Curr Psychol
DOI 10.1007/s12144-016-9476-5

Reflexive Social Orienting in Parents of Children with Autism Spectrum Disorders: Evidence from Gaze Cueing Paradigm

Maryam Tajmirriyahi[1] · **Vahid Nejati**[1] · **Hamidreza Pouretemad**[1]

Abstract Twin and family studies have shown that Autism Spectrum Disorders (ASD) have a strong genetic basis and are highly heritable. First degree relatives of individuals with ASD often show mild expressions of autistic traits attributed to Broad Autism Phenotype (BAP). While numerous studies investigated different aspects of BAP, less research has been done on gaze orienting especially in parents. In the present investigation, 43 parents of children with ASD and 29 parents of typically developed children completed a modified version of gaze cueing paradigm. Results demonstrated that the control group used the eye gaze in a way that their RT was affected by congruent versus incongruent cues, while this effect was not observed in parents of individuals with ASD. Findings of the current study provide further evidence on gaze orienting deficits in parents of children with ASD, which might relate to their mild difficulties in mind-reading abilities and a common cognitive phenotype with their affected children.

Keywords Autism spectrum disorders · Gaze orienting · Gaze cueing paradigm

Difficulties with gaze orienting and unusual patterns of eye contact in social communications could be among the earliest signs of Autism Spectrum Disorders (ASD) (e.g. Baron-Cohen et al. 1995; Dawson et al. 1998) and might be related to observed deficits in social interactions (Elsabbagh et al. 2009). In his seminal paper, Leo Kanner (1943) emphasized social deficits and lack of sensitivity to social stimuli as two core characteristics of ASD. Since then, every clinical description of this population has considered deficits in social response and social behavior primary to this disorder.

ASD is diagnosed in males 4 times more than females and is highly genetic (Ronald and Hoekstra 2011). Twin studies commencing in 1977 by Folstein and Rutter with proceeding studies provide evidence on genetic components of ASD (Folstein and Rutter 1977; Ronald and Hoekstra 2011). Other studies estimated that as much as 90 % of variance in the etiology of ASD is genetic (Bailey et al. 1998). Later behavioral genetic studies of ASD have shown that liability to its phenotype may be broader than its clinical picture of the syndrome. Studies comparing parents and siblings of children with ASD with control indicated that autistic traits manifest themselves in milder forms in first degree relatives as mild phenotype variants of the disorder. Besides, these relatives are at higher risk of social and communicative difficulties (Bailey et al. 1998; Yirmiya and Shaked 2005). Broad Autism Phenotype (BAP) is consistently used to refer to a group of sub-threshold autistic traits within three domains of ASD: social, communicative, and restricted interests and behaviors which are frequently found in first degree relatives of children with ASD (Sucksmith et al. 2011). These subclinical differences in social skills and traits, communication abilities, and personality traits are generally considered to constitute BAP.

Several electrophysiological and neuroimaging studies with individuals with ASD have shown atypicality in gaze processing. For example, Grice et al. (2005) observed larger occipitoparietal negativity in children with ASD in passive viewing of faces with direct gaze than averted gaze. This pattern was not observed in typically developing children of the same age. In another study, Senju et al. (2005) showed a bilaterally distributed response in children with ASD when viewing direct versus averted gaze targets. However, this

✉ Vahid Nejati
nejati@sbu.ac.ir

[1] Department of Education and Psychology, Shahid Beheshti University, Tehran, Iran

Published online: 16 July 2016

response was stronger and predominantly right lateralized for typically developing children. Other functional magnetic resonance imaging (fMRI) studies revealed different brain activation patterns in children with ASD in contrast with typically developing children in tasks of gaze and face processing (Pelphrey et al. 2005; Dalton et al. 2005). Landry and Parker (2013) focused on behavioral studies that assessed visual orienting in ASD using Posner-type tasks. They found that visual orienting impairments were reported inconsistently in ASD. Based on their findings, participants with ASD showed more deficits on arrow cue tasks, and less deficits on eye gaze cue tasks. This observed impairment increased with age. Based on genetic theory of ASD, the same patterns of deficits might be observed in pattern too.

Although, the subject of visual orienting in ASD has been a matter of concern in recent years, studies in the domain of gaze orienting in relatives are scarce. Also, atypicality in gaze processing and gaze orienting as an important aspect of BAP had been neglected so far. Some evidence, not comprehensive enough, showed milder but comparable problems of parents in gaze processing and gaze orienting. Wallace et al. (2010) reported significant differences between relatives of individuals with ASD and control in a directional judgment task. In their study, participants had to judge the direction of social (eye gaze) and non-social (arrows) cues which were presented on a screen for a very short time (100 msec). These researchers reported that while control group had accuracy advantage in detecting direct compared with averted eye gaze, relatives of children with ASD were less sensitive to direct eye gaze. Scheeren and Stauder (2008) reported that fathers of children with ASD responded slower than control fathers to social cues in a similar directional judgment paradigm. In another study, Chen and Yoon (2011) provided evidence on the relationship between scores on Autism-Spectrum Quotient (AQ) scale and spontaneous reciprocation of direct gaze. Individuals who scored lower in AQ, showed greater tendency to look at direct versus averted gaze.

On the other hand, there could be a relationship between gaze orienting and theory of mind. Baron-Cohen (1995) suggested that gaze perception is usually linked to the development of social understanding. An innate "eye direction detector" (EDD) enables people to detect another person's eyes and their direction (Baron-Cohen 1995). Based on this theory, EDD, which plays an important role in the ability to understand the mental states of others, is disrupted in individuals with ASD. Also, gaze processing which might relate to initiating and responding to joint attention bids in early years of life is one of the prerequisites of theory of mind development (Baron-Cohen 2000; Sodian and Thoermer 2008). Yirmiya et al. (1999) found strong evidence for the relationship between impaired gaze perception and impaired social understanding which can be found in individuals with ASD. Also, atypical eye contact in ASD is widely thought to contribute to socio-communicative deficits like impaired recognition of emotions and intentions in ASD (Itier and Batty 2009).

If impairment in gaze orienting is a potential feature of ASD, then a similar pattern, albeit of lesser degree, might be observed in parents. The focus of this study was to compare gaze orienting in parents of children with ASD with control using a modified version of Posner's gaze cueing paradigm. In this investigation, parents of children with ASD were compared with control in gaze cueing paradigm to investigate the hypothesis that they might experience difficulties in gaze orienting. Broadening our knowledge on yet undiscovered domains of BAP will improve our understanding of the genetic etiology of ASD.

Method

Participants

A quasi-experimental design was used in this study with one experimental group (43 parents of children with ASD (nine males, 34 females) and one control group (29 parents of typically developed children; seven males, 22 females).

In ASD group, all parents had at least one child with autism or Asperger's syndrome (only one of the mothers had two affected sons). Children varied in symptom severity, but all met current DSM-IV (American Psychiatric Association 2000) (this research has been conducted before releasing DSM-5) criteria for autism or Asperger's syndrome and had received a clinical diagnosis of ASD. Parents were recruited from *Autism Children Charity Foundation* (see http://www.autismcharity.ir/en/). We used the age cut-off for ≥ 50 years considering the fact that effects of typical aging on cognitive abilities are controversial (Moran et al. 2012). The children ranged in age (mean: 8.14, SD: 2.89). As shown in Table 1, mothers compromised the main part of the sample because fathers were either unavailable or reluctant to participate.

The control group comprised of 29 parents with typically developed children. The criteria for choosing typically developed children were lack of psychiatric background or clinical

Table 1 Sample characteristics

	ASD (*M*, SD)	Normal (*M*, SD)
N	43	29
gender(M:F)	34:9	29:7
Parent Age	37.16 (7.83)	34.50 (3.06)
Education	13.30 (2.65)	12.55 (4.54)
Child age	8.14 (2.89)	6.38 (3.64)
VIQ	12.51 (1.83)	13.27 (2.31)
PIQ	11.60 (2.51)	12.51 (1.80)

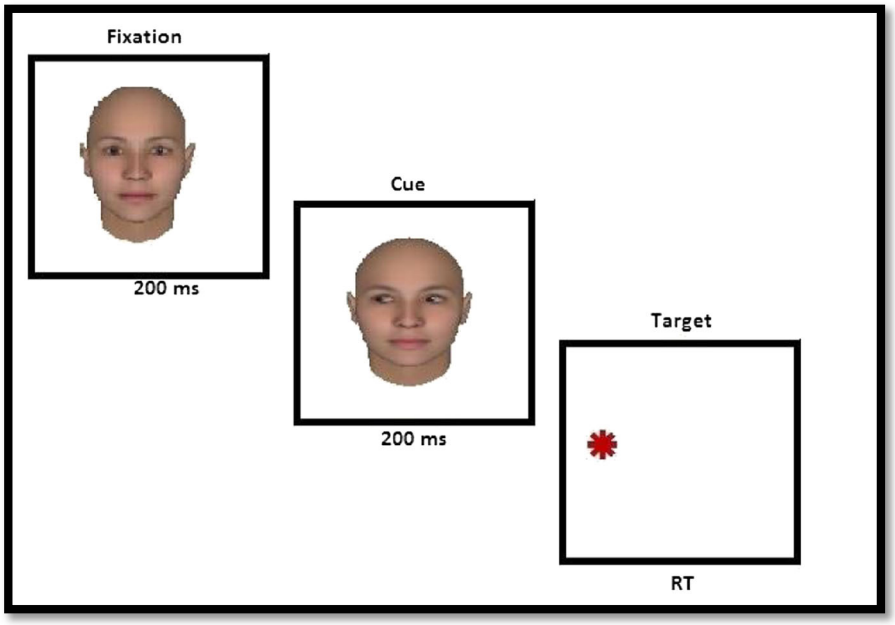

Fig. 1 Example of congruent trial

history and achieving developmental milestones within the normal range. These parents participated in this study upon notice (as a part of a larger project on Cognitive Abilities Assessment in Shahid Beheshti University) and presented at neuroCognitive Laboratory in Shahid Beheshti University. As the cultural issues matters, all of participants in both groups were Iranian with Persian as their mother tongue.

Prior to the test, participants in the two groups were asked about previous psychiatric disorders, blood pressure, brain injury, heart attack, or any other confounding variables which may affect their cognitive abilities in an abnormal way. Individuals with these problems were excluded from the sample. Also, data related to nine participants were incomplete and consequently were excluded from the final analysis.

Material and Procedure

A version of Posner's (1980) gaze cueing paradigm was used in this study. Posner task is the most widely used task for measuring visual orienting. Over the last two decades, reflecting the idea that gaze cueing paradigm tapped into social cognition, several researchers have adapted and applied this paradigm to study social attention in populations with typical and atypical social functioning (for a review, read

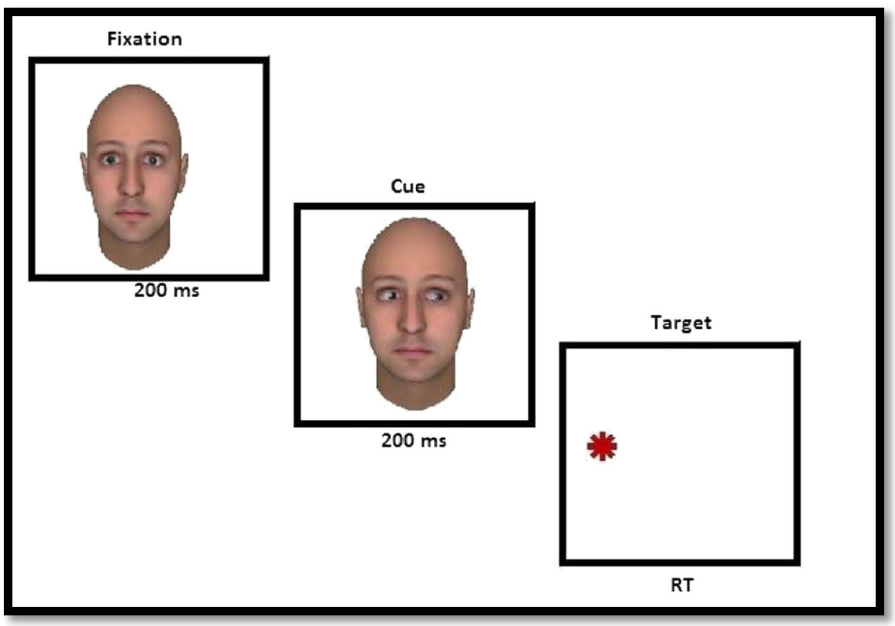

Fig. 2 Example of incongruent trial

Table 2 Mean and SD of IQ scores

	ASD Mean (SD)	Normal Mean (SD)
PIQ	11.60 (2.51)	12.51 (1.80)
VIQ	12.51 (1.83)	13.27 (2.31)

Frischen et al. 2007). In this version of gaze cuing paradigm, sixty two randomized trials were presented to each participant. In each trial, a whole digitized face image (both genders) created by FaceGen Modeller 3.1 software was presented on a 16 inch lapTop display looking straight. After 200 msec, the next schematic face with averted gaze (up, down, right, or left) was presented. Again, after 200 msec, a target star appeared while its location was either congruent or incongruent with the averted gaze (31 congruent, 31 incongruent trials). Participants were asked to look directly at the monitor and judge the target location as fast as they can. All the images were presented subliminally (200 msec). We used 200 msec intervals as studies have shown that the facilitation effect elicited by gaze cue is short-lived (Kuhn and Kingstone 2009). Participants did not have any clue about whether the eye gaze predicted the location of the target or not.

Based on literature, it's hypothesized that individuals with no impairment in gaze orienting are unable to avoid attending reflexively to where the eyes are looking and this reflexive attention would create a facilitation effect which reduce their reaction time (RTs) (longer RTs to incongruent targets). Therefore, RTs to targets occurring at the cued locations are shorter than targets appearing at non-cued ones. Even if the participants were informed that they should ignore the gaze (Kuhn and Kingstone 2009), it would impact their performance. This facilitation effect is only expected in individuals who are sensitive enough in the eye gaze. Reaction times and accuracy measures were based on keyboard responses. When scoring, participants took 1 for pressing the right key and 0 for any other answer. Figures 1 and 2 show samples of congruent and incongruent trials. The whole faces and not eye region were used in this study, because based on previous findings, processing of gaze direction is faster and more accurate in whole face compared with the eye region (Wallace et al. 2006).

Prior to the test, informed written consent were obtained from each participant. Participants were seated in front of the 16 inch laptop monitor and the experimenter ensured that they were centered with respect to the monitor and the keyboard. All of them had normal or corrected-to-normal vision and were naive to the purpose of the experiment. The participants were instructed to look straight at the monitor and press a key based on the target location as quickly as possible. Following the testing phase, the data were analyzed using SPSS 18 software.

Results

Educational level was measured based on the number of years each participant had passed in Iran's educational system (ASD = max: 18, min:5; Normal: max: 18, min:5). All of them were given tests of verbal IQ (VIQ) and performance IQ (PIQ) measured by two subset of Adult Intelligence Scale (WAIS-IV-Persian version) (comprehension and picture completion). Table 1 presents the sample tested.

T-test results showed that there was no significant difference between the groups regarding mean age (ASD = max: 50, min: 26; Normal = max: 40, min: 30; ($T = 1.956$; $P = 0.06$) and mean educational level ($T = 802$; $P = 0.42$). *T*-test was performed to ensure that the two groups did not differ significantly in verbal and performance IQ (VIQ and PIQ) (see Table 2). Results showed no significant differences between the two groups in VIQ (T (−1.68) =, $P = 0.097$) and PIQ (T (−1.56) =, $P = 0.123$) scores.

In the next stage of the analysis, a 2 × 2 mixed ANOVA was used to investigate the effects of one between-subject variable (parents of individuals with ASD and parents of typically developed children) and one within-subject factor (type of cue: congruent cue and incongruent cue) on two dependent variables (accuracy and RT). Means and SDs of the dependent measures are presented in Table 3.

Because the only within-subject factor in this study had two levels, sphericity hypothesis automatically was assumed. The results are presented in Table 4.

According to the results, parents of individuals with ASD didn't show any significant difference in RT in congruent (0.75) and incongruent (0.76) trials. While, parents of typically developed children showed significantly longer RT in response to incongruent (0.81) versus congruent (0.64) cues. As diagram 1 demonstrates the interactional effect of group and type of cue was significant on RT ($P < 0.000$). Also, the effect of

Table 3 Means and SDs of accuracy and RT

	Congruent cue		Non-congruent cue		Total	
	accuracy Mean (SD)	RT Mean (SD)	accuracy Mean (SD)	RT Mean (SD)	accuracy Mean (SD)	RT Mean (SD)
Autism	29.93 (2.82)	0.75 (0.22)	27.72 (6.58)	0.76 (0.22)	28.82 (4.34)	0.75 (0.2)
Normal	30.6 2 (0.62)	0.64 (0.12)	28.20 (5.07)	0.81 (0.17)	29.41 (2.61)	0.72 (0.12)

Table 4 Results of mixed ANOVA of group and cue on accuracy and RT of responses

source	measure		Sum of squares	df	Mean square	F	Sig.
Between-subject	Group	Accuracy	11.98	1	11.98	0.427	0.51
		RT	0.31	1	0.31	0.50	0.47
	error	Accuracy	1,966.95	70	28.9		
		RT	4.34	70	0.62		
Within-subject	cue	Accuracy	185.08	1	185.08	14.05	0.00
		RT	0.26	1	0.26	15.75	0.00
	Cue * group	Accuracy	0.36	1	0.36	0.27	0.00
		RT	0.24	1	0.24	14.78	0.00
	error	Accuracy	922.07	70	13.17		
		RT	1.16	70	0.01		

type of cue (congruent versus. incongruent) was significant on accuracy, i.e. congruent cues yielded more accurate responses than incongruent cues in both groups. Interestingly enough, the interactional effect of group and type of cue was significant on RT ($F_{(2, 97)} = 13.31$, $P < 0.0005$) and not on the accuracy.

Discussion

In this study, we probed differences in reflexive orienting to gaze direction in parents of individual with ASD in contrast with parents of typically developed children using a modified gaze cueing paradigm. As it was expected, participants in both groups yielded more accurate responses in congruent trials and obtained higher scores in congruent cue trials than incongruent ones. Therefore, the facilitation effect was only observed when the target was in congruency with the gaze. These results were expected as participants were explicitly told to ignore gaze direction and judge the target location. On the other hand, the main finding of this study stated that the interaction between group and RT was significant as each group reacted to congruent and incongruent cue trials with different RTs. A very interesting finding is that parents of children with ASD failed to show the orienting effect which is referred to the typical reaction time advantage of congruent over incongruent cues. In fact, incongruent or non-predictive gaze cues did not interfere with RTs in ASD group or capture their reflexive attention. These results are in line with previous findings (Wallace et al. 2006; Scheeren and Stauder 2008) which showed that parents of children with ASD might be less sensitive to direct gaze and show lower RT in response to social cues (eyes). The lack of reflexive orienting could imply a mild difficulty in gaze processing in parents of children with ASD. On the contrary, the analysis revealed that parents of typically developed children reacted to congruent cues faster than incongruent cues, which shows that the facilitation effect had been occurred for them. In this group, the perceived eye gaze affected the attention in a way that the RT to congruent cues was shorter than incongruent cues.

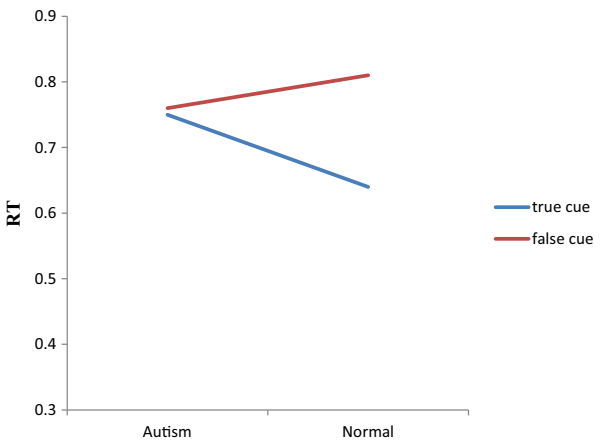

Diagram 1 Interactional effect of group and type of cue on RT

Findings of the present study, in line with previous findings, showed that atypicality in gaze orienting was manifested in parents of children with ASD and could be a cognitive phenotype. It's probable to relate gaze orienting deficits in parents of children with ASD to their higher social cognitive difficulties especially in the domain of theory of mind (see Sucksmith et al. 2011). Studies show that parents of children with ASD perform significantly poorer in Mind Reading from Eyes test, an advanced test of mindreading (for a review read, Sucksmith et al. 2011).

What is unique about this study is the observation of impaired gaze orienting in parents of individuals with ASD that is in congruent with genetic hypothesis of this disorder. It would be important for future studies to expand these findings to not only multiplex (families with more than one child with ASD) and simplex (families with one child with ASD) families but also consider the differences between mothers and fathers to determine the genetic component of ASD more precisely. One possible limitation of the present study which limits the generalization of the findings is unbalanced sample with more mothers than fathers. Previous findings have found that

autistic traits are mostly found in fathers, and fathers show more social and communicative difficulties (Sucksmith et al. 2011). Future studies are proposed to consider the gaze orienting abilities in both parents separately . Another limitation was lack of screening for autistic traits in parents. Previous studies used questionnaires like BAPQ (Losh and Piven 2007) in order to screen for a sub-group of parents defined as aloof who displayed higher rates of difficulties in social-cognitive tasks. Given the present findings, we propose more careful screening of the parents in different cultural contexts besides including only those who experience difficulties in social-cognitive domain. Regarding the relative small sample size of this study, it will be particularly important to replicate these findings with larger sample groups and more controlled experimental conditions. Also, more precise methods such as eye tracking could be used to probe into saccade patterns of parents.

Although, future studies are warranted to replicate and elucidate these findings, results of the present study suggest that impaired gaze orienting could be a subcomponent of impaired gaze processing and a candidate trait for BAP which yields more investigation.

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders, 4th edition (DSM-IV)*. Washington, DC: American Psychiatric Association.

Bailey, A., Palferman, S., Heavey, L., & Le Couteur, A. (1998). Autism: the phenotype in relatives. *Journal of Autism and Developmental Disorders, 28*, 369–392.

Baron-Cohen, S. (1995). *Mindblindness: an essay on autism and theory of mind*. Cambridge: The MIT Press.

Baron-Cohen, S. (2000). Theory of mind and autism: A fifteen year review. Understanding Other Minds, 3–20.

Baron-Cohen, S., Campbell, R., Karmiloff-Smith, A., & Grant, J. (1995). Are children with autism blind to the mentalistic significance of the eyes? *British Journal of Developmental Psychology, 13*(4), 379–398.

Chen, F. S., & Yoon, J. M. (2011). Brief report: broader autism phenotype predicts spontaneous reciprocity of direct gaze. *Journal of Autism and Developmental Disorders, 41*, 1131–1134. doi:10.1007/s10803-010-1136-2.

Dalton, K. M., Nacewicz, B. M., Johnstone, T., Schaefer, H. S., Gernsbacher, M. A., Goldsmith, H. H., et al. (2005). Gaze fixation and the neural circuitry of face processing in autism. *Nature Neuroscience, 8*, 519–526.

Dawson, G., Meltsoff, A. N., & Osterling, J. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders, 28*(6), 479–485.

Elsabbagh, M., Volein, A., Csibra, G., Holmboe, K., Garwood, H., Tucker, L., et al. (2009). Neural correlates of eye gaze processing in the infant broader autism phenotype. *Biological Psychiatry, 65*(1), 31–8.

Folstein, S. E., & Rutter, M. L. (1977). Infantile autism: a genetic study of 21 twin pairs. *Journal of Child Psychology and Psychiatry, 18*, 297–321.

Frischen, A., Bayliss, A. P., & Tipper, S. P. (2007). Gaze cueing of attention: visual attention, social cognition, and individual differences. *Psychological Bulletin, 133*, 694–724.

Grice, S. J., Halit, H., Farroni, T., Baron-Cohen, S., Bolton, P., & Johnson, M. H. (2005). Neural correlates of eye-gaze detection in young children with autism. *Cortex, 41*, 342–353.

Itier, R. J., & Batty, M. (2009). Neural bases of eye and gaze processing: the core of social cognition. *Neuroscience and Biobehavioral Reviews, 33*, 843–863.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2*, 217–250.

Kuhn, G., & Kingstone, A. (2009). Look away! eyes and arrows engage Oculomotor responses automatically. *Attention, Perception, & Psychophysics, 71*(2), 314–327.

Landry, O., & Parker, A. (2013). A meta-analysis of visual orienting in autism. *Frontiers in Human Neuroscience, 7*, 833.

Losh, M., & Piven, J. (2007). Social-cognition and the broad autism phenotype: identifying genetically meaningful phenotypes. *Journal of Child Psychology and Psychiatry, 48*(1), 105–112.

Moran, J. M., Jolly, E., & Mitchell, J. P. (2012). Social-cognitive deficits in normal aging. *Journal of Neuroscience, 32*, 5553–5561.

Pelphrey, K. A., Morris, J. P., & McCarthy, G. (2005). Neural basis of eye gaze processing deficits in autism. *Brain, 128*, 1038–1048.

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology, 32*, 3–25.

Ronald, A., & Hoekstra, R. A. (2011). Autism spectrum disorders an autistic traits: a decade of new twin studies. *American Journal of Medical Genetics. Part B, Neuropsychiatric Genetics, 156*, 255–274.

Scheeren, A. M., & Stauder, J. E. A. (2008). Broader autism phenotype in parents of autistic children: reality or myth? *Journal of Autism and Developmental Disorders, 28*, 276–287.

Senju, A., Tojo, Y., Yaguchi, K., & Hasegawa, T. (2005). Deviant gaze processing in children with autism: an ERP study. *Neuropsychologia, 43*, 1297–1306.

Sodian, B., & Thoermer, C. (2008). Precursors to a theory of mind in infancy: perspectives for research on autism. *Quarterly Journal of Experimental Psychology, 61*(1), 27–39.

Sucksmith, E., Roth, I., & Hoekstra, R. A. (2011). Autistic traits below the clinical threshold: re-examining the broader autism phenotype in the 21st century. *Neuropsychology Review, 21*, 360–389.

Wallace, S., Coleman, M., Pascalis, O., & Bailey, A. (2006). A study of impaired judgment of eye-gaze direction and related face-processing deficits in autism spectrum disorders. *Perception, 35*, 1651–1664.

Wallace, S., Sebastian, C., Pellicano, E., Parr, J., & Bailey, A. (2010). Face processing abilities in relatives of individuals with ASD. *Autism Research, 3*(6), 345–349.

Yirmiya, N., & Shaked, M. (2005). Psychiatric disorders in parents of children with autism: a meta-analysis. *Journal of Child Psychology and Psychiatry, 46*, 69–83.

Yirmiya, N., Pilowsky, T., Solomonica-Levi, D., & Shulman, C. (1999). Brief report: gaze behavior and theory of mind abilities in individuals with autism, down syndrome, and mental retardation of unknown etiology. *Journal of Autism and Developmental Disorders, 29*, 333–341.