hence, the task manipulation was successful. It should be noted though that not all parents showed an effect of congruency. This suggests some parents were able to actively ignore the information of the centrally presented cue, while still keeping their focus in the center of the screen. Furthermore, within the group of mothers a trend was observed to show a bigger congruency effect when the left side of the screen was cued than when the right side was cued. This trend was mainly produced by performances on the eye task by mothers with an autistic child. For now, it remains unclear why mothers tended to show a bigger congruency effect when the left side was cued. Finally, a four-way interaction was found between task, cue direction, congruency, and group within the group of fathers. In contrast to control fathers, fathers with an autistic child demonstrated a notably different pattern of reaction times on the eye task when compared to the arrow task. Fathers with an autistic child were found to be significantly faster on congruent than incongruent trials when eyes looked to the left side of the screen, but failed to show a significant congruency effect when eyes looked to the right. The same was true for mothers with an autistic child. As for the arrow task, no substantial congruency effects were noticed. Hence, the congruency effect for eyes looking to the left side may be a special characteristic of parents with an autistic child.

It is interesting to note that the pattern of reaction times on the eye task shown by fathers as well as mothers with an autistic child is exactly the opposite of what was shown by the young control adults in the study of Vlamings et al. (2005), namely, these controls only showed a significant congruency effect when eyes looked to the right. When control fathers and mothers in the current study were compared with the controls in the study of Vlamings et al. (2005) it became clear that they demonstrated a different pattern of reaction times. Control fathers had a symmetrical congruency effect on the eye task and mothers did not show a significant effect of congruency on either side of the eye task. Furthermore, control fathers and mothers only showed a significant congruency effect on trials where arrows were directed to the left side of the screen. A possible explanation for the incompatibility between these results and the results from Vlamings et al. (2005) is the substantial age difference between the participants from both studies. Controls in the study of Vlamings et al. (2005) were substantially younger than controls in the current study. Hence, it could be that people in their twenties respond differently than people in their forties on the reaction time tests used. Although no evidence was found for the younger parents to show a pattern of reactions more closely corresponding to the pattern of controls in the study of Vlamings et al. (2005), age should not be discarded as an explanation for the conflicting results, since these 'young control parents' were still older than the controls used in the Vlamings et al. study (2005).

When mean reaction times were examined, it became clear control fathers were considerably faster than fathers with an autistic child. Between groups of mothers no difference in overall speed was found. This offers support to the hypothesis that fathers with an autistic child demonstrate more pronounced BAP characteristics than mothers do. A slower reaction time for fathers with an autistic child seems in line with earlier research where individuals with autism were found to be significantly slower on reaction time tasks than controls (Harris, Courchesne, Townsend, Carper, & Lord, 1999; Senju et al., 2004; Wainwright-Sharp & Bryson, 1993). A developmental delay has been put forward as an explanation for the slower reaction time of autistic children. Yet, this explanation is obviously not relevant for fathers with an autistic child. Harris et al. (1999) compared autistic and control children on an exogenous reaction time task where cues consisted of squares that lit up on the left or right side of the screen. In their study no significant associations were found between IQ or age and time to respond to congruent cues. Hence, the slower reaction time that was found for the autistic children could not be attributed to any differences in IQ or age between both groups of children. A slowed reaction therefore seems to be a true characteristic of autism rather than a mere by-product of a delayed development.

A slowed reaction time could be the result of a slowed motor response. Yet, a slowed motor response does not seem to be a sufficient explanation for two different reasons. First, Landry and Bryson (2004) found autistic children to react considerably slower than typically developing children and children with Down syndrome on a reaction time task where eye movements were recorded and no button press was required. Hence, the slower reaction times of autistic children seem at least partly due to a slowed attention process. Second, when reaction times on the eye task and the arrow task were analyzed separately, the speed difference between the groups of fathers only remained significant on the eye task. If a slowed motor response had been the only reason of the slower reaction time of fathers with an autistic child, one would expect to find this slowing on the eye task as well as the arrow task. The fact that the difference in reaction time between both groups of fathers was particularly evident when results on the eye task were considered, possibly indicates that fathers with an autistic child experience specific problems with the processing of eyes. An eye-specific problem in fathers with an autistic child could be linked up with the abundant earlier findings of deviant gaze perception in individuals with autism (e.g., Klin et al., 2002; Zwaigenbaum et al., 2005).

A slowed attentional orienting may also play a considerable part in the slower reaction times of fathers with an autistic child. There are several attention processes that could be disturbed, namely, the disengagement, the shift, and/or the engagement of attention. Congruent trials are said to involve only the engagement of attention, whereas incongruent trials involve all three processes (Posner, Walker, Friedrich, & Rafal, 1984). In the present study fathers of an autistic child were found to be substantially slower on congruent trials than control fathers, that is, they were slower on trials where only the engagement of attention is needed. Thus, fathers of a child with autism spectrum disorder seem to engage attention differently than fathers of typically developing children. It may therefore be that fathers of an autistic child have a narrower focus of attention. Clearly, it is more difficult to spot a target letter outside of the direct focus of attention when this focus of attention is already quite narrow. Some studies have suggested autism is characterized by a narrow focus of attention (Rincover & Ducharme, 1986).

Besides a slowed motor response and a slowed attentional orienting, there is still another possible explanation for the slower reaction times of fathers with an autistic child. Despite a clear emphasis on speed in the task instructions, it could be that fathers with an autistic child made a trade-off for acuity rather than speed. In other words, it could be that fathers of an autistic child simply chose a different, more cautious strategy than control fathers. This strategy seems to be compatible with the inflexible behavior observed in autism. When average number of errors was compared, it was indeed found that fathers of a child with an autism spectrum disorder made fewer errors than control fathers, but this difference was not significant.

The reaction time task, the AQ and the Block Design Test were all selected as potential measures of the BAP. Even though results from the AQ and the Block Design

Test did not reveal significant differences between both parent groups, it was still interesting to see whether performances on these different measures would correlate. Jarrold et al. (2000) found a significant association between performance on theory of mind tasks and central coherence tasks within normal adults, whereas Morgan et al. (2003) did not discover significant associations between central coherence tasks and measures of joint attention and pretend play in a group of autistic children and a group of control children. In this study, no significant correlation was found between AQ score and performance on the Block Design Test, neither when results from both parent groups were taken together, nor when results were examined for each group apart. Hence, parents who judged themselves as having relatively many autistic traits, did not do better on the Block Design Test than parents who judged themselves as having few autistic traits. This finding appears to offer some support to the conclusion of Morgan et al. (2003), namely, that theory of mind skills and central coherence rely on independent mechanisms.

Within the group of parents with an autistic child, a higher score on the Block Design Test or the AQ tended to coincide with a smaller congruency effect on the eye task when the left side was cued. Hence, when parents performed more conform an autistic profile on the Block Design Test or the AQ, they showed a relatively small congruency effect on trials where eyes cued the left side of the screen. The latter congruency effect proved to be missing in the group of controls in the study of Vlamings et al. (2005). One could therefore argue that a missing or very small congruency effect on the eye task when the left side is cued is a sign of a non-autistic profile. Hence, the finding that this small congruency effect tended to co-occur with a high score on the Block Design Test score and the AQ score in the group of parents with an autistic child seems somewhat contradictory. Within the group of control parents a negative correlation was observed between educational level and mean reaction time, thus, parents who were higher educated tended to be faster on the reaction time task. A negative correlation between educational level and speed on reaction time tasks has often been found (Bates & Stough, 1997; Deary, Der, & Ford, 2001). No other meaningful correlations were detected within the group of control parents.

When results of the current study are accumulated, two of the three potential measures of the BAP, the AQ, and the Block Design Test, did not demonstrate a significant difference between parents of autistic children and parents of typically developed children. One could thus infer that the BAP in parents with an autistic child is just a myth. This myth may have kept itself alive owing to research expectancies and an overemphasis on significant findings in scientific publications. An alternative conclusion is that the BAP in parents with autistic children does exist, yet it is such a subtle phenomenon that standard measures such as the Block Design Test may not be sensitive enough to demonstrate this. In the present study a reaction time task was used to examine reflexive orienting of visual attention in response to social (gaze direction) and non-social cues (arrows). Only the reaction time task revealed differences between both parent groups. First, fathers with an autistic child showed a different reaction time pattern than control fathers, suggesting a difference in gaze processing. Second, fathers with an autistic child were overall slower on the reaction time task as compared the control fathers, particularly on the eye task. This finding fits earlier reports of atypical gaze perception and slower reaction times in individuals with autism. To our knowledge gaze perception has not been studied before in research addressing BAP.

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