Running head: VISUAL ORIENTING IN PERSONS WITH ASDs

A POINT OF DEPARTURE IN THE COMPARISON OF SOCIAL AND NONSOCIAL VISUAL ORIENTING AMONG PERSONS WITH AUTISM SPECTRUM DISORDERS

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Abstract

A Posner-like visual orienting task was used to compare social and nonsocial endogenous orienting among children with Autism Spectrum Disorder (ASD) and typically developing children matched on nonverbal mental age of approximately 8.5 years. This comparison was accomplished in the visual modality to avoid cross-modality task demands and with a particular focus on equating the stimuli with regard to complexity as these factors may have influenced earlier findings of a *social orienting impairment* among persons with ASDs. Participants were asked to detect social (face) and nonsocial (mixed face) targets on the basis of social (hand point) and nonsocial (arrow) cues, under Stimulus Onset Asynchrony (SOA) conditions of 175 ms and 650 ms. The typically developing children and the children with ASDs displayed strong orienting effects that were indicative of similar endogenous orienting abilities. The 650 ms SOA was also facilitative for the children with ASDs and for the typically developing children. Group differences did emerge in the interaction of cue type and SOA, where the children with ASDs demonstrated intact social orienting, but only at the SOA of 650 ms. The findings from this study do not support a general notion of *social orienting impairment* among children with ASDs, but rather, suggest that social orienting abilities may be contingent upon processing time for this group.

Résumé

Une tâche d'orientation visuelle de type Posner a été utilisée pour comparer l'orientation endogène sociale et nonsociale parmi des enfants autistes et des enfants au développement typique correspondant à l'âge mental non-verbal d'environ 8.5 ans. Cette comparaison a été accomplie dans la modalité visuelle afin d'éviter des demandes de tâche de trans-modalité. Aussi, un appui particulier a été placé sur le calibrage des stimulus en ce qui concerne la complexité puisque ces facteurs peuvent avoir eu une influence sur des conclusions antérieures examinant l'affaiblissement d'orientation social parmi les personnes autistes. On a demandé aux participants de découvrir des cibles sociales (le visage) et nonsociales (le visage mélangé) basé sur des signaux sociaux (le pointage des mains) et nonsocial (la flèche) dans des conditions SOA de 175 ms et de 650 ms. Les enfants au développement typique et les enfants autistes ont affiché des forts effets d'orientation qui étaient indicatifs des capacités d'orientation endogènes semblables. De plus, le SOA de 650 ms a été facilitatrice pour les enfants autistes et pour les enfants typiques. Les différences entre les groupes se sont démontrées par rapport à l'action réciproque du type de signal et de SOA, dont les enfants autistes ont manifesté une orientation sociale intacte, mais seulement au SOA de 650 ms. Les conclusions de cette étude ne soutiennent pas la notion générale d'affaiblissement d'orientation social parmi les enfants autistes, mais plutôt suggèrent que les capacités d'orientation sociales peuvent être le renforcement dépendant sur le temps d'exécution pour ce groupe.

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Table of Contents

List of Tables

List of Figures

A Point of Departure in the Comparison of Social and Nonsocial Visual Orienting among Persons with Autism Spectrum Disorders

Introduction and Rationale

Attentional peculiarities are among the earliest behavioural markers of Autism Spectrum Disorders (ASDs), which are clinically characterized by significant difficulties with social interactions, limited abilities in communication, and restricted and repetitive behaviours (American Psychiatric Association, 2000). These attentional differences are apparent in orienting, which is defined as the simple shifting of attentional focus in response to information in the environment (Enns & Trick, 2006), and are even more pronounced in the orienting to social information. Zwaigenbaum, Bryson, Rogers, Roberts, Brian, and Szatmari (2005) observed that infants who were later diagnosed with an ASD displayed orienting difficulties in response to social information as compared to infants who did not receive a diagnosis. This early characteristic pattern of orienting difficulties among children with ASDs has been described as a *social orienting impairment* (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998).

For example, marked differences in the attention patterns to social information are evident in infants later diagnosed with an ASD as compared to infants who do not receive a diagnosis (Baranek, 1999; Osterling & Dawson, 1994). In a retrospective study of first birthday videotapes, Osterling and Dawson (1994) found that children who were later diagnosed with an ASD oriented significantly less to their names as compared to children who did not receive a diagnosis. These results were replicated in another study where infants who were later diagnosed with an ASD oriented less to their names when compared to infants with other developmental disabilities associated with cognitive delays (Baranek, 1999). Young children with ASDs also demonstrate difficulty in looking at people's eyes (Klin, Jones, Schultz, Volkmar, & Cohen, 2002) and utilizing eye gaze and hand points as informational cues (Baron-Cohen et al., 1996; Goodhart & Baron-Cohen, 1993). These findings seem to support a prevailing notion of difficulty with social information in the environment for persons with ASDs. Some researchers (e.g., Dawson et al., 1998; 2004; Mundy & Neal, 2001) suggest that the early *social orienting deficit* might be the catalyst for the later difficulties in language and joint attention, the ability to share interest with another person, that form the basis of an ASD diagnosis (American Psychiatric Association, 2000). Thus, the *social orienting impairment* may set the stage for later deficits that affect everyday interactions.

Difficulties with the processing of social information may also highlight a more generalized orienting deficit among persons with ASD. According to Renner, Klinger, and Klinger (2006), "…it remains unclear whether impairments in orienting are specific to social stimuli or whether they are indicative of a more global orienting difficulty." (p.362). This is exemplified in the work by Dawson et al. (1998; 2004) who demonstrated that young children with ASDs showed deficits in orienting to social (e.g., name call) and to nonsocial (e.g., rattle, musical toy) information as compared to typically developing children (Dawson et al., 1998; 2004) and to children with other developmental delays (Dawson et al., 2004). Concordantly, Baranek (1999) found that 9-12 month olds, who were later diagnosed with an ASD performed less well on nonsocial visual orienting tasks when compared to children with other developmental delays or with typical development. Thus, in studies with naturalistic orienting paradigms, children with ASDs demonstrate difficulties with both social and nonsocial information in the environment, although

Dawson et al. (1998; 2004) reported greater difficulties in response to the social than to the nonsocial stimuli by the children with ASD.

Two methodological issues particular to information processing among persons with ASDs emerge based on the findings from naturalistic orienting paradigms. The first involves cross-modal processing and the second involves complexity. One, the naturalistic designs involved the auditory presentation of social and nonsocial information (e.g., name call, musical toy) but required a visual response (looking at the presented stimulus) by the children with ASDs in order to complete the task. Iarocci and McDonald (2006) suggest that children with ASDs have a particular deficit in processing and responding to information when a task requires the coordination of modalities. Thus, it is difficult to determine whether the orienting difficulties that were observed were as a result of the manipulation of social and nonsocial aspects of the stimuli, or because of the task demands that required the coordination of visual and auditory information. Two, another difficulty emerges in attributing orienting differences to the manipulation of the social salience of the stimuli since the complexity of the social and nonsocial information was not consistent. For example, one's name being called is often followed by some sort of event and likely conjures a history of such instances whereas, in comparison, the sound of a rattle is unlikely to be associated with much history or experience and is thus inherently less complex. One theory directly implicates complexity to explain attentional peculiarities. Dawson and colleagues suggest that children with ASDs have difficulty orienting to social stimuli in natural settings because the inherent complexity of such stimuli makes the task overwhelming (Dawson, 1991; Dawson et al., 2004; Dawson & Lewy, 1989a; 1989b). Plaisted, Swettenham, and Rees (1999) substantiated this notion with a computerized task in which participants with ASDs were presented with various target types and found that persons with ASDs, when given a choice, selectively attended to less complex targets. Thus, the notion of a *social orienting deficit* may be a relic from orienting tasks in which the social stimuli are inherently more complex than the nonsocial stimuli.

Although methodological issues may be implicated in the interpretation of the findings from naturalistic designs, the between-group and within-group differences that were observed warrant further examination in a task that addresses the issues of cross-modal presentation and complexity. One, children with ASDs demonstrated different social orienting and different nonsocial orienting as compared to typically developing children, which might indicate atypical development. Two, children with ASDs responded differently to social stimuli as compared to nonsocial stimuli which might indicate diverging developmental pathways of orienting in relation to the kind of information in the environement among persons with ASDs. The purpose of the present study was to disentangle some of the complexities embedded in this research by directly comparing the social and nonsocial orienting abilities of children with ASDs to those of typically developing children who are matched on non-verbal mental age. This was accomplished through a visual orienting task with social and nonsocial cues and targets that were equated on complexity.

Spontaneous Visual Attention and Autism Spectrum Disorders

The spontaneous attention of persons with autism was emphasised in the very first account of "autistic" behaviour by Leo Kanner (1943) whose original description of the features of autism included details of the aspects of a naturalistic context that seemed relevant to an individual with autism. For example, Kanner described the case of Donald, a five-year-old boy with autism who didn't seem to attend to the expected aspects of his home environment, "...[Donald] did not seem to notice his father's homecomings, and was indifferent to visiting relatives." (Kanner, 1943, p.218), or other environments, "When taken into a room, he completely disregarded the people and instantly went for objects, preferably those that could be spun" (Kanner, 1943, p. 220). Kanner seemed to imply a few things about the development of attention in his descriptions of Donald's attentional focus. One, Donald was capable of choosing to focus his attention on aspects of his environment that appealed to him. Two, Donald chose to attend to different aspects of his environment than would be expected from a typical five-year-old child. Three, Donald's lack of attention to social information in his environment impeded the development of his personal relationships. This first description of autism highlights the contribution of visual attention to the understanding of the disorder, suggests a developmental approach to the issue, and implies a link between visual orienting and later difficulties with everyday social interactions.

Hermelin and O'Connor (1970) tested Kanner's suggestion of a developmental deviation in attention by including two comparison groups that were matched on non-verbal mental age. In their study, the children with ASD were less focused on task-relevant information in the environment when compared to the children with developmental delays and to those with typical development. These findings support Kanner's original description in which a child with autism was able to orient their attention, but focused on less important aspects of the environment. Hermelin and O'Connor (1970) extended Kanner's work by demonstrating that the attentional choices made by children with autism were different than those made by typically developing children, and that they could not be explained by developmental delay.

In another report of spontaneous attention among persons with autism, Swettenham et al. (1998) videotaped very young children with an ASD in an unstructured play situation that included social and nonsocial information in order to determine where they would look. In accordance with expectations based on Kanner's work, the children with ASD looked less at people and more at objects than did the children with other developmental delays and those with typical development. Similarly, Klin , Jones, Schultz, Volkmar and Cohen (2002) found that adolescents and young adults with ASD looked more at irrelevant components of the visual scenes when compared to typically developing participants who were matched on developmental level. They tracked eye movements in response to a video clip of an everyday social scene and found that, while the typically developing participants spent most of their time gazing at the actors' eyes to retrieve information from the scene, the participants with ASD focused more on the actors' mouths and on the background. Together, the initial clinical descriptions and the research reports seem to highlight that children with ASDs are able to shift and focus their attention, but that they do so in a fashion that is different form typically developing children and from children with other developmental delays.

Visual Orienting

Visual orienting paradigms provide a structure within which to assess visual orienting by allowing for the detection and recording of simple shifts of attentional focus from one location to another (Posner, 1980). Visual orienting is typically studied with adapted versions of Posner's (1980) task that was developed based on the premise that attentional focus is similar to a spotlight. As the spotlight is guided to a specific location, the information within the beam becomes more salient and is easier to detect (Posner, Snyder, & Davidson, 1980). Posner (1980) found that by incorporating informational cues such as arrows into his design, he could better direct the spotlight. Thus, a typical Posner-type task entails having participants fixate on the center of a computer screen and press a button when they see a target that appears to the left or the right of fixation. This methodology allows for the control of the three key variables of cue type, the amount of time between the presentation of the cue and the appearance of the target, and the validity (or predictability) of the cues.

The first variable, cue type, is implicated in the distinction between endogenous and exogenous orienting. Endogenous orienting involves centrally located cues that are symbolic and that require some kind of interpretation. These cues provide meaningful information regarding directionality and facilitate target detection when they accurately predict the location of the target (Enns & Brodeur, 1989). Arrows are the most widely used endogenous cues in traditional Posner-type tasks, they are considered to be over-learned directional symbols that direct attention reflexively (Tipples, 2002) even among children as young as 4 years (Ristic, Friesen & Kingstone, 2002). Arrows are also the most commonly used endogenous cue in studies that compare social and nonsocial orienting with a Posner-type task (e.g., Bayliss & Tipper, 2005; Vlamings, Stauder, van Son, & Mottron, 2005). In these studies central eye gaze and an arrow cues are used as symbols to direct attention. Conversely, exogenous orienting involves peripheral cues, such as a flash of light, that appear in the same location as the target and do not require interpretation. As in endogenous orienting, target detection is enhanced when the cue accurately predicts its location (Brodeur & Boden, 2000).

Another distinction in Posner-type tasks is the cue to target interval, or the stimulus onset asynchrony (SOA). Orienting conditions at short intervals, generally those that are less than 250 ms, are considered to be covert since the entire series of events from cue presentation to target onset occurs in less time than is necessary for eye movement to be initiated (Enns, 1990); the mind's eye is well equipped to detect cues and targets that are presented in rapid succession and to initiate a response even if the signs of the attentional shift are not apparent behaviourally. Conversely, overt conditions are those that include longer SOAs (>250ms) that may be accompanied by perceptible eye movements. In studies of endogenous orienting, individuals with ASD seem to require 300-400 ms to process symbolic cues (Renner, Klinger, & Klinger, 2006; Senju, Tojo, Dairoku, & Hasegawa, 2005). Thus, in endogenous tasks it is necessary to include an SOA condition that encompasses group-specific processing of symbolic cues.

The third variable that is controlled in a typical Posner-type task is the validity, or predictability, of the cues. A design in which cues are considered to be predictive is one in which the majority of trials include cues that accurately direct attention to the location of the target. Generally speaking, enhanced performance (i.e., quicker reaction times) is demonstrated on trials where the location of the target is correctly indicated by the cue (valid trials) compared to when the target is incorrectly indicated (invalid trials) (Posner, 1980). Longer RTs are seen on invalid trials because attention needs to be redirected from the anticipated location to the actual location of the target. The primary gauge of whether attention was affected by the location of a cue is called the "orienting effect" which is derived by subtracting the RTs on the valid trials from those on the invalid trials. A positive result indicates the utility of the cue and that it was consistently used to direct attention.

In this study, a Posner-like visual orienting paradigm, that was modified to include both social and nonsocial cues and targets, was used to compare social and non-social orienting. This approach enabled the manipulation of variables (SOA, predictability) that were not considered in more naturalistic designs that examined spontaneous attention among children with ASDs.

Nonsocial Visual Orienting in Autism Spectrum Disorders

Posner-type tasks have been used to study the visual orienting abilities of persons with ASDs under both exogenous and endogenous conditions. This literature is wrought with inconsistent findings due to highly variable methodologies and matching strategies. For example, deficits in exogenous orienting are reported among persons with ASDs (Casey, Gordon, Mannheim, & Rumsey, 1993; Townsend, Courchesne, & Egaas, 1996; Townsend, Harris, & Courchesne, 1996). On a task with predictive peripheral cues to guide attention and compared both short and long SOA conditions, Casey et al. (1993) found that adults with an ASD were slower to detect a target than a group of adults who were matched on chronological age. However, the inherent difficulties associated with matching on the basis of CA (see Burack, Iarocci, Flanagan, & Bowler, 2004), confounded these results since the low IQ scores of the adults with ASD indicate lower developmental levels that are likely associated with orienting abilities. Similarly, Townsend et al. (1996) found exogenous orienting deficits among adults with ASDs who were not matched on developmental level, and who differed in levels of cerebellar abnormalities. The matching strategies used in these studies may have contributed to the finding of deficient exogenous orienting in this group of persons with ASDs.

In contrast, researchers who considered developmental level in their designs demonstrated intact exogenous orienting abilities among persons with ASDs. For example, Iarocci and Burack (2004) demonstrated that children with ASDs with an average non-verbal mental age of 7 years, were able to respond to a peripheral cue as well as the typically developing group, even at a short SOA of 200 ms. Similarly, Renner, Klinger, and Klinger (2006) found that high-functioning children and adolescents with ASD, who were matched to typically developing children on the basis of verbal skills, displayed typical exogenous orienting abilities in a short SOA condition when they had good motor functioning. Thus, when children with ASDs and typically developing children were equated on some kind of developmental measure, exogenous orienting, although possibly atypical, was relatively intact among children with ASDs (see Burack, Iarocci, Bowler, & Mottron, 2002 for a discussion).

As with the examples of exogenous orienting, the studies of endogenous orienting among persons with ASDs provide conflicting results and vary greatly with regard to methodologies. For example, Wainwright-Sharp and Bryson (1993) used an adapted Posner task with centrally located and predictive arrows, and with short and long SOA conditions. They found that the reaction times were indistinguishable between the children with ASD and typically developing children at an SOA of 800 ms, but that the children with ASD had difficulty orienting in the short SOA condition (100 ms). Wainwright-Sharp and Bryson interpreted these findings as evidence of deficient endogenous orienting because of the difficulty displayed at the short SOA. However, another interpretation is that intact endogenous orienting, but increased processing time when interpreting cues for persons with ASD (Burack, Enns, Stauder, Mottron, & Randolph, 1997). In line with this interpretation, Renner et al. (2006) found that the endogenous orienting abilities of children and adolescents with ASD were similar to those of a matched group of typically developing children at SOAs of 400 ms and 800 ms. However, Renner et al. did not include a short SOA condition (<250 ms), which makes it difficult to ascertain whether difficulties would be apparent at a shorter SOA. Overall, the results from typical Posner paradigms where attention is directed to a location based on either a centrally located arrow or on a peripheral cue, yield conflicting results that seem to be associated with matching strategies, and with SOA manipulations.

Social Visual Orienting in Autism Spectrum Disorders

Unlike the results from studies with traditional Posner paradigms, the evidence from social orienting experiments in naturalistic settings is consistent with a *social orienting impairment* (Dawson et al., 1998), a particular deficit in orienting to naturally-occurring stimuli in the environment that is characteristic of individuals with ASDs. The term *social orienting impairment* was coined in response to the evidence that young children with ASD did not spontaneously orient to social stimuli (i.e., name calls, people) in the environment (Osterling & Dawson, 1994). As most of the evidence of this deficit is derived from retrospective sources, Dawson et al. (1998) devised a paradigm of naturalistic exogenous orienting to assess looking behaviour to social and nonsocial stimuli in the environment. They compared the looking behaviour of children with ASD, who were matched to children with delayed or typical development on verbal mental age, in response to social stimuli (names called, hand clap) and in response to non-social stimuli (rattle, musical toy). They found that the children with ASD oriented less overall as compared to the children with typical or delayed development, but that this was more severe for the social stimuli. Difficulties in social orienting among the children with ASDs were also related to difficulties in sharing attention with others in social interactions (i.e., joint attention deficit). In a replication and extension, Dawson et al. (2004) increased the number of social and nonsocial stimuli used and found a similar pattern of results as the children with ASD oriented less than children with typical or delayed development, especially to the social stimuli. Similarly, Leekam, Hunnisett and Moore (1998) found that children with ASD followed fewer head turns to an exciting target than the children who were matched on verbal mental age. However, this was only the case for the children with ASD who had verbal mental ages below 4 years, which suggests that interpreting social cues may be an emerging ability among children with ASDs.

In another example of task using an endogenous social cue, Ristic et al. (2005) examined orienting in a computerized task among an older group of individuals with ASDs. Ristic et al. used a modified version of Posner's task in which the pupils of a centrally located schematic face would appear in order to direct attention to the location of a target under predictive (80% valid trials) or non-predictive (50% valid trials) conditions. The non-predictive condition was included to assess reflexive social orienting within which attention is drawn to a cued location even when the social cue is not informative. They found that the individuals with ASD and those with typical development performed similarly in the predictive condition. But, unlike the individuals with typical development, the individuals with ASD, did not shift their attention in the non-predictive condition. Ristic et al. interpreted their findings as indicating an intact *mechanical* type of social orienting, in which persons with ASDs interpret the directional but not the social components of a social cue.

The evidence from studies of social orienting among persons with ASD seems to support the notion of a *social orienting impairment* with naturalistic designs of exogenous orienting; however, cross-modal task demands and the variable complexity levels of the stimuli may have influenced these results. In contrast, social orienting seems to be intact, at least mechanically, in endogenous tasks with centrally located social cues.

Comparing Social and Nonsocial Visual Orienting in Autism Spectrum Disorders

Most of the information regarding comparisons of social and nonsocial stimuli among persons with ASD is derived from either naturalistic designs, or is pieced together from separate literatures. It is difficult to tell a coherent story of the development of social and nonsocial orienting as the research methodologies vary greatly in both areas. Thus, researchers are beginning to compare social and nonsocial orienting in adapted versions of Posner's (1980) task to limit the number of extraneous variables that may influence orienting. For example, Chawarska, Klin, and Volkmar (2002) studied the ability of toddlers with ASD to follow the centrally located moving gaze (SOA of 150 ms) of a realistic photograph to detect a star target to the left or right of fixation. They also included a nonsocial, or simulated eye, condition in which a pixelated version of the photograph contained a moving rectangle in lieu of eyes. In both cases, the responses from the toddlers with ASD were comparable to those of the typically developing toddlers who were matched on CA, suggesting intact social orienting at a short SOA in this group. Neither group oriented in the nonsocial condition which may be an indication that the centrally located rectangle was not interpreted as a symbolic cue and cannot be adequately compared to eye gaze which has been confirmed as a robust indicator of directionality (Friesen & Kingstone, 2003; Ristic & Kingstone, 2005).

In other studies of social and nonsocial orienting in individuals with ASDs endogenous eye gaze and arrow cues were used to direct attention, both of which are established as possessing inherent directionality (Langton & Bruce, 2000; Tipples, 2002). For example, Vlamings, Stauder, van Son, and Mottron (2005) compared social and nonsocial orienting to a target (the letter A) that appeared either to the left or right of an eye gaze or an arrow cue (presented for 400 ms) among adults with ASD and a group of typically developing university students matched on IQ. They found that the participants with ASD were able to orient in both contexts, but that they did not distinguish between the cues. Like Ristic et al. (2005), Vlamings et al. suggest that persons with high-functioning ASD can efficiently use the information in a directional cue, but that they do not necessarily make the same social nonsocial distinction that is seen in typically developing children who process social information faster than nonsocial information.

Senju, Tojo, Dairoku, and Hasegawa (2004) report similar findings based on their orienting paradigm which directly contrasted orienting to an asterisk based on either a centrally located arrow or the eye gaze on a photograph. They found that the children with ASD were able to orient using both cue types but did not distinguish between the cues. Conversely, the typically developing children were also able to use both cue types but were faster in response to the eye gaze cue. Senju et al. interpreted this finding as indicating of a lack of sensitivity to social cues among the children with ASDs.

Bayliss and Tipper (2005) introduced the possibility that persons with ASD demonstrate more mechanical social orienting because of the orienting paradigms in which cues and targets are decontextualized. They posited that the social or nonsocial context of the targets might be implicated in the pattern of responses to arrow and eye gaze cues and that the congruence between the cue and target contexts would facilitate performance. In their first experiment, a centrally located arrow or an eye gaze cue (presented for 376 ms) was flanked by either an intact face or by a scrambled face. In the second experiment, the same cues were flanked by either a photograph of an intact tool or by a scrambled tool. The participants, who either had high or low ASD symptomatology according to a self-report questionnaire, were asked to locate a target (a peach colored highlight) that would appear on one of the flanking photographs. Contrary to their expectations, Bayliss and Tipper found that the congruence of the cue and target type had no effect on orienting abilities, although targets were detected faster on intact figures for the participants with low ASD symptomatology. They also found that both groups of individuals with ASD demonstrated intact endogenous orienting based on the eye gaze and arrow cues, but that no distinction was made between the two cue types.

On the whole, the evidence from direct comparisons of social and nonsocial orienting using Posner-type tasks seem to support the notion of intact, but atypical, endogenous orienting to both eye gaze and arrow cues among persons with ASD. In such tasks typically developing children tend to respond more quickly to the social cues than to the nonsocial ones, whereas children with ASDs do not distinguish between the cue types. These findings corroborate Ristic et al.'s (2005) interpretation of intact *mechanical* social orienting among persons with ASDs for whom the directional but not the social information of a social cue is more salient.

Current Study

Rationale and Design

The current study was designed to examine endogenous orienting among children with ASDs and typically developing children using a Posner-type task that was modified to include social and nonsocial cues and targets. This type of task provides a structure within which researchers can develop hypotheses in relation to the information presented in an endogenous cue (social or nonsocial), the amount of time allotted for cue processing (long or short), and the predictability of the cues (predictive or non-predictive).

Two centrally located cue types were used--an arrow (nonsocial cue) and a pointing hand (social cue). The two cues were equated in three ways based on Dawson et al.'s (Dawson, 1991; Dawson & Lewy, 1989a; 1989b) suggestion that social and nonsocial stimuli might vary with regard to complexity. One, they were developed with the same visual qualities and were equated on color and size. Two, they were chosen because, unlike eye gaze and arrows, a hand point and an arrow are structurally similar. Three, both hand point and arrow cues are validated reflexive symbolic cues that draw attention to a cued location in non-predictive conditions (Langton & Bruce, 2000). In addition to being a reflexive symbolic cue, the hand point has been demonstrated to retain the same social qualities as an eye gaze cue in computerized orienting paradigms (Langton & Bruce, 2000). Thus, the purpose of using these two cues was to ensure that the comparison was about the social and nonsocial aspects of the orienting paradigm and not the complexity differences between cue types.

Two cue-to-target SOA conditions were included to determine the effects of processing time on orienting abilities. SOA conditions of 175 ms and 650 ms were included to examine orienting under covert and overt conditions and to test whether having more time to process the cues would be beneficial and facilitate responses (Burack et al., 1997). The cues predicted the location of the target with 80% accuracy, a level that is considered to be predictive and likely to produce strong orienting effects (Jonides, 1981). And, the design of this study is unique in that it also includes a comparison of target types (social and nonsocial) as previous researchers applied computerized tasks to the study of the social cueing of nonsocial targets (Kingstone, Friesen & Gazzaniga, 2000; Langton & Bruce, 1999), the nonsocial cueing of nonsocial targets (Wainright-Sharp & Bryson, 1993), and the comparison of social and nonsocial cueing of nonsocial targets (Bayliss & Tipper, 2005; Chawarska et al., 2003; Ristic & Kingstone, 2005; Senju et al., 2004; Vlamings et al., 2005). As with the cues in this study, the social (face) and nonsocial (mixed face) targets were equated on visual complexity. This design allows for the precise examination of the influence of the cues and targets separately as well as of the interaction between these by including them in the same task.

In accordance with similar research designs, RTs and error rates were the dependent measures, and the "orienting effect" was the index of the utility of the cues. Children with ASDs and typically developing children were matched on the basis of nonverbal mental age at an approximate level of 8.5 years (see Burack, Iarocci, Bowler, & Mottron, 2002 for a discussion of the developmental issues associated with matching choices).

Hypotheses

Based on evidence from studies comparing social and nonsocial cues (e.g., Bayliss & Tipper, Senju et al., 2005; Vlamings et al., 2005), the participants with ASD were expected to demonstrate intact and similar endogenous orienting patterns in response to both the arrow and hand whereas the typically developing group were expected to respond faster based on the hand point cue. In accordance with Burack and colleagues' (1997) position that individuals with ASD require more time to process cues, the participants with ASDs were expected to benefit from additional time to process the cue, and were expected to display intact orienting at the long SOA but not at the short SOA. Based on the studies of face processing (e.g., Klin et al., 2002) the participants with ASD were expected to respond more slowly to the face target than to the mixed face, the opposite of what was expected for the typically developing children.

Method

Participants

The participants included 19 children (16 males) with ASDs and 19 typically developing children (7 males). These 38 participants were chosen from a larger sample of 60 participants (26 with ASDs) because they met the inclusion criteria of not having any diagnosed attention or motor difficulties and because they could be matched closely on a measure of non-verbal mental age. Seven participants (5 with ASDs) were excluded because of diagnosed Attention problems, and the remaining 15 (2 with ASDs) were excluded because they had no mental age match.

The children with ASDs were recruited from private (N=10) and public schools (N=9) with programs for students with developmental disabilities in the Montreal area.

All of the typically developing children were recruited from public schools in the Montreal area. All of the children were screened for diagnosed attention and motor problems (see Appendix A). The children with ASDs received their diagnoses from local psychiatrists working in hospitals with specialized autism programs; all diagnoses were based on the DSM-IV criteria established by the American Psychiatric Association (1994). The diagnoses were confirmed with the Autism Diagnostic Interview-Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003), or the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord, Rutter, DiLavore, & Risi, 2002) for the 9 participants from the public setting. The diagnoses of 7 of the 10 participants from the private setting were confirmed using the Autism Spectrum Screening Questionnaire (ASSQ; Ehlers, Gillberg, & Wing, 1999). The diagnoses of 3 children from the private setting were not confirmed since the questionnaires were not returned. All confirmatory diagnoses met the criteria for Autism.

The children with ASD and those with typical development were matched on non-verbal mental age on a one-to-one basis. Non-verbal mental age was established through the Brief IQ of the Leiter International Performance Scale, Revised (Leiter-R; Roid & Miller, 1997). This matching procedure is in accordance with the framework of developmental psychopathology, in which developmental level (mental age) is considered, and it adheres to current recommendations for research in the field that highlight the need to equate the demands of experimental tasks with those of the matching measures (Burack, Iarocci, Flanagan, & Bowler, 2004). The two groups in this study are considered to be very well matched according to the standards established by Mervis and Klein-Tasman (2004) who suggest that groups can be considered matched only if a p value of 0.50 or higher is found on the test group difference. In this study, the p value for the test group difference on the non-verbal mental age measure is 0.95. The participant characteristics for both groups are presented in Table 1.

Table 1. Participant Characteristics as a Function of Group

Group	N	CA	MA	Gender
ASD	19	10.00 (*SD*=2.72)	8.50 (*SD*=3.20)	16 males
TDC	19	8.41 (*SD*=2.31)	8.48 (*SD*=2.43)	7 males

Note. ASD = Autism Spectrum Disorder, TDC = typically developing children, MA = mental age (based on Leiter-R), CA = chronological age. Matched groups did not differ on MA ($p = 0.95$), but the CA difference approached significance ($p = 0.06$).

Mental Age Measure

Leiter International Performance Scale, Revised (Leiter-R ; Roid & Miller, 1997). The Leiter-R was used to assess nonverbal, visual-spatial mental age (MA). It is a well-standardized intelligence test with excellent reliability and validity (Roid & Miller, 1997). The Brief IQ subscale was used in this study since it is an efficient way to establish overall non-verbal, visual-spatial abilities and is often used to quickly establish overall intellectual abilities. The Leiter Brief IQ is established as a good measure of overall intellectual level and correlates well with the WISC-III Full Scale IQ (r= 0.85) and Performance IQ (r= 0.85). The Brief IQ consists of four subtests with good internal consistency scores, Figure Ground (r=0.75) which entails finding details within a complex visual scene, Form Completion (r=0.88) in which the missing component of a picture is established, Sequential Order (r=0.75) in which the sequence of a visual scene is confirmed, and Repeated Patterns (r=0.76) in which a complex visual code is deciphered.

The Leiter-R is an individually administered test designed to measure a vast range of cognitive abilities from early childhood to adulthood with norms for 2 through 21 years of age. It is a measure of fluid intelligence and reflects inherent visual-spatial abilities that are rarely affected by culture, experience, and context. The Leiter-R is particularly well-suited to assess the abilities of persons with ASD as it requires few verbal instructions, no verbal responses, has few time limits, and adequately captures an extreme range of abilities (Attwood, Frith, & Hermelin, 1988).

Apparatus

The task was presented on a Macintosh laptop attached to an LCD monitor using SuperLab Pro software (version 1.75). The screen measured approximately 43.2 cm horizontally and 30.5 cm vertically. The participants were seated in a quiet room, 60 cm away from the computer screen. The participants responded to the target stimulus by pressing the left or right response key of the highly accurate (+/- 1 millisecond) SuperLab RB-530 series response pads (Cedrus Corporation). A chin rest was used to assure a stable viewing position of the center of the screen.

Stimuli

All of the stimuli were presented in greyscale on a white background. The stimuli consisted of centrally located cues that were presented in the middle of the screen, and of peripheral targets that were presented 84 mm (approximately 8° of visual angle) to the left or right of the center of the screen.

Targets. The social target was a photograph of the face of a woman with a validated neutral facial expression (in greyscale) from the MacBrain Face Stimulus Set (MacArthur Foundation Research Network on Early Experience and Brain Development) that measured 24 mm (2.3° of visual angle) vertically and 15 mm (1.4° of visual angle) horizontally. To equate the targets on visual complexity, the nonsocial target was a mixed face that was a modified version of the same photograph (created with Adobe Photoshop software, version 7.0), also measuring 24 mm (2.3° of visual angle) vertically and 15 mm (1.4° of visual angle) horizontally.

Cues. The social cue was a pointing hand and the nonsocial cue was an arrow. Both cues measured 15mm (1.4° of visual angle) vertically and horizontally. The hand point, a photograph (in greyscale), was chosen as a social cue due to its structural similarity to the arrow, to its established value as a social cue, and to its status as a reflexive symbolic cue (Langton & Bruce, 2000). The arrow cue was created using Adobe Photoshop software (version 7.0) based on the color scheme of the hand cue to ensure similar visual information between the cues. Arrow cues have also been established as reflexive symbolic cues that tend to direct attention under non-predictive conditions (Ristic, Friesen, & Kingstone, 2002; Tipples, 2002). See Figure 1 for a depiction of the targets and the cues.

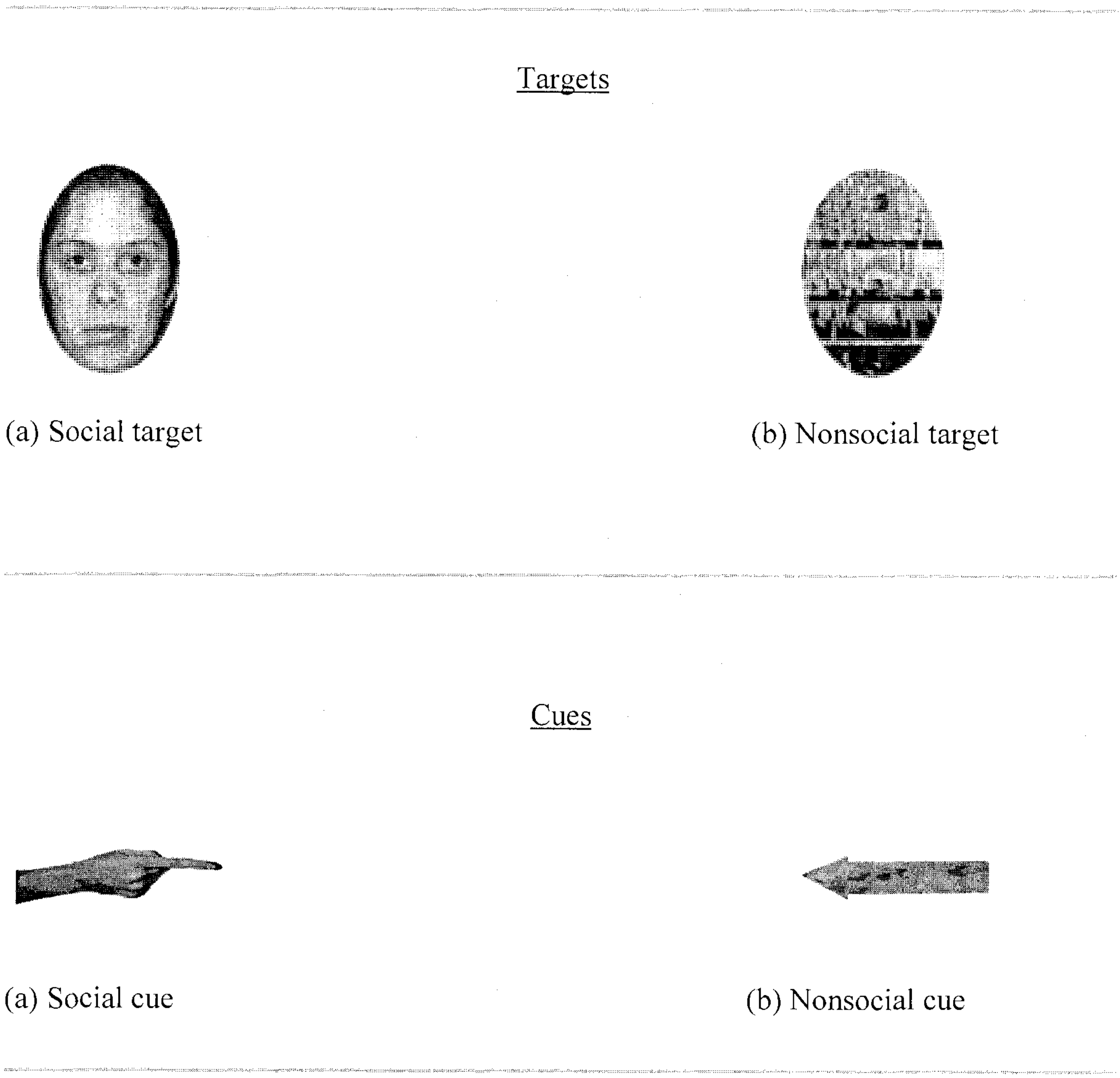


Figure 1. Illustration of social and nonsocial targets and cues (not presented to scale).

Experimental Design and Conditions

The task used to compare social and nonsocial visual orienting was a forced-choice RT discrimination task. This paradigm included sixteen conditions based on target type (social vs. nonsocial), cue type (social vs. nonsocial), SOA (175 ms vs. 650 ms), and validity (valid vs. invalid).

Two-hundred experimental trials (25 x 2 SOAs x 2 cues x 2 targets), presented in four blocks of 50 randomized trials with a break in between each block, were included in the analyses. The cues were predictive as they were valid, or they correctly indicated the location of the target, 80 % of the trials. Thus, the cues were invalid, or they incorrectly indicated the location of a target, in 40 of the 200 trials. This level of predictability has been established as sufficient to produce a strong orienting effect elicited by centrally located cues (Jonides, 1981).

Each trial began with the presentation of a fixation point, located at the center of the screen, that remained on the screen for 1000 ms. Next, the cue (the hand or the arrow), either pointing to the left or to the right, was presented. The cue remained on the screen for a cue-to-target SOA of either 175 ms or 650 ms and disappeared with the onset of the target. Next, the target (the face or the mixed face), appeared either to the left or right of the center of the screen and remained until the participant provided a response or until 3000 ms had elapsed. The inter-trial interval, which consisted of a blank screen, was set at 1000 ms. RTs were measured from the onset of the target. Two examples of possible series of events are depicted in Figure 2.

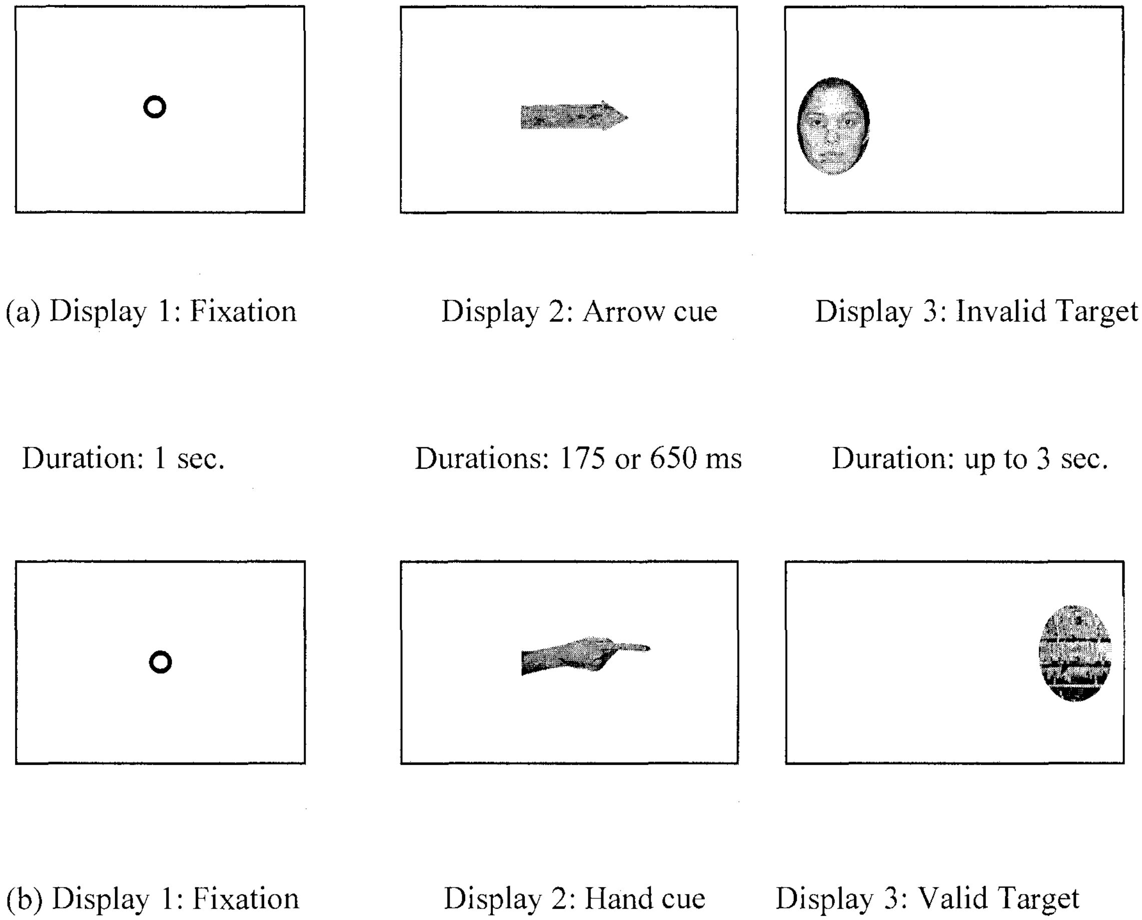


Figure 2. Two sample sequences of events. (a) Invalid trial with nonsocial cue and social target. (b) Valid trial with social cue and nonsocial target. The intertrial interval (a blank screen) lasted 1000 ms.

Procedure

After obtaining written consent from parents, trained research assistants met with the participants either at their school or at a research laboratory at McGill University. After verbal assent was established, the participants were tested individually in a quiet room. The Leiter-R and the computerized task were presented as games, and the purpose of the chin-rest was explained to familiarize participants with the procedure and to make them feel more at ease. The participants who completed the tasks at McGill did so in one session with breaks as needed. Because of their school schedules, the participants who completed the tasks at their schools did so over two shorter sessions. In both cases, the computerized task was administered first to ensure that the participants could complete the task, and the Leiter-R was administered second. Each participant completed a practice set of 40 trials that were used to determine the ability to perform the computerized task. Participants who could not complete the practice trials did not move on to the experimental trials and were excluded from the rest of the study. All participants, regardless of performance or of inclusion in this study, received a $10 gift certificate to a local bookstore.

All of the participants received the same instructions for the computerized task that highlighted focusing on the center of the screen but did not include any mention of the cues (see Appendix B). This was done purposefully to ensure that the participants ascribe meaning to the cues on their own. The same rationale was used for the presentation of the targets as participants were shown the pictures, but they were not provided labels by the experimenters. The position of the response buttons (right or left) was counterbalanced. Although eye gaze was not directly assessed, research assistants were trained to unobtrusively observe whether the participants' eyes were focused on the center of the screen.

The median reaction times were computed for all correct responses within each condition for each participant. The median has been established as an appropriate measure of central tendency in similar designs and when studying groups with variable reaction times (Goldman, Flanagan, Shulman, Enns, & Burack, 2005). Responses were considered to be errors if the wrong button was pressed, if there was no button press (3000 ms elapsed), or if RTs were less than 100 ms (anticipations).

Results

Preliminary Analyses

Accuracy. The error rates were too low to be analyzed across conditions and were not entered. The median reaction times of correct responses and overall errors across conditions for each group are presented in Table 2. The children with ASD displayed faster overall RTs than the children with typical development, but this difference was not significant ($p = 0.54$). The two groups did not differ in the number of errors ($p = 0.44$).

Table 2. Mean of Median Reaction Times and Error Information as a Function of Group

Group	Overall Correct RT	Errors	Error Rate
ASD	870.00 ms. (*SD*=196.87)	2.40 (*SD*=1.94)	1.2%
TDC	920.73 ms. (*SD*=203.94)	2.80 (*SD*=2.69)	1.3%

Note. RT = reaction times in milliseconds, ASD = Autism Spectrum Disorder, TDC = typically developing children. No significant group differences in overall RT ($p = 0.54$) or in number of errors ($p = 0.44$) were found.

To determine whether gender or school setting (for the children with ASD) needed to be considered in later analyses, a one-way ANOVA was conducted to address any initial differences on the variables of interest (MA, overall RTs, and number of errors) in relation to these two variables.

Gender differences. A one-way ANOVA with CA as the dependent measure and gender as the predictor revealed that girls were significantly older (M= 10.00 years, SD=2.61) than boys (M=8.00 years, SD=2.18), F (1,36)=6.25, p=0.02. However, follow-up analyses of the variables of interest revealed no significant gender differences when CA was used as a covariate. The boys and girls did not differ on MA (p=0.33), overall RTs (p=0.38), or on number of errors (p=0.27) when CA was controlled. Thus, the influence of gender was not considered in later analyses.

Setting differences. Since 10 of the 19 participants with ASD were from a private school, a one-way ANOVA with the variables of interest as dependent measures and school setting (private vs. public) as the independent variable was performed. There were no significant group differences between the two groups of children with ASD based on setting for MA (p=0.70), overall RTs (p=0.89), or for number of errors (p=0.88). Thus, the influence of school setting was not considered in later analyses.

Results from Experimental Task.

A mixed model ANOVA was performed with group (ASD vs. TDC) as the between-subjects factor, SOA (175 ms vs. 650 ms), Cue (hand vs. arrow), Target (face vs. mixed face), and Validity (valid vs. invalid) were the within-subject factors. The criterion for significance was $p \leq 0.05$. The sphericity assumption was tested since the risk of its violation increases when more than two conditions are introduced in designs with repeated measures (Hinton, Brownlow, McMurray, & Cozens, 2004); and the sphericity assumption was met (*epsilon*=1).

Main Effects of SOA, Cue, and Validity. There was a main effect of SOA, F (1,36)=19.613, p=0.00, η^2=0.35, in which faster RTs were recorded for the SOA of 650 ms (*M*= 861.15, *SEM*=33.25) than for SOA of 175 ms (*M*=929.57, *SEM*=33.59). See Figure 3 for a depiction of the mean RTs as a function of SOA. There was a main effect of Cue, F (1,36)=3.88, p=0.05, η^2=0.97, in which faster RTs were demonstrated in response to the hand cue (*M*=881.68, *SEM*=30.02) than to the arrow cue (*M*=909.04, *SEM*=36.19). See Figure 4 for a depiction of the mean RTs as a function of cue type. There was a main effect of Validity, F (1,36)=131.45, p=0.00, η^2=0.79, in which a strong orienting effect was demonstrated. The RTs on the invalid trials (*M*=933.62, *SEM*=32.45) were longer than on the valid trials (*M*=857.10, *SEM*=32.45). See Figure 5 for a depiction of the mean RTs as a function of validity.

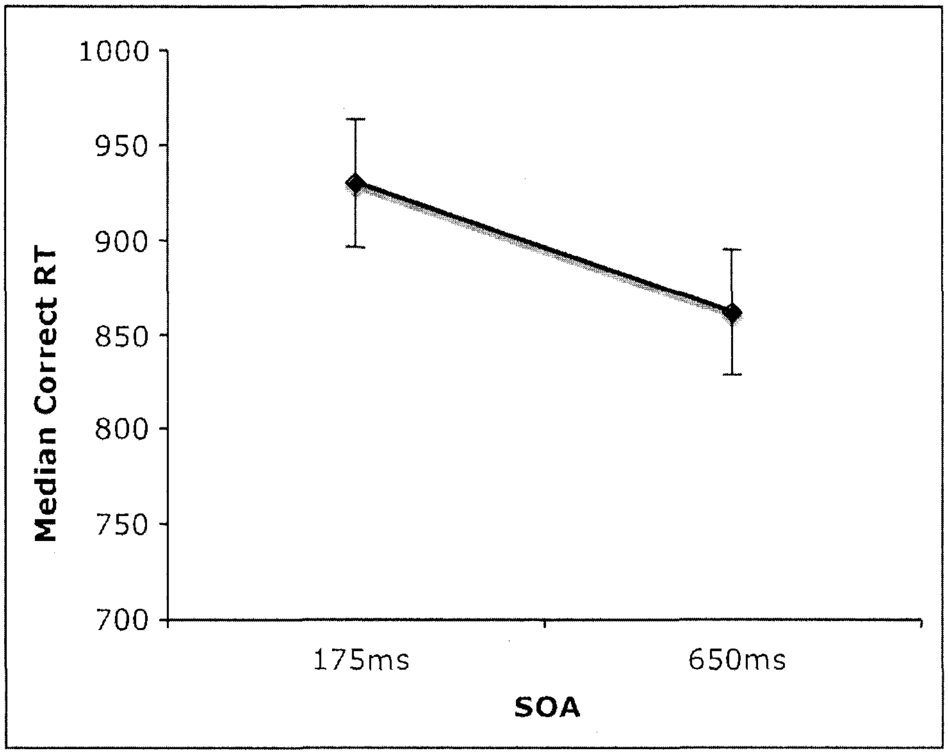


Figure 3. Mean of median reaction times (in milliseconds) as a function of SOA (175 ms. vs. 650 ms.). Error bars depict SEM. There is a significant main effect of SOA.

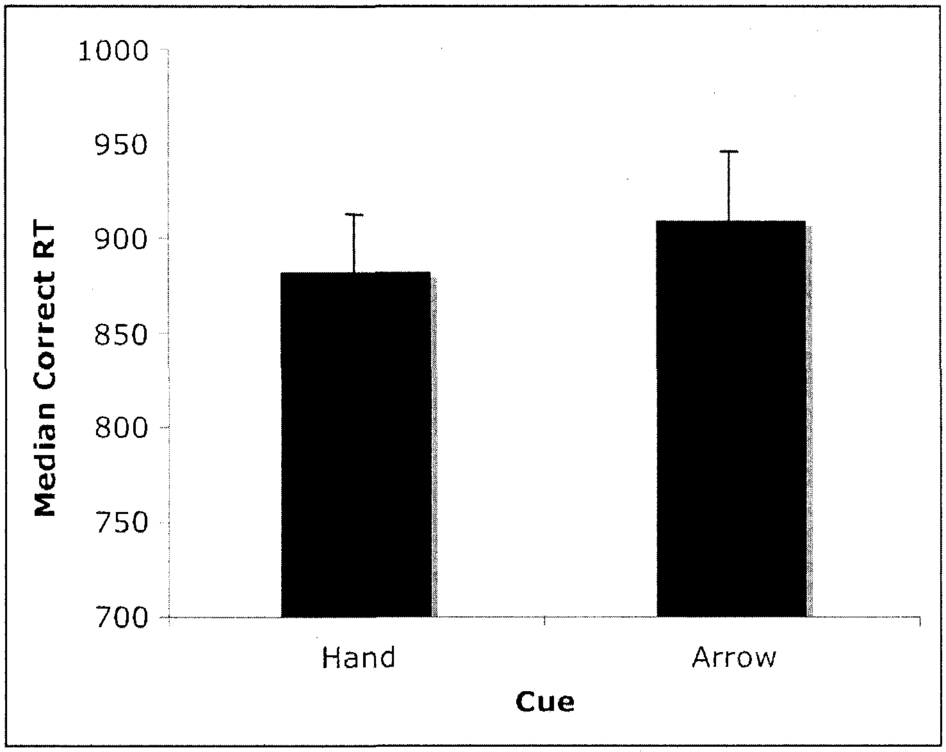


Figure 4. Mean of median reaction times (in milliseconds) as a function of Cue (Hand vs. Arrow). Error bars depict SEM. There is a significant main effect of Cue type.

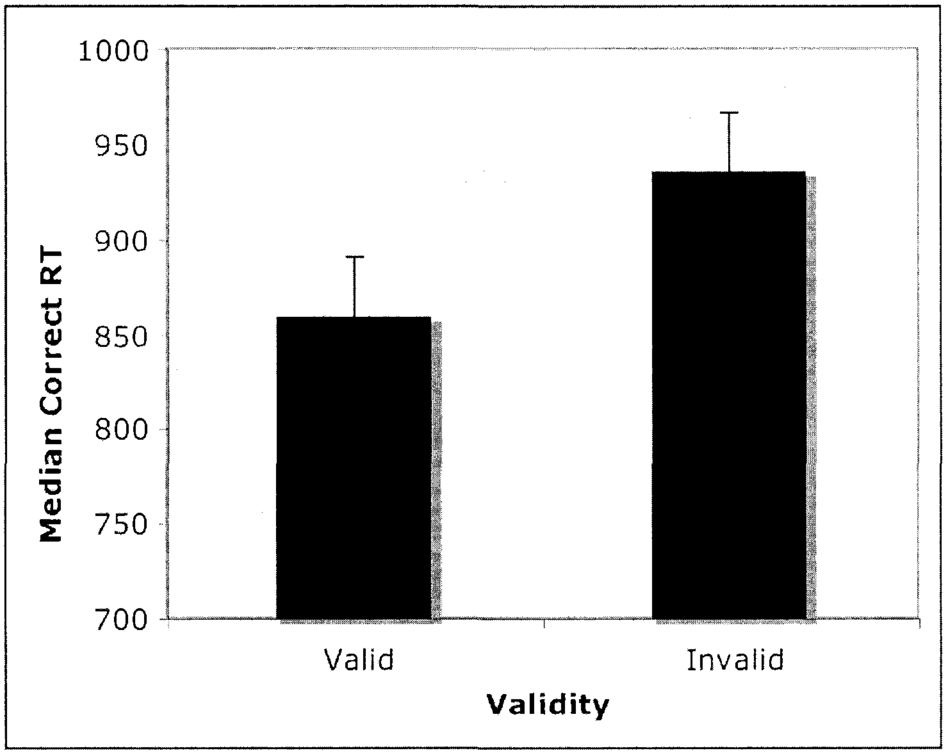


Figure 5. Mean of median reaction times (in milliseconds) as a function of Validity (valid vs. invalid). Error bars depict SEM. There is a significant main effect of Validity.

Group x Validity. A significant Group by Validity interaction, $F\,(1,36)=4.51$, $p=0.04$, $\eta^2=0.11$, revealed that the orienting effect was strong for both groups. Post hoc tests of simple effects with Bonferonni adjustments revealed a significant orienting effect for the children with ASD, *Multi* $F\,(1,36)=92.33$, $p=0.00$, as RTs to invalid trials (*M*=915.34, *SEM*=45.89) were longer than to the valid trials (*M*=824.65, *SEM*=46.56). A significant orienting effect for the typically developing children was also observed, *Multi* $F\,(1,36)=43.63$, p=0.00, as the invalid trials were longer (*M*=951.90, *SEM*=45.89) than the valid ones (*M*=889.55, *SEM*=46.56). A one-way ANOVA revealed that the orienting effect was stronger for the children with ASD than for the typically developing children, $F\,(1,36)=4.51$, $p=0.04$. The mean difference between invalid and valid trials was larger for the children with ASD (*M*=90.70, *SEM*=11.31) than for the typically developing children (*M*=62.35, *SEM*=7.09). See Figure 6 for a depiction of the mean RTs for each group as a function of validity.

Group x SOA x Cue. A significant three-way interaction of Group by SOA by Cue, $F\,(1,36)=6.09$, $p=0.02$, $\eta^2=0.15$, was found. Post hoc tests of simple effects with Bonferonni adjustments revealed that the hand cue became even more informative than the arrow cue at the longer SOA for the children with ASD. When given 650 ms to view the cue, the children with ASDs were faster in response to the hand (*M*=804.37, *SEM*=43.27) than to the arrow (*M*=871.21, *SEM*=53.53) cue, *Multi* $F\,(1,36)=7.08$, $p=0.01$.

Simple effects also revealed that the longer SOA facilitated the use of the hand cue for the children with ASDs. The RTs in response to the hand cue were significantly faster at the longer SOA (*M*=804.37, *SEM*=43.27) than at the shorter SOA (*M*=903.03, *SEM*=47.33), *Multi F* (1,36)=9.60, *p*=0.00. The longer processing time was also facilitative for the typically developing children, but for the arrow cue. For the typically developing children, RTs using the arrow cue were faster at the longer SOA (*M*=883.21, *SEM*=53.53) than at the shorter SOA (*M*=980.37, *SEM*=51.27), *Multi F* (1,36)=18.47, *p*=0.00. See Figure 7 for a depiction of the mean RTs for each group as a function of cue and SOA.

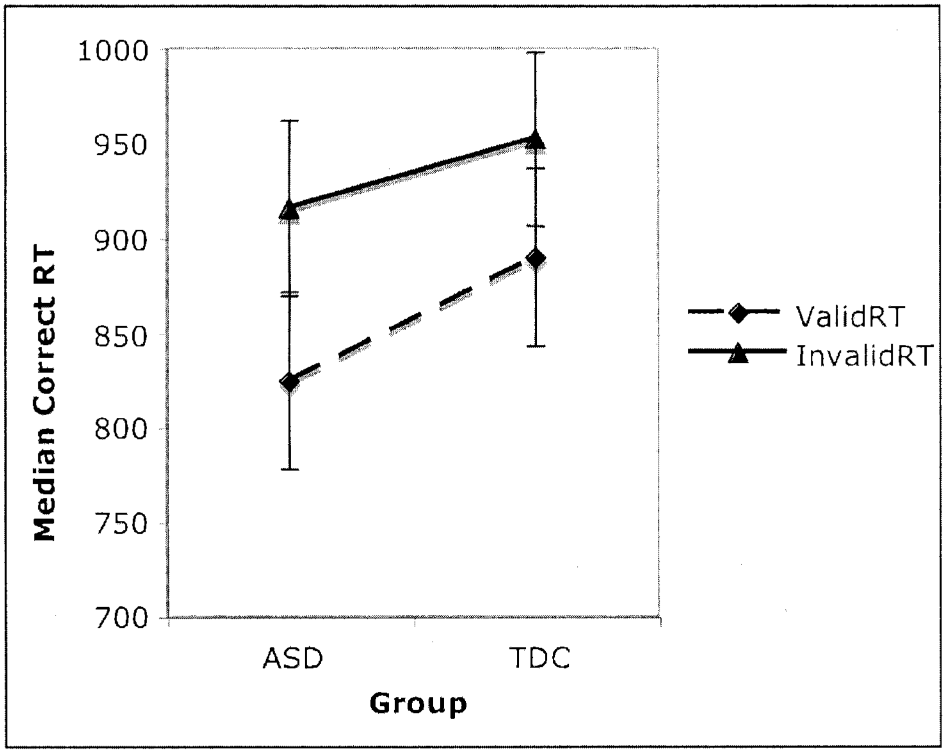
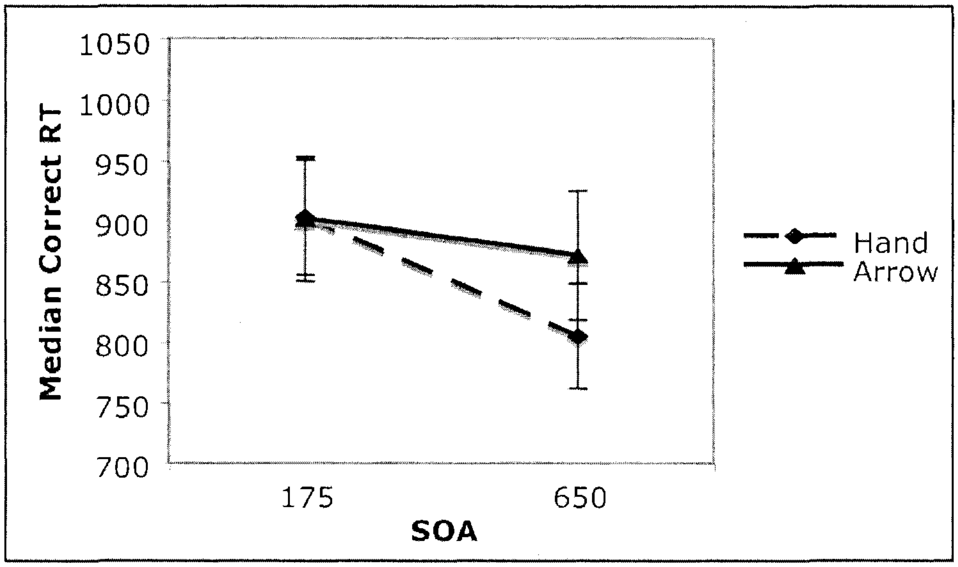


Figure 6. Mean of median reaction times (in milliseconds) as a function of Group (ASD vs. TDC) and Validity (valid vs. invalid). Error bars depict SEM. There is a significant Group by Validity interaction.

(a)



(b)

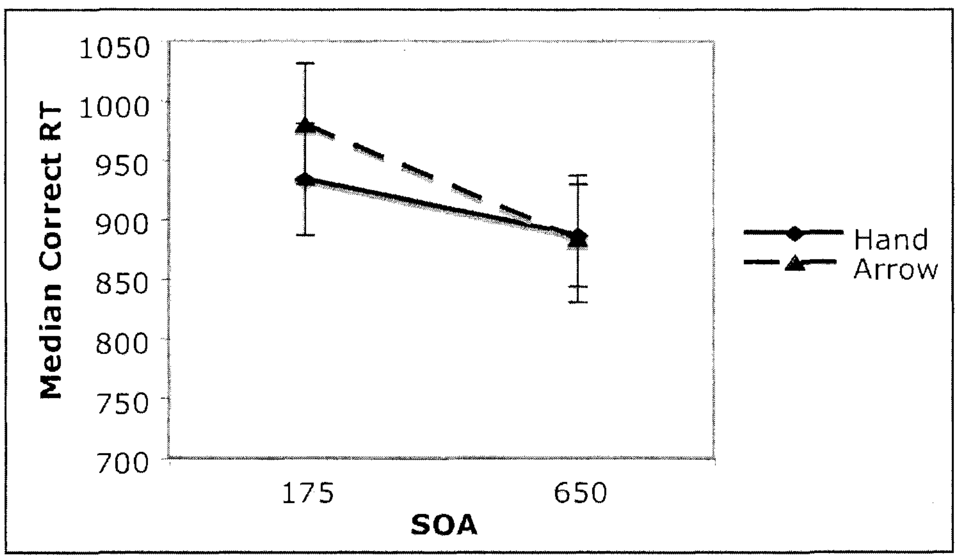
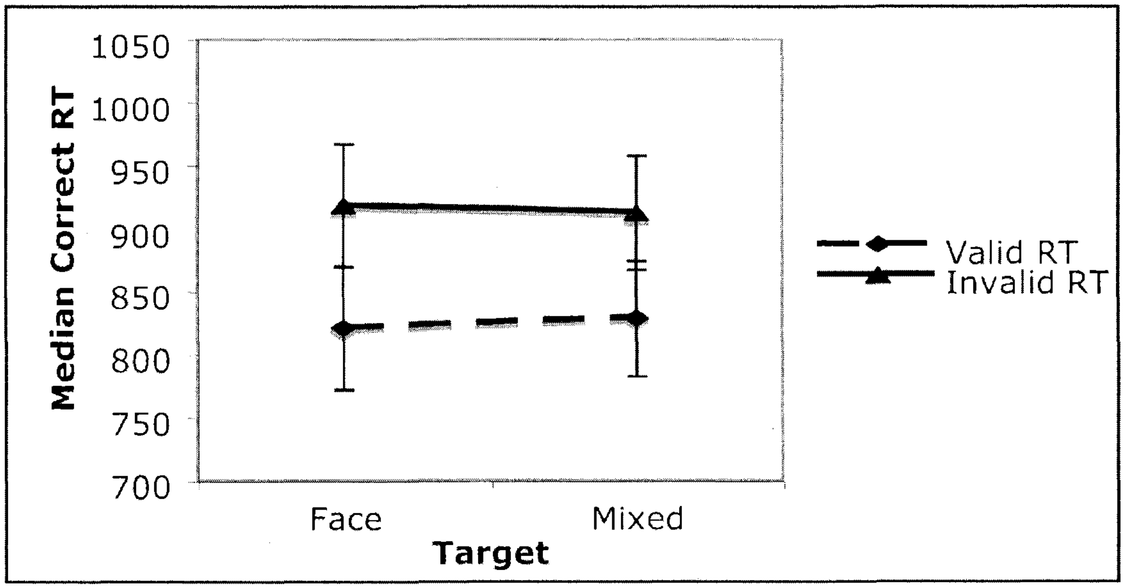


Figure 7. Mean of median reaction times (in milliseconds) per group (a=ASD, b=TDC) as a function of SOA (175 ms vs. 650 ms) and Cue (hand vs. arrow). Error bars depict SEM. There is a significant Group by SOA by Cue interaction.

Group x Target x Validity. A significant Three-way interaction of Group by Target by Validity, *F* (1,36)=5.95, *p*=0.02, η^2=0.14 was found. Post hoc tests of simple effects with Bonferonni adjustments revealed a strong orienting effect for each group in relation to both of the target types. For the children with ASD, RTs in response to the face target were longer for the invalid (*M*=918.15, *SEM*=48.20) than for the valid (*M*=820.59, *SEM*=48.91) trials, *Multi F* (1,36)=78.09, *p*=0.00. Reaction times in response to the mixed face target were also longer for the invalid (*M*=912.54, *SEM*=45.03) than for the valid (*M*=828.69, *SEM*=45.84) trials for this group, *Multi F* (1,36)=70.28, *p*=0.00. A similar pattern was demonstrated among the typically developing children, in response to the face target, the RTs for the invalid trials (*M*=927.72, *SEM*=48.20) were longer than for the valid ones (*M*=874.65, *SEM*=48.92), *Multi F* (1,36)=23.12, *p*=0.00. This was also the case when the target was the mixed face. Reaction times to the invalid trials (*M*=976.08, *SEM*=45.03) were longer than for the valid trials (*M*=904.46, *SEM*=45.84), *Multi F* (1,36)=51.28, *p*=0.00. RTs differed in accordance with target type for the invalid trials, for the typically developing children but not for the children with ASD. The reaction times during invalid trials were faster for the face target (*M*=904.46, *SEM*=45.84) than for the mixed face target (*M*=976.08, *SEM*=45.83) among the typically developing children, *Multi F* (1,36)=8.38, *p*=0.01. See Figure 8 for a depiction of mean RTs for each group as a function of target and validity.

(a)



(b)

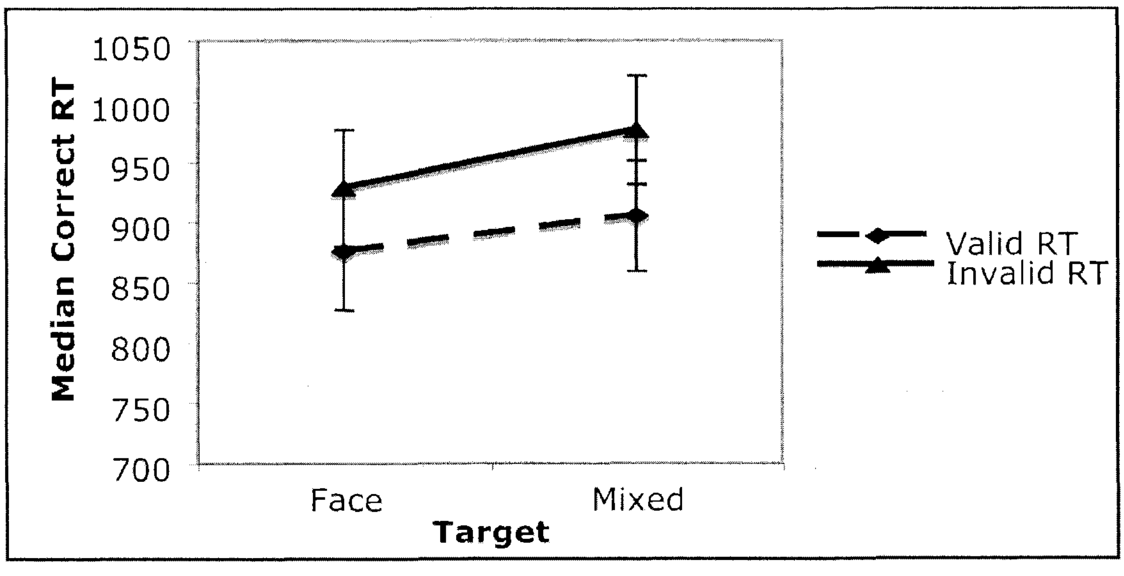


Figure 8. Mean of median reaction times (in milliseconds) per group (a=ASD, b=TDC) as a function of Target (face vs. mixed) and Validity (valid vs. invalid). Error bars depict SEM. There is a significant Group by Target by Validity interaction.

Discussion

The goal of this study was to compare visual orienting to social and nonsocial cues and targets among children with ASDs and typically developing children who were matched at a nonverbal mental age of approximately 8.5 years. A Posner-type orienting task was used to compare the influence of social (handpoint) and nonsocial (arrow) centrally located cues, and short and long SOAs (175 ms and 650 ms), in the discrimination of a social (face) and nonsocial (mixed face) targets. In accordance with Dawson et al.'s (Dawson, 1991; Dawson & Lewey, 1989a; 1989b) notion of inherent complexity differences in the effects of social and nonsocial stimuli, the social and nonsocial cues and the social and nonsocial targets were equated on the basis of visual complexity. The social and nonsocial cues were further equated on the basis of reflexivity as the directionality of arrows and hand points are followed instinctively, even in non-predictive situations (Langton & Bruce, 2000).

In contrast to the findings of endogenous orienting deficits (Wainwright-Sharp & Bryson, 1993), the findings from this study indicated generally intact endogenous orienting for both social and nonsocial cues among the children with ASDs at both SOA conditions. In this study, children with ASDs demonstrated even stronger orienting effects than the typically developing children as indicated by longer RTs on invalid than on valid trials, which highlights the utility of both cue types among this group and suggests that children with ASDs do not have difficulty interpreting the directionality of symbolic cues. These findings are consistent with those from other Posner-like comparisons of orienting to social and nonsocial information where a model of intact *mechanical social orienting* is posited in which directional components are more important than social ones for persons with ASDs when interpreting social cues (e.g., Senju et al., 2004; Vlamings et al., 2005). The notion of *mechanical social orienting* was based on the evidence that persons with ASDs did not respond differently based on cue type in these studies. The findings from this study and the previous ones differ with regard to the interaction of cue type and SOA. In this study, the children with ASDs demonstrated mechanical orienting at the short SOA as they did not differentiate between the arrow and the hand cue. However, cue differentiation was apparent at the long SOA where the children with ASDs responded quicker based on the hand point than on the arrow, but only when allotted additional time to process the cues. Thus, the children with ASDs were able to move beyond a more mechanical type of social orienting to respond to the social components of a social cue, but only at a longer SOA. On the whole, these findings support neither a *social orienting impairment* nor a *general orienting impairment* among persons with ASDs as the children with ASDs demonstrated strong orienting effects based on both cues and they differentiated between cues at the long SOA. Instead, these findings highlight the contribution of processing time to endogenous orienting to social and nonsocial information.

The Effects of SOA

A main effect of SOA revealed an overall facilitation effect in which shorter RTs were demonstrated in the long SOA condition than in the short SOA condition. 650 ms for processing the directionality of the centrally located cue proved to be beneficial for the children with ASDs and for the typically developing children in the discrimination between the target types. This supports the notion that facilitative effects typically increase with SOA (Jonides, 1981).

The Effects of Cue

In line with the expectations of typical development from naturalistic research involving social and nonsocial cues (e.g., Dawson et al., 1998; 2004), the main effect of cue revealed faster RTs in response to the hand cue as compared to the arrow cue. Thus, differential responding was apparent based on cue type even though the cues were equated closely with regard to both their physical and reflexive qualities. This suggests that the cue types differed with regard to their inherent social salience and that the hand point is comparable to the eye gaze cues that were used in other studies in which social and nonsocial orienting was compared among persons with ASDs.

The Effects of Validity

A main effect of validity revealed that the cues used in this task were generally useful since the RTs on invalid trials were longer than on valid trials. A two-way interaction of group by validity revealed that the cues were particularly helpful for the children with ASDs as they demonstrated a larger "orienting effect" than the typically developing children. This notion is supported by other research that suggests that children with ASDs benefit from prompts that guide attention in more naturalistic settings (e.g., Baranek, 1999; Leekam, Hunnisett & Moore, 1998) and that endogenous social cues are interpreted on the basis of directionality in computerized tasks (e.g., Ristic et al., 2005). Another interpretation of these findings highlights the notion that children with ASD may have difficulty disengaging their attention from a cued location on invalid trials as endogenous control (Wainwright & Bryson, 1996). However, even though the disengagement hypothesis, which describes situations where attention seems to get "stuck", is prominent in the attention literature in relation to ASDs (e.g., Zwaigenbaum et al., 2005), it is mostly supported in designs where the cues remain on the screen with the target (see Senju et al., 2005 for a discussion). Further, since the typically developing children also demonstrated large orienting effects, it is unlikely that the orienting effect demonstrated by the children with ASDs indicates more than effective cue use.

The Effects of Group in Relation to SOA and Cue

The *mechanical social orienting* explanations offered by other researchers (e.g., Bayliss & Tipper, 2005; Vlamings et al., 2005) suggest that social cues are interpreted solely on the basis of directionality among persons with ASDs. Consistent with this notion, is the expectation was that the children with ASDs would not distinguish between the hand point and arrow as the distinction between social and nonsocial cues is typically considered to be indicative of social sensitivity in tasks that directly compare social and nonsocial orienting. A three-way interaction among group, SOA, and cue revealed that children with ASD did not distinguish between the hand point and arrow cues at the short SOA of 175 ms, whereas the RTs of the typically developing children were faster in response to the hand cue at this SOA. However, the children with ASD distinguished between the two cues at the longer SOA of 650 ms and responded more quickly to the hand cue when they were allotted more time to process it. This finding corroborates Burack et al.'s (1997) *slowing hypothesis* that persons with ASDs demonstrate intact endogenous orienting when they more time to process cues. Though Burack et al.'s hypothesis was derived based on evidence from a nonsocial orienting paradigm (Wainwright-Sharp, & Bryson, 1993), it seems equally relevant to the explanation of this finding in relation to a social cue. The SOA conditions used in the studies that reported only mechanical social orienting seem to support this interpretation as they were quite a bit shorter than 650 ms. For example, Vlamings et al. (2005) who found intact endogenous orienting but decreased social sensitivity among high-functioning adults with ASD, used an SOA of 400 ms for the eye gaze and arrow cues. Similarly, Bayliss and Tipper (2005) used an SOA of 376 ms for their endogenous eye gaze and arrow cues and found that individuals with ASD did not distinguish between the cue types. This suggests that children with ASDs may be able to appreciate and distinguish cues on the basis of social salience when they have more time to process the social cues. Courchesne, Chisum, and Townsend (1995) support this notion with their suggestion that it is not the social features but the speed of social interactions that place children with ASDs at a disadvantage in everyday social situations. They note that complex social interactions require quick processing of and rapid shifts between social information in the environment that make it difficult for children with ASD to keep up. Thus, the findings from this study seem to imply that processing time is an influential factor in social orienting.

The three-way interaction among group, SOA, and cue also revealed facilitation effects for both the children with ASD and the typically developing children. But, these facilitation effects differed according to group. For the typically developing children, the longer SOA facilitated the use of the arrow cue, whereas for the children with ASD, it facilitated the use of the hand cue. One interpretation of this contradictory pattern of responses is based on the notion of visual habits (Trick & Enns, 2006). Visual habits, though automatic, are distinguished from reflexes in that they require repeated exposure in particular contexts, or to be over-learned, in order to be processed automatically. This difference in the pattern of responding between the children with ASDs and typically developing children may indicate that the arrow cue is an automatic cue for children with ASDs whereas the hand point is an automatic cue for typically developing children.

The developmental literature regarding the early use of social information seems to corroborate the notion of visual habits for social cues. For example, Goodhart and Baron-Cohen (1993) suggest that typically developing toddlers are adept at following and using hand points whereas children with ASDs demonstrate difficulty with both tasks. Mundy and Neal (2001) suggest that the early difficulty with social stimuli in the environment predisposes children with ASD to environments with less social salience. For example, in the attempt to accommodate apparent difficulties with social cues, children with ASD may be exposed to more nonsocial directional cues such as arrows in their environment. Many visual software packages (e.g., *Boardmaker*, a database of pictograms) aimed at providing teachers with visual tools to assist students with ASDs use arrows prominently to demonstrate directionality (Moos, & Hartwig, 1997). Thus, children with ASD may have much more experience with arrow cues and process these automatically. For typically developing children, early and repeated experiences with social cues would predispose them to process such cues automatically. Thus, the three-way interaction among group, SOA, and cue seems to highlight a facilitation effect for cues that are not processed automatically for the children with ASD and for the children with typical development. In this scenario, cues that are automatic do not require more than a short amount of time in order to be utilized most effectively. In this case, an SOA of 175 ms was sufficient for the children with ASDs to demonstrate optimal performance based on the arrow cue and for the typically developing children to demonstrate optimal performance based on the hand cue. This finding highlights the contribution of processing time to the literature on social and nonsocial orienting and suggests that the comparisons between arrows and hand points can provide insight into orienting based on social and nonsocial information.

The Effects of Group in Relation to Target and Validity

A three-way interaction among group, target, and validity revealed a strong orienting effect to both target types for both children with ASD and for typically developing children as longer RTs were recorded on invalid trials than on valid trials. This orienting effect varied in relation to target type for the typically developing children, but not for the children with ASDs. The typically developing children displayed faster RTs on invalid trials in which a face target appeared as compared to invalid trials in which a mixed face appeared. This finding supports Bayliss and Tipper's (2005) notion that the context of the targets might be important in orienting. Here, the context was only important for the typically developing children, since the children with ASDs did not distinguish between target types. This is in contrast to other findings that clarify that persons with ASDs use contextual information as readily as typically developing children in memory tasks (Brian & Bryson, 1996). One interpretation of this is that although the mixed face may not have provided any sort of real context since it was not an object. This notion is supported in Bayliss and Tipper's findings that photographs of whole faces (social) and tools (nonsocial) were responded to more quickly than the photographs of scrambled faces and tools seem to highlight the importance of being able to label the target in order to ascribe some kind of a context. These findings offer marginal support to the literature on spontaneous attention of children with ASDs (e.g., Swettenham et al., 1998) in which children with ASDs look less at faces than at objects as compared to typically developing children. However, since the nonsocial target in this task cannot be considered an object, comparisons between these findings and those from more naturalistic designs are difficult to make.

Limitations

There were two main limitations of the current study. One, the social salience of the task could have been increased to be more consistent with more naturalistic examples of social orienting. The social salience of the hand point cue was validated on typically developing adults (Langton & Bruce, 2000), and may hold a different meaning in developmentally younger groups. And, although faces are inherently social, this task was quite simple in that it required the detection of a stationary face, which is less demanding than what is required in everyday social interactions. Two, the comparison of orienting to social and nonsocial information was made at a particular developmental stage, at approximately 8.5 years, and may not generalize to other developmental stages. In order to assess the emergence of these abilities, it would be necessary to examine orienting to social and nonsocial information developmentally.

Conclusions and Future Directions

In sum, this study was designed to compare orienting to social and nonsocial information using a visual task where the complexity of the stimuli was carefully equated. The findings presented here suggest intact endogenous orienting among children with ASD who were matched to typically developing children on the basis of nonverbal mental age at approximately 8.5 years. The findings from this study challenge the notions of a *social orienting impairment* and of a *general orienting impairment* as the children with ASDs in this study demonstrated strong orienting effects in all conditions social sensitivity in the long SOA condition. Instead, this study highlights the contribution of processing time and demonstrates that Burack et al.'s (1997) *slowing hypothesis* is as applicable to social orienting paradigms as to nonsocial orienting ones. More research is needed to determine whether these findings remain consistent at other developmental stages, with other comparison groups, and using different social cues and targets. Further, as social orienting abilities have been linked to larger difficulties with everyday social interactions, this link should be tested directly.

Original Research Contributions

The original contributions of this study to the empirical literature are methodological and theoretical in nature. In this study, a Posner-like paradigm was used to compare social and nonsocial orienting among children with ASDs and typically developing children who were matched on nonverbal MA. First, with regard to the methodological contributions, this study was designed in the visual modality to avoid cross-modality task demands and with a particular focus on equating stimuli with regard to complexity as these factors may have influenced earlier findings of a *social orienting impairment* among persons with ASDs. This is the first study to directly address Dawson et al.'s (Dawson, 1991; Dawson & Lewey, 1989a; 1989b) position that social information is inherently more complex, and thus more difficult to interpret for children with ASDs. This is also the first study comparing endogenous hand points and arrows among persons with ASDs, which contributes to the utility of these cue types in examining orienting to social and nonsocial stimuli. Second, this study contributes to the theoretical literature by challenging the notion of a *social orienting impairment* that seems to prevail in most research in this area. The findings from this study contributes to the re-conceptualization of social information processing in this group by offering alternative explanations for the previous findings that highlighted significant deficits. In this study, the findings highlight the unique contribution of processing time in the emergence of orienting to social and nonsocial information. These theoretical contributions may help to inform future research directions, and may contribute to interventions and curricula aimed at children with ASDs and may help to refocus attention away from a deficit model of Autism Spectrum Disorders.

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Appendix A: Screening Questionnaire

General Information

1. **Child's name:**__________________________________
2. **Date of Birth:**__________________________________
3. **Handedness: right**__________ **left**__________ **ambidextrous**________
4. **Glasses?** ______________________________________
5. **Diagnosed attention problems?** _____________________________
6. **Diagnosed motor problems?**________________________________

Appendix B: Task Instructions

"Today we are going to play a game on the computer. On the screen you will see one of two pictures [show both target pictures]. You will only see one picture at a time. You will see the picture either on the right or the left of the center [point to right and left of center]. What I want you to do is press the red button when you see this picture [show face picture]. And, press the blue button when you see this picture [show mixed face picture]. I want you to press on the buttons as quickly as you can, but only if you see one of the pictures that I showed you. It is very important that you keep your eyes on the center of the screen. Ok? So, there are three important things to remember. One, press the red button as quickly as you can when you see this picture [show face] and the blue button as quickly as you can when you see this picture [show mixed face]. Two, do not press the buttons unless you see one of the pictures. Three, always keep your eyes on the center of the screen. First we will practice together and then you will play the game by yourself. Are you ready? Do you have any questions? Let's begin."

Appendix C: Ethics Certificates and Consent Forms

McGill

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(514) 398- 4679

This consent form clearly specifies the purpose, procedures and conditions required for your child's participation in the study that is being conducted by the McGill Youth Study Team of McGill University.

1. **Purpose**

   I have been informed that the purpose of this research is to study complex thought processes and orienting. I understand that the data gathered may provide answers to important questions about the development of abilities such as problem-solving and decision-making, which are essential to daily life for persons of all ages. I understand that the aim of the study is to obtain data about children in general as well as build a database of the cognitive, social, and processing abilities of children within the autism spectrum.

2. **Procedures**

   I understand that my child will be asked to participate in tasks that involve pointing to pictures, pushing keys on a key board, and playing games. I have been informed that the tasks present no known risk and have been used before with persons of the same age as my child. Everything my child is asked to do will be explained to him/her beforehand. If my child wishes to stop or not perform the task, he or she may do so at any point. I understand that my child's performance in the study will not affect his or her status in any way.

3. **Conditions of Participation**

   I understand that the tasks will be presented in the context of games, and my child will receive compensation regardless of performance on the games played.

   I understand the purpose of this study and know the benefits and inconvenience that this research project entails.

   I understand that my child's identity will remain anonymous and all information about me will be kept confidential. I understand that all data will be stored in a locked cabinet. I understand that any specific information collected in this study is confidential and is protected under the Freedom of Information and Protection of Privacy Act 1989 (Bill 49). The researchers will disclose information only if compelled by law.

I have been advised that the data will be used for research purposes only. I consent to the published reporting of this study so long as the results are reported as group averages and my child's name or any other personal information is never used in these reports.

I understand that the researchers involved will be available to answer any questions regarding the procedures of this study.

****

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND MY PARTICIPATION IN THIS AGREEMENT. I VOLUNTARILY AGREE AND FREELY CONSENT FOR MY CHILD TO PARTICIPATE IN THIS STUDY.

_____________________________	_____________________________
Child's Name	Child's date of birth
_____________________________	_____________________________
Date	Signature of Parent or Guardian