Visual-Spatial Orienting in Autism

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Visual-spatial orienting in high-functioning adults with autism and both chronological- and mental-age normal controls was examined. Three experiments were conducted in which stimuli were presented centrally and/or laterally (left or right of central fixation), and either detection or identification was required. The group with autism differed from normal controls by responding faster to central than to lateral stimuli, and by showing a left visual field advantage for stimulus detection only in the simplest condition (lateral presentations alone). Discussion focuses on the apparent abnormalities in disengaging/shifting attention, and on the coordination of attentional and motor systems in autism.

INTRODUCTION

Accumulating evidence implicates attentional impairments in people diagnosed as autistic. The early studies of Hermelin and O'Connor (1970) indicate, among other things, that children with autism learn little through perception alone. Rather, their ability to learn a discrimination appears to depend on the production of an overt motor response (e.g., pointing; Hermelin & O'Connor, 1967). In autism, it may be that motor responses like...
pointing direct attention such that it is focused on relevant perceptual information (Bryson, Wainwright-Sharp, & Smith, 1990; see Williams, 1992, who suggests that touch may serve a similar function).

Others have argued that attention is overly focused in autism (e.g., Lovaas, Schreibman, Koegal, & Rehm, 1971). Later findings indicate that the factor that distinguishes children with autism from matched developmentally disabled controls is the spatial distance separating different aspects of a stimulus (Rincover & Ducharme, 1987). That is, as the distance between stimulus features increases, children with autism show evidence of selectively responding to only a small part of the stimulus array. Rincover and Ducharme coined the term "tunnel vision" to refer to this overfocused attention.

As might be predicted, overfocused attention in individuals with autism appears to coexist with impairments in disengaging and/or shifting attention, both within the visual modality (Casey, Gordon, Mannheim, & Rumsey, 1993; Townsend & Courchesne, 1994; Wainwright-Sharp & Bryson, 1993) and across visual and auditory modalities (Courchesne, Akshoomoff, & Ciesielski, 1990). There is also evidence that within the visual modality the difficulties are particularly marked when attention must be moved to the left side of space (Casey et al., 1993; Wainwright-Sharp & Bryson, 1993). Such findings may implicate attentional processes associated with the right posterior and/or frontal areas of the brain (Posner, 1988). They also raise the question of whether visual-spatial orienting is lateralized in people with autism.

The present research examined lateral differences in spatial attention in high-functioning young adults with autism. We employed a traditional visual orienting task in which participants are required to detect simple lateralized stimuli. Normal people typically respond more quickly to left-sided stimuli, suggesting that the right hemisphere is usually dominant for the processes of orienting to and detecting a stimulus in visual space (e.g., Heilman & Van Den Abell, 1979). In Experiment 1, simple target stimuli (crosses) were presented to the left or right of fixation, and participants simply responded on each trial when the stimulus appeared (simple detection task). Experiment 2 was exactly the same, except that target stimuli appeared to the left or right of, or at, fixation (also simple detection). Experiment 3 was the same as Experiment 2, except that the task involved a decision rather than detection alone: both crosses and boxes appeared, and participants responded only to crosses (identification task).

A main question of interest was whether high-functioning people with autism would show the typical left field–right hemisphere advantage for orienting to stimuli in visual space. Several authors have implicated the right hemisphere, and specifically right hemisphere attentional mechanisms,
Visual-Spatial Orienting in the neuropathology of autism (Bryson et al., 1990; Dawson & Lewy, 1989a, 1989b; Fein, Humes, Kaplan, Lucci, & Waterhouse, 1984; Kinsbourne, 1987). To our knowledge, laterality differences in visual attention have not yet been examined in people with autism. Simple visual stimuli were presented laterally in Experiment 1 to assess response patterns to left versus right stimuli. Centrally located stimuli were included in Experiment 2 to determine whether reports of overfocused attention, and of problems disengaging and/or shifting attention, could be substantiated in a simple orienting paradigm. Experiment 3 extended the results of Experiment 2 by enhancing the cognitive demands of the task (identification vs. detection alone). In all three experiments, the performance of high-functioning adolescents and adults with autism was compared to that of two normal control groups, matched on either chronological or mental age.

EXPERIMENT 1

In this experiment participants were required to detect single targets presented either to the left or right of fixation. The main question of interest was whether people with autism would show the typical left field-right hemisphere advantage for orienting to visual stimuli.

Method

Subjects

Ten males, formally diagnosed as autistic according to DSM-III-R criteria (n = 8; APA, 1987), or as meeting ICD-9 criteria for Asperger syndrome (n = 2; WHO, 1986), participated in this experiment. All autistic participants have a long-standing history of classic autistic behavior, and continue to manifest severe problems in socialization and reciprocal communication. Obsessive-compulsive features are marked, and difficulties with change or novelty are common. Table 1 provides descriptive data on this relatively high-functioning and homogeneous group of men with autism. All but two are right-handed. Each participant received $5 remuneration for their assistance.

The chronological age (CA) controls consisted of 10 normal males, matched to the autistic group on age (M age = 23 years 6 months) and handedness. This group was recruited mainly from an undergraduate subject pool; younger subjects were recruited through acquaintances. A group of 10 younger normal males (MA controls; M age = 11 years 9 months)
were matched to the participants with autism on handedness, and on receptive language ability, the Peabody Picture Vocabulary Test–Revised (PPVT-R; Dunn & Dunn, 1981) raw scores (see Table I). A verbal measure was chosen for matching purposes on the assumption that this is most conservative, although research indicates that in autistic adults, verbal and non-verbal IQ are highly correlated. IQ is also highly correlated with their performance on a variety of other tasks (see Bryson, Landry, & Wainwright, in press, for a review). The MA controls were recruited through a church group, and received a small gift for their efforts.

Task Design

Each trial began with a tone (less than 1-second duration), which was a signal for the participant to fixate on a simultaneously appearing, centrally
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located asterisk. The fixation point remained on the screen for a randomly determined period of between 1 and 2 seconds. Correct fixation at the beginning of each trial was monitored by the experimenter. Immediately following the offset of the fixation point, the target stimulus appeared randomly to the left or right of fixation. Target stimuli remained on the screen until the participant depressed the microswitch, or for a maximum period of 3 seconds. There was a 2-second intertrial interval from the last button press to the next tone. Twenty trials per location were completed with one hand. After a 5- to 10-minute break, participants repeated the block of trials with the other hand. For each participant, and in each block of trials, targets were presented in a different, random order. The order of hand used was counterbalanced within each group.

Materials and Apparatus

The stimuli for the simple reaction time (RT) task consisted of crosses (0.8 x 0.6 cm) that appeared in the left or right visual field. The peripheral targets were 6.5 cm on either side of the central fixation point. Participants were seated in front of a computer screen on which the stimuli appeared. Their heads were held in a fixed position by a chin rest 25.0 cm away from, and eye level with, the stimuli, which subtended a retinal angle of 1.8 degrees. A microswitch was centrally placed on a response board, on which the subject's hand was resting. Presentation of the stimuli, timing of the RT task fore period, and measurement of RT in milliseconds were controlled by an IBM computer.

Procedure

Each participant was introduced to the testing area, and familiarized with the equipment. Participants were told that they were helping to find out how quickly people react to things they see, and were given a brief description of the task requirements. They were told that crosses would appear in one of two places on the computer screen, and were asked to react ("hit the button") with a specified hand as quickly as possible after seeing the cross. Participants were encouraged to stare at the middle of the screen upon hearing the tone, to increase their chances of seeing the crosses sooner. Twelve practice trials were given to ensure that the instructions had been understood. None of the participants had any difficulty with the task requirements.
**Results and Discussion**

Mean RTs in each condition were calculated for each participant. Any RT less than 100 milliseconds was considered anticipatory, and was eliminated from the calculation of means. As well, outliers (RTs deviating from the means by 1.5 standard deviations, calculated by condition per subject) were omitted. Together, these eliminated very few data points (<5%). No trials were excluded because of a failure to respond within the given time, thus precluding the analysis of accuracy. To assess the possible effect of IQ, versus MA, a regression analysis was performed with PPVT-R standard scores. Results indicated that no relationship existed between these scores and the pattern of performance on any of the tasks employed here (all Fs < 1). The same was the case for nonverbal IQ (measured via Raven's Progressive Matrices), although Raven's scores were only available for the autistic and CA-matched normal groups.

The data were subjected to a 3 × 2 × 2 (Group × Field × Hand) mixed-design ANOVA, with group (autistic vs. CA vs. MA) as the only between-subject variable, and field (right vs. left) and hand (right vs. left) as the two within-subject variables. This analysis revealed a significant main effect of Field, $F(1, 27) = 7.97, p < .009$, and a significant Group × Hand interaction, $F(2, 27) = 3.60, p < .04$ (see Table II). No overall group difference in RT was found. The main effect of Field indicated that for all groups, targets in the left visual field (289.4 ms) were detected more quickly than targets in the right visual field (299.4 ms). Nine of 10 CA controls, 6 of 10 MA controls, and 8 of 10 autistic participants displayed this left field advantage.

To examine the Group × Hand interaction more closely, and to validate the Field effect within each group, individual ANOVAs were performed on each group's data. These analyses revealed first, a significant main effect of Field (left field) for both the CA controls, $F(1, 9) = 6.98, p < .03$, and the participants with autism, $F(1, 9) = 6.58, p < .03$, but not

<table>
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<th>Group</th>
<th>Left hand</th>
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<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>Autistic</td>
<td>340.3</td>
<td>117.5</td>
<td>323.9</td>
</tr>
<tr>
<td>MA controls</td>
<td>312.7</td>
<td>88.1</td>
<td>298.4</td>
</tr>
<tr>
<td>CA controls</td>
<td>239.7</td>
<td>47.8</td>
<td>251.4</td>
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the MA controls, $F(1, 9) = 0.71, p < .42$ (see Table III). With regard to the Group × Hand interaction, the CA controls responded significantly faster with their left hand than with their right hand, $F(1, 9) = 6.28, p < .03$. In contrast, the MA normal controls showed the opposite pattern, with right-hand responses being faster than left-hand responses, $F(1, 9) = 5.22, p < .05$. The participants with autism showed the same, but nonsignificant, pattern as the MA controls, $F(1, 9) = 1.87, p < .20$.

Like the normal adults, the participants with autism showed a reliable left field advantage for detecting simple visual stimuli. No such effect was found for the MA controls, who were much younger than the other two groups. In addition, both the normal children (MA controls) and the adolescents/adults with autism failed to show the overall left-hand advantage demonstrated by all but one of the normal adults. The MA controls responded faster overall with the right hand, and no hand advantage was found for the group with autism. Research using simple visual orienting paradigms have yielded variable hand effects, depending on the nature of the task and the response type and location (see Bashore, 1981, for a review). In experiments most similar to ours, left-hand responses were faster, but failed to reach statistical significance (Milner, Jeeves, Ratcliff, & Cummings, 1982).

The finding that the MA controls did not show evidence of a left field advantage is consistent with earlier research on normal children (e.g., Shapiro & Hynd, 1985). Together, this work suggests that the lateralization of visual-spatial attention may not be well established until late adolescence. The absence of a left-hand advantage in the normal children on our task may be seen as consistent with their failure to show a visual laterality effect. Others have suggested that motor and attentional systems develop somewhat independently, and that a major developmental achievement is to bring motor mechanisms under the control of more central mechanisms like attention (Rothbart, Posner, & Boylan, 1990). From this viewpoint, the congruence between left-hand and left-field effects observed in the nor-

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<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>Autistic</td>
<td>325.1</td>
<td>102.3</td>
<td>339.0</td>
</tr>
<tr>
<td>MA controls</td>
<td>301.8</td>
<td>76.3</td>
<td>309.2</td>
</tr>
<tr>
<td>CA controls</td>
<td>241.0</td>
<td>49.2</td>
<td>250.1</td>
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mal adults may reflect greater control of, and coordination between, attentional and motor systems. Recall that for the participants with autism the pattern of motor responses resembled more closely the MA controls, whereas the visual field advantage paralleled that of the CA controls. The relationship between motor and attentional systems in this group is a matter to which we return.

EXPERIMENT 2

Reports of overfocused attention, and of difficulties disengaging and/or shifting attention, both anecdotal and empirical, have begun to appear with more regularity in the autism literature (e.g., Courchesne et al., 1990; Rinecover & Ducharme, 1987; Williams, 1992). The simple visual orienting paradigm used in Experiment 1 provides an opportunity to further evaluate these claims. To this end, central targets were included in Experiment 2 on the assumption that their presence at fixation might differentially influence the responses of individuals with autism.

Method

Subjects

Eleven adult males, diagnosed as autistic \( n = 7 \) or as having Asperger syndrome \( n = 4 \), participated in this experiment. All but one is right-handed. Seven of these individuals took part in Experiment 1, which was conducted on a separate occasion. The CA control group comprised 11 normal males recruited through an undergraduate subject pool. This group was matched to the participants with autism on age \( M = 20 \) years 6 months) and handedness. The MA controls consisted of 11 younger normal males \( M \) age = 14 years 3 months), matched to the individuals with autism on handedness and receptive language (PPVT-R raw scores). Table 1 contains descriptive data on each group.

Task Design, Apparatus, and Procedure

All aspects of this experiment were the same as in Experiment 1, except that target stimuli appeared at, as well as to the left and right of, fixation.
Results and Discussion

Raw data were treated in the same manner as in Experiment 1. Once again, no targets were missed by any of the participants. The data were subjected to a 3 (Group) x 3 (Field; left, right, and central) x 2 (Hand) mixed-design ANOVA. This analysis revealed a significant main effect of Group, $F(2, 30) = 5.11, p < .01$, and two significant interactions: between Group and Hand, $F(1, 20) = 6.08, p < .02$ (Table IV), and between Group and Field, $F(2, 40) = 7.75, p < .002$ (Table V). Post-hoc Newman-Keuls comparisons revealed that the autistic group responded significantly slower than both the MA controls, $p < .05$, and the CA controls, $p < .05$, who did not differ (autistic = 367.7 ms, MA = 282.1 ms, CA = 252.0 ms).

To further examine the Group x Hand and Group x Field interactions, separate ANOVAs were performed on each group’s data. These analyses revealed a significant effect of Field for the CA-matched controls, $F(2, 20) = 47.52, p < .0001$. Newman-Keuls tests indicated that RTs to each of the lateral stimuli were significantly faster than RT to the center stimulus (left = 236.7 ms, right = 247.9 ms, and center = 271.4 ms, $p < .01$). In addition, left field stimuli were responded to significantly faster than right field stim-

Table IV. Experiment 2: Mean Response Latencies as a Function of Hand and Group

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<th>Left hand</th>
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<th>Individual analyses</th>
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<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>Autistic</td>
<td>383.7</td>
<td>185.4</td>
<td>352.7</td>
</tr>
<tr>
<td>MA controls</td>
<td>290.2</td>
<td>79.5</td>
<td>274.0</td>
</tr>
<tr>
<td>CA controls</td>
<td>246.1</td>
<td>34.0</td>
<td>258.0</td>
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Table V. Experiment 2: Mean Response Latencies as a Function of Field and Group

<table>
<thead>
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<th>Visual field</th>
<th>Left</th>
<th>Right</th>
<th>Center</th>
<th>Individual analyses</th>
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<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Autistic</td>
<td>370.1</td>
<td>140.3</td>
<td>379.4</td>
<td>162.8</td>
</tr>
<tr>
<td>MA controls</td>
<td>274.2</td>
<td>67.6</td>
<td>285.1</td>
<td>76.8</td>
</tr>
<tr>
<td>CA controls</td>
<td>236.7</td>
<td>22.2</td>
<td>248.0</td>
<td>29.4</td>
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uli, $p < .01$, with 91% (10/11) of the CA control group showing this effect. In contrast, no effect of field was found for the MA normal control group, $F(2, 20) = 1.97, p < .16$. Similarly, the autistic group's RTs to left, right, and central stimuli did not differ significantly, $F(2, 20) = 1.66, p < .21$.

Results from the within-group ANOVAs indicated further than the CA controls responded significantly faster with their left hand than with their right hand, $F(1, 10) = 4.98, p < .05$, thus replicating the results in Experiment 1. Both the autistic group and the MA controls tended to show the opposite pattern, although this difference did not reach statistical significance in either group, autistic: $F(1, 10) = 3.50, p < .09$; MA: $F(1, 10) = 1.95, p < .19$.

These data extend previous research by showing that even when targets are presented at fixation, normal adults show the well-documented left-field advantage for visual orienting (e.g., Berlucchi, Heron, Hyman, Rizzolatti, & Umilta, 1971). In contrast, both the normal children and the adolescents/adults with autism failed to display any reliable field or hand differences. Thus, the inclusion of central stimuli eliminated the significant left field advantage displayed by the autistic group in Experiment 1. Inspection of Table V suggests further that different patterns of responses to central and lateral stimuli were exhibited by the three groups: CA controls responded more quickly to lateral than to central stimuli, MA controls showed no differences in response times, while the high-functioning adults with autism showed the opposite, but nonsignificant, pattern of faster RTs to central than to lateral targets.

It bears emphasizing that in the present study, peripheral targets, which appear in an otherwise empty visual field, need only be detected. In contrast, targets in the central position must be detected, and identified as being different from the fixation point before a motor response is initiated. In our task participants are thus required to execute two attentional operations (detection and identification) before responding to central targets. Viewed in this light, it is not surprising that the CA controls responded faster to lateral than to central stimuli (see Bashore, 1981, for a discussion of the effects of task complexity on RT). Conversely, the tendency in the autistic group to respond more quickly to central targets appears even more striking. To our knowledge, such effects have been found in normal people only when the two operations are required at lateral as well as central target locations (Tassinari, Aglioti, Chelazi, Marzi, & Berlucchi, 1987).

EXPERIMENT 3

In this experiment, we attempted to enhance the difference between responses to lateral and central targets in autistic people by increasing the
task requirements. Rather than simply detecting targets, participants were required to distinguish between target and nontarget stimuli appearing to the right, left, or center of fixation. Two operations (detection and identification) were thus required at each target location, although only central stimuli (targets and nontargets) had to be distinguished from the fixation asterisk (cf. Tassinari et al., 1987).

Method

Subjects

The participants (n = 11 per group) were the same as those who served in Experiment 1, including the one participant whose data from Experiment 1 was lost (see Table I). Experiments 1 and 3 were conducted in the same testing session, and order of presentation was counterbalanced within groups.

Task Design

The design was the same as Experiment 2, except that an additional stimulus, which subjects were required to ignore, was presented. After fixating at the beginning of each trial, either a cross or a box appeared randomly in one of three (left, right, or center) locations. Targets (crosses) were presented four times more frequently than nontargets (boxes). Thus, within the block of 75 trials completed per hand, 60 required a button-press, and 15 required no response.

Materials, Apparatus, and Procedure

Target stimuli were identical to those in the previous two experiments. Nontargets consisted of filled boxes (0.8 × 0.6 cm). The same location in the left, right, or center of the visual field was employed for both targets and nontargets. Participants were instructed to ignore boxes and respond ("hit the button") only to crosses. Ten practice trials were given to all participants to ensure that the instructions had been understood.

Results and Discussion

Raw data were treated in the same manner as in Experiments 1 and 2. The percentage of false alarms was low for all groups (CA = 7.0%; MA
= 3.9%; autistic = 4.8%), and missed targets were confined to the autistic group (1.2%)

The data were subjected to a 3 x 3 x 2 mixed-design ANOVA, with group (autistic vs. MA vs. CA) as the between-subject variable, and field (left vs. right vs. center) and hand (left vs. right) as the two within-subject variables. The analysis yielded only one significant interaction between Group and Field, $F(4, 60) = 4.48, p < .003$ (Table VI). Again, within-group ANOVAs were performed to clarify the nature of this interaction. Results of these ANOVAs revealed that for both the normal groups, RTs did not differ according to target location, CA: $F(2, 20) = 0.62, p < .55$; MA: $F(2, 20) = 0.73, p < .50$. In contrast, the analysis for the autistic group yielded a significant effect of field, $F(2, 20) = 7.53, p < .004$. Newman-Keuls comparisons revealed that RTs to central targets were significantly faster than RTs to either left field ($p < .05$) or right field ($p < .05$) targets, which did not differ.

When required to identify and not only detect visual targets (Exp. 3), the normal participants (both CA and MA) failed to show any visual field effect, or any differences between central and lateral targets. The control groups also failed to show any hand differences in speed of responding. The findings for normal adults stand in contrast to the results in both Experiments 1 and 2. When detection alone was required (Exps. 1 and 2), they responded faster to lateral than to central targets, and showed evidence of both left-field and left-hand advantages. The null effects for the CA control group in Experiment 3 suggest that the task of identifying simple visual targets results in greater involvement of left-hemisphere processes (cf. Cohen, 1972). Note further that in normal adults, the advantage of lateral over central targets disappears when the task requirements are equated at all spatial locations (i.e., both detection and identification are required at central and lateral locations).

As predicted, the task of identifying visual targets resulted in significantly faster responses to central than to lateral stimuli in the participants

| Table VI. Experiment 3: Mean Response Latencies as a Function of Field and Group |
|-----------------|-----------------|-----------------|---------|---------|
| Visual field    | Left            | Right           | Center  | Individual analyses |
|                 | $M$ | $SD$ | $M$ | $SD$ | $M$ | $SD$ |                                |
| Autistic        | 495.1 | 153.9 | 499.9 | 162.2 | 457.5 | 144.1 | $C < L = R$, $p < .05$ |
| MA controls     | 466.4 | 158.7 | 453.6 | 166.5 | 468.9 | 143.1 | $ns$ |
| CA controls     | 367.9 | 53.6 | 367.4 | 58.0 | 372.9 | 57.3 | $ns$ |
with autism. No differences were found between left- and right-field responses, or in hand used to respond. The main finding is that in people with autism, the advantage of central over lateral targets is enhanced when the processing demands of the task are increased (cf. Exp. 2). Our findings also indicate that this phenomenon is not related to overall ability level, as measured by the PPVT-R or Raven's.

CONCLUSION

The present research examined visual-spatial orienting in high-functioning adolescents and young adults with autism. Experiments 1 and 2 required detection of simple visual targets. In Experiment 1, the stimuli appeared either to the left or right of fixation; central targets were included in Experiment 2. Experiment 3 required identification of both lateral and central targets. Two main findings emerge.

First, data from Experiment 1 suggest that visual orienting is lateralized to the right hemisphere in high-functioning adolescents/young adults with autism. Like the normal adult controls, the participants with autism showed a left field–right hemisphere advantage for the detection of simple visual stimuli. On our task, however, the individuals with autism did not show the left-hand advantage demonstrated by the normal adults. We can only speculate about the significance, if any, of the null hand effect in the group with autism. Clearly, the initiation and coordination of voluntary (intentional) motor responses depends on the effective interface of motor and attentional systems (Rothbart et al., 1990). Evidence indicating that people with autism show a variety of motor dysfunctions (e.g., perseveration; see Smith & Bryson, 1994, for a review) further suggests that the coordination of these systems may be problematic. At a minimum, it is important that future research consider the relationship between attentional and motor systems in autism.

The second major finding is that, unlike both control groups, the adolescents/adults with autism responded faster to central than to lateralized stimuli. Recall that at the beginning of each trial, attention was directed toward a central fixation point. The advantage of central targets in the autistic participants appears consistent with previous reports of overfocused attention (“tunnel vision”; Rincover & Ducharme, 1987), and of difficulties disengaging and/or shifting attention in space (e.g., Courchesne et al., 1990; Wainwright-Sharp & Bryson, 1993).

Note further that the presence of central targets in Experiment 2 extinguished the left field advantage previously displayed by the participants with autism (Exp. 1). This suggests that although attention is lateralized in
high-functioning people with autism, its behavioral impact may be overridden by problems shifting spatial attention. Moreover, the enhanced effect of central targets in Experiment 3 (cf. Exp. 2) suggests that these impairments in attention are exaggerated when the processing demands are increased (i.e., from detection to identification). The low false alarm rate in this experiment is inconsistent with problems in response inhibition; rather it may be that in people with autism difficulties shifting attention render less resources available for processing additional information.

Discussions of overfocused attention have typically emphasized the size of the attentional spotlight. In people with autism, it has been argued, the beam of attention is reduced relative to normal, thereby restricting that which can be attended (Rincover & Ducharme, 1987; but see Burack, 1994, who has argued for a broader than normal beam of attention). Later research has yielded evidence of problems disengaging and/or shifting visual attention (Courchesne et al., 1990; Wainwright-Sharp & Bryson, 1993). Overfocused attention may be a behavioral manifestation of difficulties moving attention at will. As such, overfocused attention refers to where in space attention is located and the ease with which it can get there, and not simply to the magnitude of that attentional focus.

Problems with moving attention through space have a number of potentially critical consequences, not the least of which is disrupting the emergence of shared attention between infants and their caregivers (Courchesne et al., 1993; Smith & Bryson, 1994). Deficits in shared attention are well documented in children with autism (Loveland & Landry, 1986; Mundy, Sigman, Ungerer, & Sherman, 1986; Mundy, Sigman, & Kasari), the repercussions of which may include, among other things, impairments in the development of theory of mind, self-concept, and emotional responsivity (Mundy & Sigman, 1989). Indeed, it has been argued that the ability to coordinate information from a variety of sensory modalities underlies the enrichment of emotional understanding (Hobson, 1989). Difficulties shifting attention between, as well as within, different modalities could clearly impact on these and other aspects of cognitive and socioemotional development.

Finally, it is striking to note that group differences in the present experiments cannot be attributed to either developmental factors or to differences in overall ability. This stands in contrast to previous research indicating that inferior performance in those with autism (vs. MA-matched controls) is often highly correlated with IQ (e.g., Ozonoff, Pennington, & Rogers, 1991; Rumsey, 1985). We nonetheless acknowledge that comparisons with normal control groups are limited. They do not address the important question of whether the observed atypicalities are specific to autism, or whether they also exist in other cognitively or language-impaired
groups. Although the small sample precludes statistical analyses, observation of the data does suggest that the effects reported here do not differentiate adults with autism from those with Asperger syndrome (cf. Ozonoff, Rogers, & Pennington, 1991). The present findings are consistent with the claim that high-functioning people with autism show abnormalities in moving attention through space (Casey et al., 1993; Courchesne et al., 1994; Wainwright-Sharp & Bryson, 1993).

REFERENCES


