SOCIAL AND NONSOCIAL ORIENTING IN YOUNG CHILDREN WITH AUTISM, DEVELOPMENTAL DISORDERS, AND TYPICAL DEVELOPMENT

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Impairments in social development are defining features of autism and of disorders on the autism spectrum (American Psychiatric Association, [APA], 2000). Although autism is also characterized by impairments in communication and the presence of a restricted range of interests, it is the social impairments that many consider the primary deficits of individuals with the disorder (Baron-Cohen, 1995; Hobson, 1989; Mundy, 1995). Social impairments are present throughout the lifespan for individuals with autism, and must be present in an individual for him or her to receive a diagnosis of any disorder on the autism spectrum (APA, 2000). In addition, impairments in social development may be among the first observable symptoms of autism (Baranek, 1999; Osterling, Dawson, & Munson, 2002).

Within the domain of social development, some researchers have suggested that a social orienting deficit may be a core deficit for children with autism (Dawson & Lewy, 1989; Mundy & Neal, 2001; Tantam, 1992). Orienting of attention is defined as the “aligning of attention with a source of sensory input” (Posner, 1980, p. 4), and is considered the first step toward processing information (Wainwright & Bryson, 2002). The term social refers to the interaction of individual people. Social orienting, then, refers to the alignment of sensory receptors to a person or a social event and is considered a key component of social information processing (Mundy & Neal, 2001). One example of social orienting includes responding to hearing one’s name called. Although orienting
behavior is similar to reflexive action, sensory stimuli in the environment will only elicit overt orienting behavior (e.g., head turn or shift in eye gaze) if they hold some importance to an individual (Posner, 1980). As such, individuals with autism may experience deficits in orienting to people in their environment because they are not considered important sources of information. In contrast, typically developing children seem to have a natural proclivity to orient and attend to people in their environment (Trevarthen, 1988; and see Rochat & Striano, 1999, for a review). When infants orient to stimuli in the environment, these stimuli become more easily remembered (Lansink & Richards, 1997). As a result, children with early social orienting impairments would not only engage less frequently with people in their environment, but would also miss many learning opportunities that exist during infant social interaction.

The proposed reasons for a social orienting deficit in autism differ among theorists, with some suggesting that an innate social response mechanism is missing (Tantam, 1992), others suggesting that humans are overstimulating due to their unpredictable nature (Dawson & Lewy, 1989), and others suggesting that social stimuli do not hold the same reward value for children with autism as for other children (Mundy, 1995). In contrast, some researchers consider social orienting deficits to reflect more general attention deficits that are not necessarily social in nature (Harris, Courchesne, Townsend, Carper, & Lord, 1999; Townsend, Courchesne, & Egaas, 1996; Townsend, Harris, & Courchesne, 1996; Wainwright-Sharp & Bryson, 1993). These researchers suggest that individuals with autism have impairments orienting to nonsocial stimuli, such as objects or sounds, as well, and that social orienting deficits can be explained by general attention deficits.
Determining the nature of orienting deficits in autism is important for several reasons. First, learning about the core features of autism would help scientists, clinicians, and parents understand the disorder and how it develops. Second, these types of deficits might be observable early in life, and could potentially improve both early identification of autism and early intervention for children with autism. Recent research has demonstrated that children with autism who enter into specialized early intervention programs at younger ages may benefit more from treatment than those who enter programs at older ages (Harris & Handleman, 2000; McGee, Morrier, & Daly, 1999), further supporting the need for a better understanding of both early signs of the disorder and early treatment targets for children. Finally, understanding early behavioral features of autism could help direct researchers who study autism at the neurological or genetic level.

Research has been conducted to examine both social and nonsocial orienting deficits in individuals with autism, though few studies have compared both in the same sample (Baranek, 1999; Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Dawson et al., 2004; Harris, et al., 1999; Leekam, Lopez, & Moore, 2000; Osterling et al., 2002; Townsend et al., 1996; Townsend, Harris, & Courchesne, 1996; Wainwright-Sharp & Bryson, 1993; Werner, Osterling, Dawson, & Dinno, 2000). Thus the question of whether social orienting deficits are distinct from general underlying attentional deficits remains unanswered. Studies of social orienting have taken many forms: retrospective videotape studies of infant behavior, studies of social responsiveness in young children, and studies of joint attention skills in young children. In contrast, studies of nonsocial orienting have primarily focused on high-functioning (i.e., average or above average IQ)
adolescents and adults with autism, and have used computer orienting paradigms. Only a small number of studies have examined both social and nonsocial orienting in the same sample of children (Baranek, 1999; Dawson et al., 1998; Leekam et al., 2000; Swettenham et al., 1998). In addition, there are some methodological problems with many previous studies. As a result, there remain many questions about the nature of social orienting deficits in children with autism. It may be the case that orienting deficits and social deficits are independent of one another, but in combination yield autistic symptoms.

The following sections of this paper will: 1) summarize theoretical accounts and recent research on social and nonsocial orienting impairments in children with autism, 2) discuss the limitations of previous studies, and 3) describe a study that further examines social and nonsocial orienting in children with autism compared to children with developmental delays and typical development.

*Social and Nonsocial Orienting in Autism: Theories and Research*

Some researchers have proposed that very early deficits in social orienting are core to understanding autism (Dawson et al., 1998; Mundy & Neal, 2001; Tantam, 1992). Other researchers have suggested that there is a more general orienting deficit that is not necessarily social in nature (Bryson, Wainwright-Sharp & Smith, 1990; Courchesne et al., 1994; Harris et al., 1999; Townsend et al., 1996; Wainwright-Sharp & Bryson, 1993). Because both types of orienting could be important for early social development, in particular as components of initiating joint attention (IJA) and responding to joint
attention (RJA; both defined below), they are relevant areas of study in autism. Below, research will be reviewed to present a description of IJA and RJA, of how both may be impaired for children with autism, and of how social and nonsocial orienting behaviors may be associated with their development. Next, accounts of social and nonsocial orienting deficits in autism will be reviewed separately. Few studies have examined both social and nonsocial orienting. Because those that have examined both types of orienting have been most interested in social orienting, these studies will be reviewed in the section on social orienting.

**IJA and RJA in Autism**

Triadic interactions refer to situations in which an infant and another person share reference to an object or third referent in the environment. Two types of triadic interactions, IJA and RJA, have been the focus of a great deal of research with young children with autism. During one type of triadic interaction, initiating joint attention (IJA), children orient socially while they are engaged with an object to share their experience of the object with another person (Mundy, 1995). A different type of triadic interaction, responding to joint attention (RJA), refers to situations in which a child follows the gaze or point of another person to a target (Mundy et al., 1986). Many researchers who study the development of language have suggested that both initiating and responding to joint attention facilitate infants’ early language learning (Bakeman & Adamson, 1984; Baldwin, 1995; Tomasello, 1988). Specifically, researchers suggest that, through engaging with one’s mother about an object or event in the environment,
infants learn referential language and communicative competence (Bakeman & Adamson, 1984; Trevarthen, 1988; Tomasello, 1988). Researchers have also suggested that joint attention skills serve as precursors for other social cognitive milestones, such as the development of a theory of mind (Baron-Cohen, 1991; Tomasello, 1995).

Children use many behaviors to initiate joint attention, such as making eye contact with another person, showing objects, pointing, and verbally commenting. Research across many studies has shown that young children with autism demonstrate fewer of these behaviors to initiate joint attention than children with developmental delays and typically developing children (Mundy, Sigman & Kasari, 1990; Mundy, Sigman, Ungerer, & Sherman, 1986; Sigman, Mundy, Sherman, & Ungerer, 1986; Stone, Ousley, Yoder, Hogan, & Hepburn, 1997). Both social and nonsocial orienting are components of IJA. Children often engage in episodes of IJA after orienting to interesting social or nonsocial events in their environment. For example, a child may orient to an airplane flying in the air and then look to an adult to share that experience.

To engage in RJA, children must first engage in a social orienting episode by looking at a person, then by following his or her cue. Some studies have found RJA skills to be impaired in children with autism compared to children with developmental delays (DD; Baron-Cohen et al., 1997; Leekam, Hunnisett, & Moore, 1998; Leekam et al., 2000; Loveland & Landry, 1986). Leekam et al. (1998; 2000) found that group differences were most prominent for low-IQ children with autism compared with those with DD. A different study found group differences only between children with autism and typically developing children, with no differences between autism and DD groups (Mundy et al., 1986). Social orienting could be considered a key component to RJA, as
children must first orient to an adult before following his or her eye gaze or point to the object of interest. Nonsocial orienting may also be important in the development of RJA, as the ability to direct one’s attention and interest in directing one’s attention to objects is a part of RJA.

Deficits in initiating and responding to joint attention could have significant effects on a child’s development of language. In children with autism and typically developing children, some research has supported this idea. For children with autism, concurrent and predictive relations have been demonstrated between IJA, RJA, and language skills (Mundy et al., 1990; Sigman & Ruskin, 1999). Similar results have been found for typically developing children (Morales et al., 2000; Mundy & Gomes, 1998). However, there are studies that have not found the same associations between joint attention and language for clinical (Charman et al., 2000), or typical populations (Bates, Thal, Whitesell, Fenson, & Oakes, 1989; Desrochers, Morissette, & Ricard, 1995; Fenson, Dale, Reznick, & Bates, 1994). Furthermore, few studies have broken down the component behaviors involved in both IJA and RJA to determine which may be most important for language and social learning.

To date, very little research has examined orienting as a component of either IJA or RJA. The relation between social and nonsocial orienting to RJA has been examined in two studies by the same research group (Dawson et al., 1998, 2004). Dawson et al. found that social orienting was associated with RJA and IJA for children with autism, but not for DD or typically developing controls. Nonsocial orienting was not associated with RJA for any group in these studies. Because of the importance of joint attention in the development of language and social cognition, more research in this area is needed. The
following sections will review research that has examined nonsocial and social orienting
in autism.

*General Orienting Impairments*

Several researchers have considered that general attention impairments underlie
autistic symptomatology (Bryson et al., 1990; Courchesne et al., 1994; Harris et al.,
1999; Rimland, 1964; Townsend et al., 1996; Wainwright-Sharp & Bryson, 1993).
Specific theories have focused on inattention to stimuli in the environment (Bryson, et al.,
1990), impairments in the ability to shift attention (Courchesne et al., 1994), and
difficulties with disengagement of attention from a central target (Landry & Bryson,
2004; Wainwright & Bryson, 1996) as potential deficits responsible for the broad range
of autistic symptoms. Disengagement refers to the terminating of attention to a specific
target (Landry & Bryson, 2004). Before reviewing studies that have tested these theories,
a brief description of the typical development of orienting and of orienting paradigms
used in these studies is provided.

Recent research with typically developing infants has demonstrated that very
early in life infants have some orienting skills (See Posner, Rothbart, Thomas-Thrapp, &
Gerardi, 1998, for a review). Most research on the development of orienting during
infancy has focused on visual orienting, rather than auditory orienting (Rothbart et al.,
1994), and has found that orienting skills develop along with the development of the
visual system. Though some orienting responses are present at birth, disengagement
from stimuli develops quickly between 2 and 4 months of age, coinciding with the
development of the parietal system in the brain. Infants begin to prefer novelty of both objects and locations between 4 and 6 months. Finally, infants begin to demonstrate learning in computer orienting paradigms by 4 months (Posner et al. 1998).

The types of orienting paradigms used most frequently with individuals who have autism were originally designed by Posner (1978). These paradigms typically measure covert, rather than overt orienting, and visual, rather than auditory orienting. Overt orienting can be observed through head or eye movements, while covert orienting does not require an individual to display an observable behavior. Rather, for covert orienting, an individual can maintain eye gaze on a fixed target and indicate that he or she notices a stimulus in the environment by pressing a button. Posner has found that these two systems of orienting are different in that individuals can covertly orient to a stimulus without overtly orienting to it (Posner & Peterson, 1990).

Covert orienting is measured because it limits motor functioning to a button press rather than a head turn, and because many researchers who study the attention system are more interested in the internal mechanisms of attention (Fernandez-Duque & Posner, 2001). In these paradigms, an individual sits facing a computer screen (See figure 1 for an illustration). Either a plus sign or an arrow pointing left or right is then presented in the center of the screen. Next, a delay occurs before a detection stimulus is presented to the left or to the right. Researchers often vary the length of delay before the detection stimulus is presented. This paradigm allows researchers to measure reaction time, the benefits of the arrow cue over a non-directional cue, the costs in response times if cues are incorrect, and the differences in response times at different delays (Posner, 1980).
Figure 1. Posner computer orienting paradigm (from Fernandez-Duque & Posner, 2001).
Courchesne and colleagues have used variations of the Posner visual orienting paradigm described above to study the role of the cerebellum in shifting attention. Most studies conducted by this group have focused on high-functioning adolescents and adults with autism compared to normal controls (Courchesne et al., 1994; Townsend et al., 1996; Townsend et al., 1999), and one study used this paradigm to study orienting in children with autism (Harris et al., 1999). In addition, these researchers have studied attention shifting between visual and auditory nonsocial stimuli (Courchesne et al., 1994). These studies have demonstrated that adolescents, adults, and children with autism orient more slowly than normal control subjects (Harris et al., 1999; Townsend et al., 1996; Townsend et al., 1999), demonstrate impairments shifting between visual and auditory stimuli (Courchesne et al., 1994), and that the degree of orienting impairment is associated with abnormalities in particular areas of the cerebellum (Harris et al., 1999; Townsend et al., 1999). In addition, these orienting deficits have not been found to correlate with IQ for adults or children with autism (Harris et al., 1999; Townsend et al., 1999). Based on these findings, Courchesne and colleagues have suggested that autism is characterized by slow orienting to stimuli across sensory modalities and slow shifting of attention (Courchesne et al., 1994; Harris et al., 1999; Townsend et al., 1996; Townsend et al., 1999).

However, groups of children and adults with autism have not been matched on IQ with comparison groups in any of the above studies (Harris et al., 1999; Townsend et al., 1996; Townsend et al., 1999). Despite the use of high-functioning individuals with autism, large discrepancies in IQ between the autistic and comparison groups have been present, and associations with IQ were not tested in control groups. Therefore, it remains
unclear whether the faster orienting of the normal control groups has been due to their higher levels of intelligence.

Despite this limitation, researchers have described how a general deficit in orienting might affect a child (Harris et al., 1999). Specifically, orienting deficits in childhood could lead to decreased learning opportunities, impaired social-emotional development, impaired development of self-regulation of arousal and affect, and impaired joint attention skills. In particular, these researchers have highlighted the importance of shifting attention in reciprocal social interaction (Courchesne et al., 1994)

A different group of researchers has also been interested in nonsocial aspects of attention in autism (Bryson et al., 1990; Landry & Bryson, 2004; Wainwright & Bryson, 1996; Wainwright-Sharp & Bryson, 1993). Specifically, Bryson, Wainwright and colleagues have suggested that individuals with autism have difficulty processing sensory information due to impairments in the disengagement of attention and reorienting of attention to a new target (Wainwright-Sharp & Bryson, 1993). One study tested this theory using a Posner orienting paradigm with high-functioning adults with autism spectrum disorders (ASD; autism and Asperger’s syndrome) and chronological age-matched, normal controls. Groups were not matched on cognitive or language ability. During disengagement and shift trials, visual stimuli were presented in the center of a screen. For disengagement trials, this stimulus remained present while a second stimulus was presented to the left or right. For shift attention trials, the central stimulus was removed for a brief period before the second stimulus to the left or right was presented.

Results indicated that high-functioning adults with autism had difficulties compared to normal controls in both disengagement and shifting attention (Wainwright-
Sharp & Bryson, 1993). In a second study, these authors found further evidence for impairments in disengagement of attention in adults with autism spectrum disorders compared to both chronological-age matched controls and controls matched on receptive language raw scores from the Peabody Picture Vocabulary Test- Revised (Wainwright & Bryson, 1996). These studies suggested that orienting or shifting attention deficits in autism may be due to difficulties with disengagement.

One other study examined shifting attention in adults with autism (Casey, Gordon, Mannheim, & Rumsey, 1993). In this study, results revealed that high-functioning adults with ASD demonstrated deficits in shifting attention between visual and auditory nonsocial stimuli compared to chronological age-matched, normal controls (Casey et al., 1993).

A recent study examined overt orienting in children with autism (Landry & Bryson, 2004). A computer paradigm was used to examine visual disengagement and shifting attention in children with autism, Down Syndrome, and typical development. The groups were matched on mental age as measured by the Leiter International Performance Scale. The children with autism ranged in age from 3 ½ to 7 years. Results revealed that children with autism were slower to disengage and to shift attention than control groups. Other studies have examined shifting attention in children (Leekam et al., 2000; Swettenham et al., 1998). Because these studies focused on shifting attention between social and nonsocial stimuli, they will be reviewed in the following section.

This review of studies covering nonsocial orienting of attention in autism has shown that all attentional impairments experienced by individuals with autism are not social in nature. Unfortunately, there are many limitations of the findings presented.
First, many studies have included only high-functioning adults, making it difficult to understand when or how orienting impairments began. Second, many studies have not matched groups on intellectual level. Third, the use of computer tasks may limit the generalizability of findings, as the stimuli are not those that occur naturally, nor are they particularly meaningful. Finally, little research has examined nonsocial orienting in young children. Despite these limitations, the studies reviewed above are suggestive of attentional impairments in autism at the level of orienting.

Social Orienting Impairments

Other researchers have suggested that the orienting deficits in children with autism are social in nature (Dawson & Lewy, 1989; Mundy, 1995). One theory, proposed by Dawson & Lewy (1989), suggests that children with autism find social stimuli more overstimulating than other types of stimuli in their environment because of the unpredictable and complex nature inherent to them. They suggest that people orient most frequently to stimuli that are somewhat novel and different from expectations. Stimuli that vary from this level of novelty or predictability may elicit aversive reactions or no reactions. For children with autism, the threshold for a stimulus to elicit an aversive response or no response may be different than for other individuals, and individuals with autism may have a narrower range of optimal stimulation. Because people are characterized by features such as intentions and feelings, which are indeterminate and not fully predictable, they are more likely than objects to produce stimuli that fall out of the range of optimal stimulation for children with autism. A low
aversion threshold in autism interrupts the typical development of social relationships from very early ages. Specifically, children with autism are not able to benefit from some of the early parent-child interactions that foster typical social and emotional development (Dawson & Lewy, 1989).

Similarly, Tantam has proposed that a primary “social gaze response” is absent in children with autism, suggesting that they have no propensity to focus on social cues in the environment (1992). Tantam (1992) defined this social gaze response as the “inherent tendency of typical infants to focus gaze and attention on social cues.” (p. 83), and suggested that it was innate for typically developing children. A later developing, secondary social gaze response involves children following the gaze of another person, which may be a first sign of developing triadic behaviors. Through these two gaze responses, typical children are attentive to social cues, and are able to learn from the environment, as well as develop pretense and a theory of mind. The absence of the innate social gaze response is described as the primary social abnormality of autism, and Tantam suggests that it leads to many of the social impairments, such as joint attention deficits, experienced by children with autism.

Mundy and Neal (2001) proposed a comprehensive theory of a social orienting deficit whereby early deficits in social orienting reflect initial neuropathological processes in children with autism. Mundy has suggested that the reward value of social interaction is lower for children with autism than for other peers (1995). Because children with autism spontaneously orient to people less often than typical children, they receive less input and do not form the synaptic connections necessary for subsequent social development. Next, this attenuation of typical social orienting leads to a secondary
neurological disturbance and impaired experience for the child, leading to disturbances in joint attention and in the development of a theory of mind. The initial and secondary neuropathological processes combine to affect the child, causing development to continue away from the typical path. In this theory, Mundy and Neal have refined a basic theory that joint attention deficits are the most profound impairments in autism (Mundy, 1995) to implicate even more basic social orienting deficits that lead to these deficits in joint attention.

Although these theories differ from one another, they share common features. First, they focus on orienting deficits that should be evident at very young ages. Second, they suggest that this early social orienting deficit could be responsible for creating an impoverished social environment for children with autism. Finally, although they consider general orienting impaired in children with autism, the social deficit is considered primary.

Different types of studies have supported these theories that children with autism have deficits in orienting to social information. First, retrospective videotape studies have found evidence of such deficits in infants who later receive autism diagnoses (Baranek, 1999; Osterling & Dawson, 1994; Osterling et al., 2002; Werner et al., 2000). Second, studies of preschool aged children have demonstrated such deficits (Dawson et al., 1998, 2004; Leekam et al., 2000). These studies are reviewed below.

_Retrospective studies._ Retrospective videotape studies have provided some support for social orienting impairments in children with autism. In four studies, experimenters coded social behaviors from videotapes of infants from 8 to 12 months of age. These children later received diagnoses of autism or developmental delay, or were
typically developing. Two of these studies compared videotape samples of children who later received diagnoses of autism to those of typically developing children on a variety of social, communicative, affective, and autism specific behaviors to determine whether differences were apparent at very young ages (Osterling & Dawson, 1994; Werner et al., 2000). In the first study, experimenters coded home videotapes of first year birthday parties (Osterling & Dawson). There were videotapes of 11 children with autism and 11 typically developing children. Experimenters coded for the presence or absence of key behaviors for each minute of tape. Whether the child oriented to his or her name being called was one of the measured behaviors. Results revealed that one-year-old children who later received diagnoses of autism oriented to their name being called less often than typically developing children. Within the autism sample, results revealed that orientation to name was not associated with the presence of cognitive delay at older ages. These findings suggest that, by twelve months of age, infants who will later receive an autism diagnosis are less responsive than children who do not receive autism diagnoses to some social cues, and that this decreased responsiveness may be independent from cognitive delays.

In a follow-up study, Werner et al. (2000) compared videotapes of the same infants at 8 to 10 months of age (4 additional infants were added to each group) and found that as young as 8 months of age, children later diagnosed with autism responded to their names less often than typically developing children. In this second study, children with autism responded to their name being called 37% of the time compared to 75% of the time in the typically developing sample. However, these results were found only after removing three children with autism from the sample. The parents of these
three children reported “late-onset autism.” When these children were included in the autism sample, no social behaviors discriminated the autism sample from the typically developing sample. The general findings are similar to the findings with the twelve-month-old sample (Osterling & Dawson, 1994), suggesting that deficits in social orienting may be detectable very early in development. However, the differences that are found when children with “late-onset autism” are removed from the sample may suggest that the decreased responsiveness in infants with autism is not universal among individuals with autism.

Two other infant studies included control groups of children later diagnosed with developmental delays or mental retardation in addition to a typically developing control group (Baranek, 1999; Osterling et al., 2002). Experimenters coded videotapes of 9 to 12 month old infants. Similar to previous studies, both studies found that children later diagnosed with autism oriented to their names being called less often than children with developmental delays and typical children. In addition, one study found that children with autism demonstrated less orienting to nonsocial visual stimuli than both other groups (Baranek, 1999). The other study found that children with autism oriented to non-social stimuli less than controls only when people held the non-social stimuli (Osterling et al., 2002). This finding demonstrates how important it may be to carefully define what is considered social and what is not. As a result, while these findings offer more support for the early deficit in social attention, it is unclear whether there is a general deficit in attention or a specific deficit in social attention or whether deficits are more pronounced for visual or auditory stimuli.
In these four infant video studies, results revealed that very young children with autism respond less often than control groups when their name is called (Baranek, 1999; Osterling & Dawson, 1994; Osterling et al., 2002; Werner et al., 2000). However, children with autism were less attentive to nonsocial visual stimuli as well (Baranek, 1999; Osterling et al., 2002).

Preschool studies. In one study, researchers examined the ability of preschool children with autism and developmental delay (DD) to orient attention to people and objects, and to shift attention (Leekam et al., 2000). Children with autism (n = 20) and DD (n = 18) were individually matched on nonverbal cognitive ability as measured by either the Leiter International Performance Test or the Bayley Scales of Infant Development. For the 8 children (all in the autism group) who were administered the Bayley, an overall cognitive score was used for matching, as this test does not provide a measure of nonverbal cognitive ability. Two typically developing children were included for matching children with autism with high cognitive scores. Children ranged in age from 34-67 months.

In one part of this study, an experimenter, sitting at a table facing a child, first attempted to achieve eye contact with the child without speaking, then called his/her name, and finally called, "Look at me" (Leekam et al., 2000). Results revealed that more children in the DD sample than in the autism sample responded consistently to every bid received from experimenter. In this study, verbal comprehension scores, measured by the Reynell Developmental Language Scales or the MacArthur Communicative Development Inventory (MCDI), correlated with response to the attention bid for the autism group but
not for the DD group. Nonverbal cognitive ability did not correlate with responding to the attention bid for either group.

This study also examined gaze following behaviors in each group of children and found children with autism to demonstrate weaknesses relative to controls in these behaviors. A third focus of this study was to determine whether gaze following deficits in children with autism might be due to deficits in attention shifting in general. To test this possibility, a paradigm was used to measure the accuracy and latency of responses to non-social cues presented to the left and right of the children. A central stimulus was presented during half of the trials to test whether there would be an effect of an overlapping stimulus on attention shifting responses. Results revealed that children with autism did not demonstrate weaknesses on either accuracy or latency of attention shifting responses. These results were found when there was an overlapping central stimulus and when there was no overlapping stimulus. These findings suggest that gaze following deficits may not be due to general weaknesses in attention shifting to nonsocial stimuli.

A different study examined attention shifting behaviors in a sample of 10 children with autism, 17 children with DD, and 16 typically developing children (Swettenham et al., 1998). Children were all 20 months of age; children with autism were those who screened positive on the Checklist for Autism in Toddlers (CHAT; Baron-Cohen, Allen, & Gillberg, 1992) at 18 months and received subsequent diagnoses of autism. There were no group differences between the autistic and DD groups for expressive language equivalents (determined by the Reynell Language Scale) or nonverbal mental age equivalents (determined by the Griffiths Scale of Infant Development). However, both groups exhibited lower language and nonverbal levels than the typical group. Three
types of attention shifts were measured within a 5 minute free play period: object–object, object–person, and person–person. Results revealed no group differences in the frequency per minute of object–object shifts. However, for the attention shifts that involved people (i.e., between objects and people, and between two people), the children with autism demonstrated lower frequencies than both other groups. These two studies suggest that social orienting deficits may not be due to general impairments in the ability to shift attention (Leekam et al., 2000; Swettenham et al., 1998).

These two attention shifting studies of children reflect different findings than the studies reviewed above with adults and children (Casey et al., 1993; Courchesne et al., 1994; Landry & Bryson, 2004; Wainwright & Bryson, 1996; Wainwright-Sharp & Bryson, 1993), which revealed group differences in nonsocial covert and overt orienting. In the studies with children, impairments were found only for attention shifting that involved people in their environment (Leekam et al., 2000; Swettenham et al., 1998). Perhaps impairments in shifting attention have been more pronounced in older individuals with autism due to the choices of control groups studied. For adult control groups, individuals without disabilities have been compared to autistic groups. In contrast, for studies of children, control groups have consisted of children with developmental delays. Because the studies that included social stimuli did not measure disengagement separately from shifting attention, some impairments shifting to and from nonsocial stimuli may have been missed. Individuals with autism may also perform differently in naturalistic paradigms (e.g., free play) than in controlled computer paradigms. Finally, different measures of orienting have been used. Some studies have measured performance by examining latency to orienting responses (Wainwright &
Bryson, 1993, 1996), while others have examined the frequency of looks (Swettenham et al, 1998), making direct comparisons of findings even more challenging.

These findings may reflect a developmental pathway whereby early social impairments in autism lead to nonsocial impairments at older ages. However, it is possible that general attention impairments during infancy have a larger impact on social learning than other areas of learning. This larger impact on social learning could be due to the importance of timing in social interactions (Murray & Trevarthen, 1986). Timing may be less important in learning about objects than in learning about and from people. Applying this theory to the studies reviewed above, it is possible that the covert orienting impairments found in adults reflect general attention deficits. If timing of looking to important events in the environment is impaired, then evidence of more severe overt orienting impairments for social stimuli than for nonsocial stimuli would be expected.

Dawson and colleagues have conducted two studies directly comparing social and nonsocial orienting in young children (1998; 2004). Each of these is reviewed below. In the first study, this group tested the theory that, for 4 – 6 year old children with autism, deficits in orienting and shifting attention are more severe when stimuli are social in nature than when they are not social. Groups of participants with autism, Down Syndrome (DS), and typical development were matched on receptive language age as assessed by the Preschool Language Scale – 3 (PLS) and scores on the communication subscale of the Vineland Adaptive Behavior Scales. Clinical groups had mean chronological ages of 64 months, while the typically developing group had a mean age of 31 months. The children with autism had higher nonverbal cognitive ability than the DS
An examiner presented four orienting stimuli to each child (Dawson et al., 1998). The social stimuli were clapping hands and calling the child’s name, and the non-social stimuli were shaking a rattle and operating a jack-in-box. When a child did not orient to a presented stimulus within 15 seconds, examiners recorded the error. When children did orient, examiners recorded responses as immediate (within 2 sec.) or delayed. Results revealed that children with autism failed to orient more often than controls for social and nonsocial stimuli, but differences were more pronounced when stimuli were social in nature. Of the children who did orient to social stimuli, children with autism exhibited a more delayed response to all stimuli, but especially to social stimuli. These findings support a general weakness in orienting, but a more pronounced weakness for social orienting in children with autism. Without a longitudinal study, it is unclear whether this more pronounced weakness for social stimuli is a developmental effect of general orienting deficits or reflective of a core impairment in social orienting.

Results from this study also revealed that social, but not non-social, orienting was correlated with responding to joint attention (RJA; defined as gaze or point following) in the clinical groups, but not in the typical group. This finding suggests a link between social attention in dyadic orienting and triadic (RJA) contexts for children with autism that may be different for typically developing children. In the typical group, social orienting was related to receptive language age. Nonverbal cognitive ability was not related to social orienting in any group. The authors concluded that children with autism
have a particular deficit in social orienting, and that this deficit might play an important role in the joint attention deficit evidenced by these children (Dawson et al., 1998).

In their more recent study, this group modified their original study to increase the social and nonsocial stimuli, increase the sample size, use a different control group, and study somewhat younger children (Dawson et al., 2004). The focus of this second study was to replicate the findings of group differences for social and nonsocial orienting, and to examine the association of social orienting and attention to distress with joint attention skills and language abilities. More social and nonsocial stimuli were added to the original 4 stimuli described above. Rather than include a control group of children with Down Syndrome, the study included a mixed group of children with developmental delays. A majority had no genetic condition (n = 31), and three had Down Syndrome. Finally, the average age in this study for children with autism was 42 months, which was younger than the previous study.

Findings from this study were similar to previous findings. Children with autism were found to exhibit impairments in both social and nonsocial orienting, with more severe impairments found for social orienting. Further, the authors found that measures of social orienting and joint attention discriminated between children with ASD and controls better than measures of joint attention alone. Specifically, adding measures of social orienting decreased sensitivity somewhat, but increased specificity, as almost no children without ASD showed impairments in social orienting. Structural equation modeling was conducted to test whether there was an indirect association between social orienting and language through a composite measure of initiating and responding to joint attention. Results supported this hypothesis.
In sum, young children with autism orient to their name being called less often than typically developing and developmentally delayed children (Dawson et al., 1998, 2004; Leekam et al., 2000). This social orienting response in children with autism was related to concurrent receptive language in one study (Leekam et al., 2000), but not in a different study (Dawson et al. 1998). Furthermore, social orienting was not associated with later degree of cognitive delay in infants who received diagnoses of autism (Osterling & Dawson, 1994), or with nonverbal cognitive ability in either study (Dawson et al., 1998; Leekam et al., 2000). This response was related to RJA and IJA in children with autism, though the same correlation was not found with typically developing children (Dawson et al., 1998, 2004). Finally, nonsocial orienting deficits were found in three studies (Baranek, 1999; Dawson et al., 1998, 2004), but not in others (Leekam et al., 2000; Swettenham et al., 1998).

Conclusions and Limitations of Previous Research

Studies of both social and nonsocial orienting in individuals with autism have demonstrated that both may be impaired. Evidence is not conclusive about whether orienting deficits demonstrated by individuals with autism are necessarily social in nature. It may be the case that subgroups within the autism spectrum exist, with some children demonstrating more basic orienting deficits while others only demonstrate weaknesses for social orienting. Current understanding in the field of autism research is that autism is the prototype of a spectrum of disorders (Provence & Dahl, 1987). Within
this spectrum, it is quite possible that the developmental pathways differ among subgroups.

Unfortunately, there are several limitations to previous research. Many different methodologies have been used. Some studies have utilized computer paradigms; others have utilized free play paradigms, while others have retrospectively coded videotapes of infants. However, for the case of social orienting, these different methodologies have yielded consistent findings, suggesting strong convergent validity. The studies reviewed above have also covered a wide age range, making comparisons across studies difficult. In addition, some studies have compared children with autism to groups matched on ability level, while others have not.

An additional limitation of previous research is the lack of comparisons of the types of social and nonsocial stimuli used, and the sensory modalities to which they have been presented. For example, one study found that children with autism attended less frequently than controls to nonsocial stimuli if a person held these stimuli (Osterling et al., 2002). In one study with children that measured nonsocial orienting (Dawson et al., 1998), both “nonsocial” stimuli were held by people (i.e., rattle and jack-in-the-box). Perhaps these types of stimuli cannot be considered entirely non-social. Future research must define these constructs more clearly. In addition, comparisons of visual versus auditory stimuli have not been conducted. Finally, though evidence seems quite clear that young children with autism are less responsive to hearing their name called than developmentally matched peers (Baranek, 1999; Dawson et al., 1998; Werner et al., 2000), few other social stimuli, such as emotional expressions or nonverbal stimuli have been studied.
Because of these limitations, more research is needed to understand the nature of orienting deficits in autism. First, more studies of nonsocial orienting are needed with young children and developmentally matched controls. Second, studies utilizing more naturalistic paradigms are needed to understand how children with autism orient to stimuli in their environment compared to stimuli on a computer screen. Third, more studies examining both social and nonsocial orienting in the same sample are needed with more stimuli presented to different sensory systems. Finally, to understand how social and/or nonsocial orienting deficits might contribute to the development of autistic symptomotology, studies need to examine the relation between these two forms of orienting and other symptoms of autism, such as deficits in IJA and RJA. Although many studies have demonstrated the links between IJA, RJA, and language (Morales et al., 2000; Mundy & Gomes, 1998; Mundy et al., 1990; Sigman & Ruskin, 1999), few have examined component skills to determine which are most important for developing these two forms of triadic interaction.

**Current Study**

There were several aims of the current study. The first aim was to develop a measure of social and nonsocial orienting for use with young children. The second aim of the current study was to replicate and extend previous findings of social and nonsocial orienting (S/NSO) deficits with samples of young children with autism, developmental delays, and typical development. Two control groups were included to understand typical social and nonsocial orienting, and to understand what effects general
developmental delay may have on these orienting processes. Based on the findings of previous research, it was expected that children with autism would demonstrate impairments relative to controls in both social and nonsocial orienting, with more severe impairments found for social orienting.

A third aim of this study was to examine the relation of social and nonsocial orienting to joint attention skills (IJA and RJA). This aim was more exploratory in nature for two reasons. First, research examining the relation between S/NSO and joint attention is extremely limited, making it more difficult to make theory driven predictions. Second, due to the low base-rate of autism and developmental delays, the sample sizes that were practical for this study would yield lower power than necessary for extensive analyses. Despite these limitations, it was expected that social and nonsocial orienting would correlate with both IJA and RJA for children with autism. These correlations could be considered circular in nature, because social orienting is a first step in an RJA episode, and either social or nonsocial orienting is a first step in an IJA episode. Therefore, the association that will be tested is between joint attention measures and the amount of effort involved in eliciting an orienting response to social and nonsocial stimuli.

Finally, a fourth aim of this study was to examine the relation of social and nonsocial orienting to measures of expressive language ability within the autism spectrum sample of children. Again, little research has examined this relation, and this aim was considered exploratory. However, it was predicted that both measures of orienting would correlate with language measure, with higher responsiveness associated with stronger language skills.
Examining social and nonsocial orienting in young children with autism, and the relation between orienting and joint attention, is important for both theory and clinical practice. Gaining a better understanding of social and nonsocial orienting impairments could inform both theory about development, practice of early identification, and early intervention for children with autism.

Hypotheses

Primary Hypotheses

It was hypothesized that:

1. Compared to both developmentally delayed (DD) and typically developing (TYP) groups matched on mental age, the autism spectrum (ASD) group would demonstrate more orienting deficits to all social and nonsocial (S/NS) stimuli.
   a. The ASD group would orient to fewer S/NS stimuli than DD or TYP groups.
   b. More trials would be required to elicit orienting responses for the ASD group than for control groups.
   c. The latency to respond would be longer for the ASD group than for the DD or TYP groups.

2. Compared to both DD and TYP groups, the ASD group would demonstrate different patterns of orienting responses to social and nonsocial stimuli.
a. The ASD group would orient to more nonsocial stimuli than to social stimuli, while the DD and TYP groups would not demonstrate differences in number of orienting responses across stimulus type.

b. More trials would be required to elicit orienting responses for the ASD group when stimuli are social than when they are nonsocial, while the DD and TYP groups would not demonstrate differences in number of trials across stimulus type.

c. The ASD group would show longer latencies to social than nonsocial stimuli, while the DD and TYP groups would not demonstrate differences in latency across stimulus types.

d. Compared to both TYP and DD groups, the ASD group would demonstrate more severe social orienting (SO) deficits than nonsocial orienting (NSO) deficits.

3. DD and TYP groups would not differ from each other on total number of orienting responses to social and nonsocial stimuli, though the DD group would demonstrate longer latencies overall than the TYP group.

*Exploratory Hypotheses (For the ASD group only)*

It was predicted that:

4. SO and NSO scores would be positively correlated with RJA and IJA.

5. Expressive language ability would be positively correlated with both social and nonsocial orienting scores.
6. IJA and RJA skills would serve as mediators of the association between orienting and expressive language.

7. SO and NSO would be negatively correlated with autism severity.
CHAPTER II

METHOD

Participants

Total Sample

Informed consent was obtained from parents of 73 children: 34 with autism spectrum disorders (ASD), 18 with developmental delays (DD), and 21 with typical development (TD). Seventy-two of these children were recruited from other research projects being conducted through TRIAD at Vanderbilt (39 from a study focusing on identification of autism in children under two, 32 from a study focusing on social orienting in autism and young siblings, and 1 from a study of imitation skills in children with autism). An additional child was recruited from a clinical screening clinic run by Wendy Stone. See Table 1 for a description of the total sample.

Children in the two clinical groups met the following criteria: age of 12 to 42 months; absence of severe visual, hearing, or motor impairments; and absence of an identifiable metabolic or genetic disorder. Additional inclusion criteria for children in the ASD group included a clinical diagnosis and ADOS classification of either autism or PDDNOS. An additional inclusion criterion for the DD group was determined during the recruitment process. Many children who had older siblings with autism met inclusion
Table 1

*Total sample characteristics*

<table>
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<th></th>
<th>ASD</th>
<th>DD</th>
<th>TD</th>
</tr>
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<td>(n = 21)</td>
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<td>16 – 42</td>
<td>12 – 24</td>
</tr>
<tr>
<td><strong>Mental age</strong></td>
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<td></td>
<td></td>
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<td>19.2 (3.8)</td>
</tr>
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<td>9.3 – 34.5</td>
<td>15.0 – 25.5</td>
</tr>
<tr>
<td><strong>Expressive language age</strong></td>
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<td></td>
<td></td>
</tr>
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<td>10 – 28</td>
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<tr>
<td>% Male</td>
<td>88</td>
<td>83</td>
<td>43</td>
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</table>

*29 Autism, 5 PDDNOS
criteria for the DD group. Because research has demonstrated that siblings of children with autism often demonstrate some symptoms of autism, such as social difficulties and language delays (Bailey et al. 1998; Szatmari et al., 2000), it was decided not to recruit these children to participate. At the time this decision was made, there was one child in the DD group who had an older sister with autism. Analyses were performed including and excluding this child. No differences were noted in the results. Therefore, this child is included in the study. However, no additional children with siblings who had autism were recruited to participate. Inclusion criteria for the TD group included chronological age between 12 and 24 months, and absence of any developmental delays. See Table 1 for a description of the entire sample.

**Matched Sample for Group Differences Analyses**

A subsample of 57 children (25 with ASD, 16 with DD, and 16 with TD) was used to examine group differences in social and nonsocial orienting. These groups were matched on mental age and expressive language age equivalents determined by the Mullen Scales of Early Learning (MSEL; Mullen, 1995). See Table 2 for a description of this subsample of children. From the initial sample of 73 children, the 11 children with ASD and 5 children with TD who had the lowest mental ages, and 2 children from the DD group with the highest mental ages were dropped to form these matched groups. Analysis of variance revealed no group differences for mental age equivalents, $F(2, 54) = .17, p = .84$, or expressive language age equivalents, $F(2, 54) = .47, p = .63$. Significant group differences were present for chronological age, $F(2, 54) = 50.72, p < .001$, as the
Table 2

Matched sample characteristics

<table>
<thead>
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<th>TD</th>
</tr>
</thead>
<tbody>
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<td>(n = 25)*</td>
<td>(n = 16)</td>
<td>(n = 16)</td>
<td></td>
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<tr>
<td>Chronological age</td>
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<td></td>
<td></td>
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<tr>
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<tr>
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<td>12 – 24</td>
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<td>Mental age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
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</tr>
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<td>Range</td>
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<td>9.3 – 29.5</td>
<td>15.8 – 25.5</td>
</tr>
<tr>
<td>Expressive language age</td>
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<td></td>
</tr>
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<tr>
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<td>4 – 35</td>
<td>10 – 28</td>
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<tr>
<td>Race</td>
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<tr>
<td>% Male</td>
<td>100</td>
<td>81</td>
<td>31</td>
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</table>

*20 Autism, 5 PDDNOS
TD group was significantly younger than both clinical groups, $p < .001$. In addition, groups differed in the percentage of boys included, $\chi^2 (3, N = 57) = 25.3, p < .001$. All 25 children in the ASD group were boys, 13 of 15 (81%) children in the DD group were boys, and only 5 (31%) of the children in the TD group were boys.

**ASD Sample**

A subsample of 31 children with ASD was used to examine the associations between social and nonsocial orienting to measures of joint attention, language, and autism severity. Three children with ASD did not complete the ESCS, all due to fatigue and/or difficulty remaining seated at the table. Although too small a group to compute statistics, visual comparison of these three children compared to the remaining sample who completed the ESCS revealed that they had lower mental ages and expressive language ages than children who completed the ESCS. Table 3 provides a description of the 31 children included in the analyses.

**Measures**

**Demographic Measure**

An information form was completed by parents of each participant. This form provided demographic information about the child’s race and sex, as well as socioeconomic information about the parents, such as occupation and educational history. The information obtained from the demographic measure was used to describe the samples. This form took parents under 10 minutes to complete.
Table 3

*ASD within group analysis sample characteristics*

<table>
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<tr>
<th></th>
<th>Autism</th>
<th>PDDNOS</th>
<th>Total</th>
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<tbody>
<tr>
<td></td>
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<td>n = 5</td>
<td>N = 32</td>
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<tr>
<td>Chronological age</td>
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<tr>
<td>Mean (s.d.)</td>
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<td>33.8 (6.1)</td>
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<tr>
<td>Range</td>
<td>24 – 41</td>
<td>25 – 39</td>
<td>24 – 41</td>
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<td>Mental age</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
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<td>22.1 (7.5)</td>
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<td>Range</td>
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<td>15.5 – 42.5</td>
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<td>Verbal mental age</td>
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<td></td>
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<td>23.0 (11.6)</td>
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<td>Mean (s.d.)</td>
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<tr>
<td>% Caucasian</td>
<td>84.6</td>
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</tr>
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</table>
**Cognitive Measure**

The Mullen Scales of Early Learning (MSEL) was used to measure cognitive functioning. The MSEL is a standardized assessment of cognitive skills for infants and children under the age of 6 years (Mullen, 1995). This assessment takes approximately 30 – 60 minutes to complete. In the present study, the MSEL was administered by trained graduate students in psychology. This measure yields one comprehensive standard score (Early Learning Composite), and 4 subscale scores measuring skills in the following areas: Visual Reception, Fine Motor, Expressive Language, and Language Comprehension. T-scores and age equivalents are provided for each subscale. The age equivalent scores were used in the current study. The 4 subscale age equivalent scores were averaged to estimate mental age.

**Diagnostic Measures**

For children in the ASD group, diagnoses were confirmed with the Autism Diagnostic Observation Scale (ADOS; Lord et al., 2000). The ADOS was administered by trained graduate students or a post-doctoral fellow. All children also received clinical diagnoses of ASD and met criteria for autism or autism spectrum on the ADOS. The ADOS is a standardized, semi-structured, interactive diagnostic assessment that provides opportunities for the evaluation of participants’ social behaviors and communicative skills. A diagnostic algorithm classifies participants into categories of autism, autism spectrum, or nonautism spectrum. The “nonautism spectrum” category on the ADOS
applies to any child who does not meet criteria for autism or for autism spectrum on this measure. The ADOS demonstrates strong interrater (correlation coefficient = .92) and test-retest reliability (correlation coefficient = .82) (Lord et al., 2000). Module 1 or 2 of the ADOS was administered to each participant. Each module took approximately 30 minutes to complete.

Diagnoses for children in the DD group were confirmed using scores from the MSEL. Children with both global developmental delays and with specific language delays were included. To meet criteria for global delay, children had Early Learning Composites on the MSEL below 77 (1.5 standard deviations below the mean). To meet criteria for language delay, children demonstrated a T-Score below 35 (1.5 standard deviations below the mean) in both expressive and receptive language on the MSEL and/or a T-Score below 30 (2 standard deviations below the mean) in either receptive or expressive language on the MSEL. Children in the TD group met none of these criteria for developmental delay.

The Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Renner, 1988) was also completed by the team of clinicians who participated in assessments for all children. This team typically included psychology graduate students, research assistants, post-doctoral fellows, and a clinical psychologist. The CARS is an observational measure assessing the severity of social, affective, cognitive, and communicative impairment in individuals with autism. A cutoff score separates children in the autistic range from those in the nonautistic range. An examiner completed this measure based on observations made throughout the assessment. The CARS measure was completed for all children in the DD and TD groups to ensure that none met criteria for autism.
Two measures of expressive language development were used. Expressive language and receptive language are typically highly intercorrelated in young children with autism. Expressive language, rather than receptive language was chosen for the present study because there is potentially less error in measuring use of language than understanding of language, particularly in parents’ reporting. Specifically, it may be more likely for a parent to incorrectly assume a child understands a word than for the parent to incorrectly report the expressive use of a word by their child. The expressive language scale from the MSEL was used to estimate expressive age equivalents (EA). Age equivalent scores were used rather than standard scores for two reasons. First, it was more interesting to examine the association between orienting and expressive language level rather than degree of language delay. Second, many children with autism and developmental delays did not obtain valid standard scores on the MSEL language scale. Specifically, children receive T-scores based on their performance and chronological age on the MSEL. The average score is 50, with a standard deviation of 10. The MSEL will provide T-scores above 20, or 3 standard deviations below the mean. Many children with autism score below 20, and are assigned a T-score of “< 20,” making it impossible to detect language differences among the children with the most significant delays. The MacArthur Communication Development Inventory (MCDI; Fenson et al., 1993) was completed by all parents. Because of the language delays experienced by young children with autism, the infant form was used. From this measure, the total number of words “said and understood” was used as measures of communication skills.
The Dyadic Orienting Test (DOT) was developed based on results from pilot testing (See Appendix A for a description of the pilot study conducted to develop the DOT; See Appendix B for a description of the final DOT). Administration took approximately 20 minutes. The DOT was administered by the author and trained research assistants. During DOT administration, the child sat behind a table in the corner of a room. Experimenter 1 sat behind the child and placed a variety of developmentally appropriate toys on the table. These toys included playdough, puzzles, stacking blocks, and books. Experimenter 1 was instructed to help the child stay at the table and face the center of the room, to help the child become and remain engaged with toys, and to provide no response when DOT stimulus items were presented.

Experimenter 2 presented stimulus items and scored the child’s responses. The DOT contains 14 stimulus items: 7 social items and 7 nonsocial items. See Table 4 for a list of these items. Experimenter 2 presented each item approximately 5 – 7 feet from the child, alternating to the left and right side. Remote control devices were used for three nonsocial items (star, radio static, and car ignition). In most cases, the experimenter was not on the same side of the room where these items were being presented. The order of item presentation was pre-determined using a random number table. The side (left or right) of the first stimulus item was also predetermined using a random number table; subsequent item presentation alternated between the left and right side. Experimenter 2 began presenting each item when the child was engaged with toys. Each item was presented up to three times to elicit an orienting response. After the child oriented, no
Table 4

*DOT stimulus items*

<table>
<thead>
<tr>
<th>Social</th>
<th>Visual</th>
<th>Auditory</th>
<th>Visual and auditory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wave hand</td>
<td></td>
<td><strong>Verbal:</strong></td>
<td>Clap hands</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Name call</td>
<td>Stomp feet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wow!</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oh no!</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Nonverbal:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cough</td>
<td></td>
</tr>
<tr>
<td>Nonsocial</td>
<td>Star light</td>
<td>Phone ring 1</td>
<td>Bouncy balls fall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Car ignition sound</td>
<td>Jack-in-the-box</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radio static</td>
<td>Rattle</td>
</tr>
</tbody>
</table>
additional trials were presented. Trials for each item were approximately 15 seconds apart. Items were presented approximately one minute apart.

Experimenter 2 coded responses while administering the DOT. This experimenter noted whether a child oriented to each trial presented. Orienting was defined as visually shifting attention toward the stimulus item within 5 seconds of the stimulus presentation. For social items, a child oriented when s/he looked toward Experimenter 2. Eye contact was not required. For nonsocial items, a child oriented when s/he looked toward the item or sound. No explicit instructions were given regarding how far the child’s head or eyes needed to move; rather, a shift toward the item was sufficient. Experimenter 2 also noted behaviors used to orient and whether a response was immediate or delayed. These ratings were used for training purposes only, and were not included in analyses. For approximately one third of administrations, a second person scored the DOT live. This observer sat in the room observing the administration while scoring, but was not involved in administration of the DOT. This observer was blind to the diagnostic group of the child. Effort was made to spread these observations across diagnostic groups and throughout the data collection period. DOT administrations were videotaped when permission was given by parents. These tapes were coded to calculate latency scores for each DOT item.

Several indices of orienting were used for the present study: proportion of orienting responses to social and nonsocial stimuli, average number of trials needed to elicit social and nonsocial orienting responses, and average latency of social and nonsocial responses. Definitions of these variables are provided below and summarized in Table 5.
**Proportion scores.** The proportion variable divided the number of responses by the number of items administered in each dimension. The range of scores was $0 – 1$.

**Average trials.** The average trials variable represented the average number of trials presented for items in each dimension. Children who did not orient on any of the 3 trials were assigned a score of 4. The range of possible scores for the average trial variable was $1 – 4$.

**Average latency.** The average latencies were calculated for each dimension. Items for which a child did not orient were not included in calculations of this variable because it represented latency to response when a child provided a response.

**Efficiency rating.** An efficiency score was also created by combining for each item the number of trials presented with the latency scores. With this rating scale higher efficiency scores were assigned to a child who responded quickly on the first trial than to a child who responded more slowly on the first trial. First, for each item, the median latency was calculated. Children who responded more quickly than the median were considered “fast” responders, while those at or above the median were considered “slow” responders. Next, this fast/slow categorization was combined with the trial on which the child responded. The final efficiency rating scale was $0 – 6$. 
Table 5

Definitions of DOT variables

<table>
<thead>
<tr>
<th>Definition</th>
<th>Range of scores</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of responses</td>
<td>Total number of items 0 – 1 Higher scores reflect that the child oriented to a higher proportion of stimuli</td>
<td></td>
</tr>
<tr>
<td></td>
<td>that elicited an orienting response from the child/ Total items presented</td>
<td></td>
</tr>
<tr>
<td>Average trials</td>
<td>Average number of trials 0 – 4 Higher scores for children who require fewer trials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>administered per item.(^a) (no response = 4) before orienting.</td>
<td></td>
</tr>
<tr>
<td>Latency scores(^b)</td>
<td>Time between item presentation and .1 – 5 sec. Higher numbers reflect more delayed responses. orienting response</td>
<td></td>
</tr>
<tr>
<td>Efficiency ratings</td>
<td>Combination of trials and latency 0 – 6 Higher numbers reflect more trials and longer latencies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0: 1 trial, fast 1: 1 trial, slow 2: 2 trials, fast 3: 2 trials, slow 4: 3 trials, fast 5: 3 trials, slow 6: no response</td>
<td></td>
</tr>
</tbody>
</table>

Note. Each variable was computed for the social and nonsocial dimension.

\(^a\) Only the number of trials necessary to elicit a response were administered for each item.

\(^b\) For latency variables, only items that elicited a response were included in calculations.
Joint Attention

Measures of initiating joint attention (IJA) and responding to joint attention (RJA) were presented from the Early Social Communication Scales (ESCS; Mundy, Hogan, & Doehring, 1996). The ESCS is a structured observation measure of nonverbal communication skills that typically develop between 8 and 30 months of age. A modified version of the ESCS (only items targeting IJA and RJA) was administered by one experimenter and coded by a second experimenter in the room. This method follows standard procedure for scoring the ESCS. ESCS sessions were videotaped. As a measure of inter-observer reliability, videotapes of all administrations were also coded for IJA and RJA behaviors; scores from live-coding and video coding were compared to assess interobserver reliability. Administration required between 15 and 25 minutes. Several scores of nonverbal communication skills can be coded during administration of the ESCS or from videotapes of administrations. For the purposes of the present study, the variables measuring IJA and RJA were coded.

For IJA trials, the experimenter played with 6 interesting toys (e.g., wind-up toy, balloon), then presented the toys to the child for several turns. Each of the toys was presented up to 3 times, yielding a range of IJA trials of 0 – 18. The observer coded the following low level IJA behaviors: making eye contact with an adult while playing with a toy and alternating gaze between a toy and person (low IJA). The observer also coded high level IJA behaviors: pointing toward objects and showing objects (high IJA). All 18 trials were not administered to every child for various reasons including fatigue and refusals. Therefore, the proportion of trials on which children demonstrated these
behaviors was used in analyses. All ESCS scores were proportion scores, with the IJA behaviors divided by the IJA trials, low RJA behaviors divided by low RJA trials, and high RJA behaviors divided by high RJA trials.

For low RJA trials, the experimenter presented a colorful book to the child and pointed to pictures while saying the child’s name. The experimenter pointed to up to 9 pictures. The observer coded whether the child visually followed this proximal point to the book. For the low RJA score, the proportion of correct responses was scored. For high RJA trials, the experimenter made eye contact with the child, then pointed to a picture on the wall either to the left, right, or behind the child while saying the child’s name. Up to 2 trials were presented in each location, yielding a range of 0 – 6 high RJA trials. For high RJA responses, the observer coded whether the child followed the distal point to the posters. See Table 6 for definitions of ESCS variables coded in the present study.

Procedures

Thirty-nine of the participants were recruited from a study focusing on identification of autism in children under two, thirty-two from a study focusing on social orienting in autism and young siblings, and one from a study of imitation skills in children with autism. The procedures for each of these studies differed slightly. However, in all three studies, the children participated in cognitive and diagnostic assessments. In addition to these core assessments, children participated in different assessments of social and communicative skills based on the goal of the particular study.
Table 6

*Definitions of ESCS variables*

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low IJA</td>
<td>Child makes eye contact while adult plays with toy or alternated gaze between toy and adult</td>
</tr>
<tr>
<td>High IJA</td>
<td>Child points to toy while adult plays with it, or shows toy to adult</td>
</tr>
<tr>
<td>Low RJA</td>
<td>Child follows a proximal point to pictures in a book</td>
</tr>
<tr>
<td>High RJA</td>
<td>Child follows a distal point to posters on the wall</td>
</tr>
</tbody>
</table>

*All ESCS variables are proportions based on the number of trials presented to elicit these behaviors.*
During all evaluations, a post-doctoral fellow or research assistant who was not involved in this dissertation introduced the study to families while they were at Vanderbilt. If interested, families were given the option to stay for an additional 15-30 minutes to complete the measures for this study, or to return at a later date. Children participated in evaluations that lasted between 1.5 and 4 hours, allowing time for breaks between assessments. Children in all groups received cognitive testing, the DOT, the CARS, and the Demographic form; the autistic sample also received the ADOS, the ESCS, and the MCDI.

Data Analysis

Evaluation of Psychometric Properties of the DOT

Because it was a newly developed instrument, the reliability and validity of the DOT were examined for the entire sample, and for the ASD sample. Performance on the items presented to the left and right were compared. In addition, analyses were conducted to determine whether performance varied by when an item was presented (e.g., beginning or end of DOT). Internal consistency, or the extent to which items within a scale measure the same construct, was measured for the social and nonsocial dimensions of the DOT. Alpha coefficients were used to evaluate internal consistency. These coefficients range from 0 to 1, with higher scores reflecting higher levels of internal consistency. Interobserver reliability was also examined. For 30% of the children in this study, a second observer scored the DOT as it was presented. Cohen’s kappa was
calculated to measure agreement for each item. Psychometric properties were evaluated for the entire sample and separately for the ASD group.

**Group Comparisons**

Hypotheses 1 – 3 were tested using 3 (Diagnostic group) x 2 (Stimulus type) factorial designs for each of the 4 dependent variables measured by the DOT (proportion of orienting responses, average trials to orienting, average latency scores, and efficiency ratings; See Table 5). These 3 x 2 factorial designs were also conducted with visual versus auditory DOT stimuli. Planned comparisons were then conducted to compare performance in the ASD group with each of the two control groups separately. Classification of groups was attempted using discriminant function analysis.

**Exploratory Hypotheses**

Exploratory hypotheses stated that SO and NSO would be positively correlated with RJA and IJA. To test this hypothesis, Pearson correlation coefficients were calculated between measures of social and nonsocial orienting and ESCS scores of IJA and RJA. Exploratory hypothesis 2 stated that expressive language ability would be negatively correlated with measures of social and nonsocial orienting. To test this hypothesis, Pearson correlation coefficients were calculated between average trials for social and nonsocial orienting and scores from the MSEL and the MCDI. If zero-order correlations were significant, a mediation model was tested as described by Baron and
Kenny (1986) to determine whether joint attention skills served as mediators in the relation between orienting and language. Finally, Pearson correlation coefficients were calculated between SO, NSO, and CARS scores to test the relation between orienting and autism severity.
CHAPTER III

RESULTS

Psychometric properties and descriptive statistics of the DOT

Description of the DOT

To determine whether there were differences in orienting for items presented to the left versus right of the child, paired-sample t-tests were conducted. Average trial scores were used in this analysis. Results revealed no differences in the average number of trials presented to the left and right, $t(72) = .89, p = .39$, suggesting that children did nor require more trials to respond on either side. These results were consistent for social and nonsocial DOT dimensions, and across diagnostic groups.

Although the order of item presentation was randomized, it was important to determine whether children’s performance improved or declined over time during DOT administration. To test this association, average trial scores for each item were correlated with item number (1 – 14). Higher average trial scores indicate that the child needed additional prompts to orient. Results revealed that orienting performance was not correlated with the order of presentation for any of the 14 stimulus items for the entire sample and the ASD sample (all $ps > .2$), suggesting that the number of trials required to elicit an orienting response was not associated with when an item was presented during the DOT.
Average trial scores were correlated with mental age equivalents from the MSEL and with chronological age. Results revealed nonsignificant correlations between both social and nonsocial orienting scores and mental age, \( r(71) = -0.08, \) and \( r(71) = -0.09, \) \( p > .4. \) In contrast scores were significantly correlated with chronological age, \( r(71) = 0.42, \) and \( r(71) = 0.33, \) \( p < .01. \) Because children in the TD group were younger than both groups, these correlations were also conducted for each diagnostic group separately. Results revealed non-significant correlations within the ASD and DD groups. Within the TD group, nonsocial orienting scores were significantly positively correlated with CA, \( r(19) = 0.51, \) \( p < .05, \) suggesting that older typically developing children respond after more nonsocial trials than younger typically developing children.

Because there was a higher percentage of girls in the TD group than in both the ASD and DD group, DOT scores for girls and boys were compared. Only children in the DD and TD groups were included in these analyses, because there were no girls in the ASD group. Results revealed no significant differences in performance on any DOT variable for girls and boys, \( p > .25. \)

**Inter-observer Reliability**

**Total responses.** The DOT was scored live for all 73 children by a primary examiner (either L. T., or trained research assistant, A.S.). For 22 of these 73 children (30%), a second observer scored the DOT live (A.S.). In all cases, the primary examiner and secondary observer were both in the testing room. The number of children in each diagnostic group represented the total sample as follows: 9 children with ASD, 6 with
DD, and 7 with TD. For each DOT item, observers marked whether a child provided an orienting response. Inter-observer agreement for responses to each of the 14 items was measured using Cohen’s kappa. The range of kappas for these items was from .80 to 1.0. There was 100% agreement for 8 items: 6 nonsocial items and 2 social items. The lowest agreement was for the *cough* item in the social dimension. Results were similar within the ASD group (n = 9), with kappas ranging from .78 to 1.0. The total number of orienting responses scored by each observer was also summed. The intraclass correlation coefficient (ICC) between these totals for the 22 cases score by the primary and secondary coder was .99. The ICC for the 9 ASD cases scored by the primary and secondary coder was 1.

*Average trials.* Average trial scores for each rater were also correlated with each other. Results revealed ICCs between the average trials scored by each rater for social trials of .98, and for nonsocial trials of .99. For the ASD group, these ICCs were .99 for social trials and 1.0 for nonsocial trials.

*Latency scores.* Latency of DOT responses was measured from videotapes using Procoder-DV. Coders scored the start of each stimulus item presentation and the start of each orienting response. These times were exported into an excel file to compute latency to response. Average latencies were then computed for the social and nonsocial dimensions of the DOT for each child. A primary coder scored 72 DOT tapes. No tape was made for one child in the total sample. A secondary coder scored 29 tapes chosen to represent the three diagnostic groups, and chosen across the time-span of data collection: 11 children with ASD, 6 with DD, and 13 with TD. This subsample was not the same sample as the sample used for live inter-observer reliability coding. ICCs between
primary and secondary coders of latency variables were .73 and .74 for social and nonsocial dimensions, respectively. For the 11 children with ASD, ICCs between primary and secondary coders for latency variables were .64 and .87 for social and nonsocial dimensions, respectively. All $p$ values were $< .01$.

*Internal Consistency*

For the social and nonsocial dimensions of the DOT, alpha coefficients were calculated to evaluate the degree to which these dimensions measured unitary constructs. First, alpha coefficients were calculated for each dimension using the variables denoting in a dichotomous way whether children oriented to each stimulus item. Using these dichotomous variables, the alpha coefficient for all fourteen items was .83. Splitting the dimension into social and nonsocial dimensions, the alpha coefficient for the seven social items was .76, and for the seven nonsocial items was .62. In general, alpha coefficients greater than .80 are considered adequate. Removal of items is one way to improve the alpha coefficient for dimensions. Removal of items did not increase either of these scores to greater than .8.

One potential reason for the low alpha levels could be the dichotomous nature of these variables. DOT raters also scored on which trial children oriented to each item. Internal consistency was also measured using these average trial variables. Alpha coefficients for the entire DOT, for the seven social items, and for the seven nonsocial items were .85, .80, .65, respectively. By removing two nonsocial items (the *star* and *static* items, the alpha coefficient for the nonsocial dimension became .70. The
remaining five nonsocial items (ball, ignition, rattle, jack-in-the-box, and phone) were used to form the nonsocial dimension variables for the remaining analyses presented below.

The somewhat low internal consistency for the nonsocial dimension may reflect that this dimension is not measuring a unitary construct. In addition, the internal consistency of the entire DOT was higher than for either dimension. This finding may be due to the increased number of items. However, the dimensions may not reflect separate constructs. The correlations between social and nonsocial dimension scores ranged from .5 to .6, ps < .001, using all 73 children.

**Group Differences for DOT Variables**

**Proportion of Responses**

The average proportion of items in each dimension that elicited orienting responses was calculated for each group. See Table 7 for descriptive statistics for the different DOT variables. For the social dimension, the average proportion of items was .47 (s.d. = .34), .75 (s.d. = .21), and .86 (s.d. = .17), for the ASD, DD, and TD groups, respectively. For the nonsocial dimension, the average proportion of items was .69 (s.d. = 27), .95 (s.d. = .09), and .93 (s.d. = 18), for the ASD, DD, and TD groups, respectively. See Figure 2.

A 3 x 2 analysis of variance was conducted to compare the proportion of responses on each DOT dimension for the three matched groups in this study. Results
<table>
<thead>
<tr>
<th></th>
<th>ASD</th>
<th>DD</th>
<th>TD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social dimension</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
<td>.47 (.34)</td>
<td>.75 (.21)</td>
<td>.86 (.17)</td>
</tr>
<tr>
<td>Range</td>
<td>0 – 1</td>
<td>.29 – 1</td>
<td>.57 – 1</td>
</tr>
<tr>
<td>Average trials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
<td>2.9 (.97)</td>
<td>2.1 (.52)</td>
<td>1.6 (.48)</td>
</tr>
<tr>
<td>Range</td>
<td>1 – 4</td>
<td>1.3 – 3.1</td>
<td>1 – 2.4</td>
</tr>
<tr>
<td>Average latency scores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
<td>1.5 (.69)</td>
<td>1.1 (.40)</td>
<td>1.2 (.26)</td>
</tr>
<tr>
<td>Range</td>
<td>.3 – 3.7</td>
<td>.7 – 2.1</td>
<td>.8 – 1.8</td>
</tr>
<tr>
<td>Efficiency ratings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
<td>4.1 (1.88)</td>
<td>2.5 (1.14)</td>
<td>1.7 (.94)</td>
</tr>
<tr>
<td>Range</td>
<td>.33 – 6</td>
<td>.5 – 5.17</td>
<td>.5 – 3.33</td>
</tr>
<tr>
<td><strong>Nonsocial dimension</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
<td>.69 (.27)</td>
<td>.95 (.09)</td>
<td>.93 (.18)</td>
</tr>
<tr>
<td>Range</td>
<td>.2 – 1</td>
<td>.8 – 1</td>
<td>.4 – 1</td>
</tr>
<tr>
<td>Average trials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
<td>2.2 (.81)</td>
<td>1.5 (.48)</td>
<td>1.4 (.72)</td>
</tr>
<tr>
<td>Range</td>
<td>1 – 3.6</td>
<td>1 – 2.4</td>
<td>1 – 3.2</td>
</tr>
<tr>
<td></td>
<td>Average latency scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------</td>
<td>--------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td></td>
<td>Mean (s.d.)</td>
<td>1.2 (.41)</td>
<td>1.4 (.83)</td>
</tr>
<tr>
<td>Range</td>
<td>.5- 2.3</td>
<td>.7 – 3.8</td>
<td>.5 – 1.6</td>
</tr>
<tr>
<td>Efficiency ratings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean (s.d.)</td>
<td>2.6 (1.5)</td>
<td>1.4 (.96)</td>
</tr>
<tr>
<td>Range</td>
<td>0 – 5.2</td>
<td>0 – 3.6</td>
<td>.2 – 4.6</td>
</tr>
</tbody>
</table>
Figure 2. Proportion scores for DOT dimensions
revealed a significant main effect for group, $F(2, 54) = 14.86, p < .001$. Planned comparisons revealed that, across social and nonsocial dimensions of the DOT, the ASD group oriented to a lower proportion of items than both the DD and TD groups, $ps < .05$. Proportions of orienting responses were not different between the DD and TD groups, $ps > .5$. Results also revealed a significant main effect of dimension, $F(1, 54) = 21.11, p < .001$, indicating that, across groups, children oriented to a higher proportion of nonsocial stimuli than social stimuli. Finally, the group by dimension interaction failed to reach significance, $F(2, 54) = 1.86, p = .17$, indicating that the pattern of orienting to different types of stimuli was not significantly different across the three groups. Planned comparisons examining the interaction between group and dimension between the ASD and TD group were not significant, $p > .05$. Further, the interaction between group and dimension for the ASD and DD groups was not significant, $p > .05$.

*Average Trials*

The average number of trials presented in each DOT dimension was calculated for each group. Children oriented on the first, second, or third trial, or did not orient. Those who did not orient to an item were assigned a score of 4. Descriptive statistics are listed in Table 7. For the social dimension, the average number of trials was 2.87 (s.d. = .97), 2.05 (s.d. = .52), and 1.63 (s.d. = .48), for the ASD, DD, and TD groups, respectively. For the nonsocial dimension, the average number of trials was 2.15 (s.d. = .81), 1.49 (s.d. = .48), and 1.40 (s.d. = .72), for the ASD, DD, and TD groups, respectively. See Figure 3.
Figure 3. Average trials for DOT dimensions
A 3 x 2 analysis of variance was conducted to compare the average number of trials for each DOT dimension for the three matched groups in this study. Results revealed a significant main effect for group, $F(2, 54) = 543.81, p < .001$. Planned comparisons revealed that, across social and nonsocial dimensions of the DOT, the ASD group required more trials than the DD and TD groups before orienting to stimulus items, $ps < .05$. There were no differences between the TD and DD groups. Results also revealed a significant main effect of dimension, $F(1, 54) = 22.18, p < .001$, indicating that, across groups, children required more trials prior to orienting to social than nonsocial stimuli. Finally, the group by dimension interaction failed to reach significance, $F(2, 54) = 1.92, p = .16$, indicating that the differences in trials between groups were similar across social and nonsocial dimensions of the DOT. Planned comparisons examining the interaction between group and dimension between the ASD and TD group were not significant, $p > .05$. Further, the interaction between group and dimension for the ASD and DD groups was not significant, $p > .05$.

**Average Latency**

The latency scores for each DOT item were scored from video tape, and averages were computed for each DOT dimension. Only responses within 5 seconds were considered orienting responses. Items that elicited no responses were not included in these average latency scores. Therefore, the latency scores represent the average amount of time it took to orient when a child oriented. If children did not orient to an item at all, no latency score was included in the average score for that item. Further, three children
in the ASD group did not orient to any social items. There was one child in the TD group whose DOT was not videotaped. These four children are not included in this analysis.

For the social dimension, the average latency was 1.46 (s.d. = .69), 1.11 (s.d. = .40), and 1.16 (s.d. = .26), for the ASD, DD, and TD groups, respectively. For the nonsocial dimension, the average latency was 1.19 (s.d. = .41), 1.42 (s.d. = .83), and 1.05 (s.d. = .33), for the ASD, DD, and TD groups, respectively. See Figure 4.

A 3 x 2 analysis of variance was conducted to compare the orienting latencies between groups and across DOT dimensions. Results revealed a non-significant main effect for group, $F(2, 50) = 2.67, p = .09$. Results also revealed no significant main effect of dimension, $F(1, 50) = .05, p = .83$. Finally, the group by dimension interaction was not statistically significant, $F(2, 50) = 2.65, p = .08$. Planned comparisons examining the interaction between group and dimension between the ASD and TD group were not significant, $p > .05$. Further, the interaction between group and dimension for the ASD and DD groups was not significant, $p > .05$. These results suggest that when children with autism respond to a stimulus, they do so as quickly as other children.

Efficiency Ratings

Efficiency ratings were calculated to combine information about how many trials of each item were presented and the latency to response. With this rating scale higher efficiency scores were assigned to a child who responded quickly on the first trial than to a child who responded more slowly on the first trial. First, for each item, the median latency was calculated. Children who responded more quickly than the median were
Figure 4. Average latency scores for DOT dimensions.
considered “fast” responders, while those at or above the median were considered “slow” responders. Next, this fast/slow categorization was combined with the trial on which the child responded. The final efficiency rating scale was 0 – 6; see Table 5 for a description of these values. Six was the most efficient and 0 the least efficient (no response). Mean efficiency ratings are presented in Table 7.

A 3 x 2 analysis of variance was conducted to compare the efficiency ratings between groups and across DOT dimensions. Results revealed a significant main effect for group, $F(2, 54) = 15.54, p < .001$, with the ASD group showing a lower efficiency score than DD and TD groups, $ps < .01$, who did not differ, $p = .47$. Results also revealed a significant main effect of dimension, $F(1, 54) = 20.72, p < .001$, with lower efficiency scores found for the social dimension than the nonsocial dimension. Finally, the group by dimension interaction was not statistically significant, $F(2, 54) = 1.51, p = .23$.

Planned comparisons examining the interaction between group and dimension between the ASD and TD group were not significant, $p > .05$. Further, the interaction between group and dimension for the ASD and DD groups was not significant, $p > .05$. These results are consistent with previous analyses of average trial scores. See Figure 5.

Classification of Groups

To determine whether scores from the DOT could correctly classify children into diagnostic groups, discriminant function analyses were conducted. These analyses were conducted first with proportion scores and second with average trials scores to determine which measure classified groups better. As scores from the DOT did not differ between
Figure 5. Average efficiency ratings for DOT dimensions.
TD and DD groups, these groups were collapsed into a nonspectrum group to compare to the ASD group. First, the discriminant function that included both social and nonsocial proportion scores correctly classified 72% of children in the ASD group and 84% of children in the nonspectrum group. The second analysis that included social and nonsocial average trial scores correctly classified 68% of children in the ASD group and 91% of children in the nonspectrum group.

*Sensory Modality*

Although orienting was defined as a visual response in the DOT, stimulus items were visual and auditory. Two items were visual only (wave and star light), 7 were auditory only (name, wow, oh no, cough, radio static, car ignition, phone), and 5 were both visual and auditory (clap hands, stomp feet, bouncy ball, shake rattle, jack-in-the-box). For these 4 items that were visual and auditory, the child could orient to the visual feature of the stimulus (e.g., jack-in-the-box being held out) or the auditory feature of it (e.g., music playing). Figure 6 displays the average number of trials for items in each sensory group for each diagnostic group.

Although no a priori hypotheses were proposed regarding performance by sensory modality, an analysis was conducted to compare the performance of each diagnostic group on auditory and visual DOT items. The combined sensory group was not included in this analysis. A 3 x 2 analysis of variance was conducted to compare the average trials for visual items and auditory items by diagnostic group. Results revealed a significant main effect of sensory modality, $F(1, 54) = 20.76$, $p < .001$, and a significant group by
Figure 6. Average trials by DOT sensory modality
sensory modality interaction, $F(2, 54) = 11.63, p < .001$. Results also revealed a non-significant main effect for group, $F(2, 54) = 1.82, p = .17$. These results indicate there were no differences in the number of trials presented for visual items between the three groups, but that the ASD group required more trials to orient to auditory items than other groups. In addition, the two control groups responded in fewer trials to auditory items than to visual items, while there were no differences between sensory modality for the ASD group.

Associations with Measures of Joint Attention, Language, and Autism Severity within ASD group

ESCS Reliability Data

Thirty-one children with ASD completed the ESCS. A coder scored 30 of these administrations in the testing room (no live coding was conducted for one child; this child’s tape was coded). Twenty-six administrations were taped, and a second observer coded these tapes independently. Eleven variables were coded: total IJA trials, total low IJA behaviors, total high IJA behaviors, total low RJA trials, total low RJA responses, total high RJA trials to the right, left, and back, and total high RJA responses to the right, left, and back. For a review of ESCS definitions, please see Table 6. To assess interobserver reliability, each of these variables scored by the live observer was correlated with the variable scored by the tape observer. ICCs ($n = 26$) ranged from .65 to .91. To provide the best estimate of these scores, the ratings from the live observer and
video observer were averaged. For the 5 children who only had live ratings and one child who only had video ratings, these scores were used for analyses.

From these averages, 4 proportion scores were computed: proportion of low IJA behaviors to IJA trials (low IJA), proportion of high IJA behaviors to IJA trials (high IJA), proportion of low RJA responses to low RJA trials (low RJA), and proportion of high RJA responses to total high RJA trials (high RJA). Only 8 children demonstrated any high IJA behaviors during the ESCS administration. Because of the low variability of these scores, the high and low IJA variables were combined (i.e., the total number of high and low IJA behaviors were added together, then divided by the number of IJA trials administered). This one measure of IJA was used for all analyses. The means and standard deviations for each of these variables are presented in Table 8.

Previous research with children who have autism has demonstrated that measures of IJA and RJA are positively correlated with both expressive and receptive language (Mundy, Sigman, Ungerer, & Sherman, 1987). Because the ESCS procedures presented to children in the present study were a shortened version of the ESCS, it was important to test whether the findings were comparable to other ESCS findings. As a means of testing whether the ESCS data from the present study was valid, receptive and expressive language age scores from the MSEL were correlated with ESCS variables. Results revealed that IJA scores were significantly positively correlated with both receptive and expressive language, $r(31) = .50, p < .001$, $r(31) = .37, p < .05$. Both low and high RJA scores were also significantly correlated with measures of receptive and expressive language (all $r$ values $> .66, ps < .001$). These findings suggest that the measures of joint attention are associated with language as would be predicted from previous research.
Table 8

*Descriptive statistics for ESCS variables*

<table>
<thead>
<tr>
<th>ESCS scores</th>
<th>Mean</th>
<th>s.d.</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low IJA</td>
<td>.13</td>
<td>.14</td>
<td>0</td>
<td>.50</td>
</tr>
<tr>
<td>High IJA</td>
<td>.03</td>
<td>.07</td>
<td>0</td>
<td>.35</td>
</tr>
<tr>
<td>Total IJA</td>
<td>.15</td>
<td>.16</td>
<td>0</td>
<td>.60</td>
</tr>
<tr>
<td>Low RJA</td>
<td>.36</td>
<td>.31</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>High RJA</td>
<td>.37</td>
<td>.34</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
As described above, in the group differences analyses, there were four DOT variables computed for each dimension: proportion of items that elicited a response, the average number of trials administered per item, the latency to response, and efficiency ratings. The average trial variable was chosen for the following analyses because it provides information about how many items a child responded to and how many repetitions were required, and may best reflect the construct of the effort required to elicit the attention of a child to social and nonsocial stimuli. Because of the strong positive correlation between the social and nonsocial dimension scores, and the lack of evidence for a unique impairment in social orienting presented above, total orienting scores (average trials for all DOT items presented) were also included in the following analyses.

Higher scores indicated that the child either responded to fewer items and/or required more trials before turning his head. These variables for social and nonsocial DOT dimensions and for all DOT items (total DOT) were correlated with measures of IJA and RJA. No significant correlations were found for IJA or RJA scores with the average DOT social trials, all \(p > .1\). Table 9 displays the \(r\) values for these analyses. For the nonsocial DOT dimension, associations between the average trials per item and IJA were not statistically significant. For low RJA behaviors and high RJA behaviors, statistically significant correlations were found, \(r(29) = -.51, p < .01\), and \(r(28) = -.38, p < .05\). The negative correlation reflects that stronger RJA skills were associated with fewer trials presented per item for the nonsocial dimension. For the total DOT, significant
correlations were found for low RJA only, \( r(29) = -.39, p < .05 \). Trend level associations between the total DOT score and both IJA and high RJA were found, \( ps < .1 \).

**Associations between DOT Dimensions and Expressive Language**

The second set of zero-order correlations examined the association between social, nonsocial, and total DOT orienting scores and expressive language measures. Two measures of expressive language were used: Mullen age equivalent scores (EA) and CDI reported words said. To maintain the same sample used in joint attention correlation, only children who completed the ESCS were included in these analyses.

Results of language analyses revealed that social orienting scores did not correlate significantly with any language measure, all \( ps > .1 \). See Table 9 for these correlations. In contrast, nonsocial orienting scores were significantly positively correlated with EA, \( r(29) = -.36, p < .05 \), and CDI total words said \( r(29) = -.38, p < .05 \). Total DOT scores were significantly positively correlated with both EA, \( r(29) = -.36, p < .05 \), but not significantly with CDI total words said, \( r(29) = -.31, p < .1 \). These correlations indicate that higher expressive language ability was associated with fewer trials presented in the nonsocial dimension of the DOT, and fewer trials for the total DOT.

The a priori hypotheses predicted a mediation model to explain the associations between orienting and language. Because nonsocial orienting and total orienting scores were associated with RJA and expressive language, as reported above, models testing whether the association between nonsocial orienting and RJA mediated the association between orienting scores and expressive language were conducted using the Sobel
Table 9

*Correlations between DOT variables and measures of joint attention, expressive language, and autism severity in ASD sample*

<table>
<thead>
<tr>
<th>DOT</th>
<th>IJA</th>
<th>RJA low</th>
<th>RJA high</th>
<th>MSEL EA</th>
<th>CDI</th>
<th>CARS</th>
<th>Total words said</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social orienting</td>
<td>-.25</td>
<td>-.12</td>
<td>-.15</td>
<td>-.14</td>
<td>-.06</td>
<td>.37*</td>
<td></td>
</tr>
<tr>
<td>Nonsocial orienting</td>
<td>-.22</td>
<td>-.51**</td>
<td>-.38*</td>
<td>-.36*</td>
<td>-.38*</td>
<td>.35</td>
<td></td>
</tr>
<tr>
<td>Total orienting</td>
<td>-.31</td>
<td>-.38*</td>
<td>-.32</td>
<td>-.36*</td>
<td>-.31</td>
<td>.50*</td>
<td></td>
</tr>
</tbody>
</table>

*p > .05, **p > .01
method (Baron & Kenny, 1986). Three models were tested based on the significant correlations reported above: 1) Does low RJA mediate the relation between nonsocial orienting and expressive language?, 2) Does high RJA mediate the relation between nonsocial orienting and language?, and 3) Does low RJA mediate the relation between total orienting and language?

To test a mediation model, three equations are calculated: First, the independent variable (e.g., nonsocial orienting) must be associated with the mediator (RJA). Second, the independent variable must be associated with the dependent variable (EA). The third equation tests the association between the mediator and the dependent variable (EA). The weights of these associations are reported above and in Table 9. Next, to test whether the relations between nonsocial orienting and EA were significantly reduced when taking RJA into consideration, the Sobel equation was used:

\[
Z - \text{Value} = a \times b / \sqrt{b^2 \times s_a^2 + a^2 \times s_b^2}
\]

- \(a\) = raw (unstandardized) regression coefficient for the association between IV and mediator.
- \(s_a\) = standard error of \(a\).
- \(b\) = raw coefficient for the association between the mediator and the DV (when the IV is also a predictor of the DV).
- \(s_b\) = standard error of \(b\).

In the first model, low RJA was tested as a mediator of the association between nonsocial orienting and EA. See Figure 7 for models of each of these analyses. The
Figure 7. Mediation effects of RJA on NSO, Total orienting and EA<sup>a</sup>

<sup>a</sup>Beta weights and (standard errors) presented for each association
relation between nonsocial orienting and EA was $\beta = -.36$, $p < .05$, while the relation between nonsocial orienting and EA when considering low RJA was $\beta = -.02$, $p = .89$. Using the Sobel equation, results indicated that there was a statistically significant effect of low RJA on the relation between nonsocial orienting and EA, $Z_{med} = -2.68$, $p < .001$.

In the second model, high RJA was tested as a mediator of the association between nonsocial orienting and EA. The relation between nonsocial orienting and EA was $\beta = -.36$, $p < .05$, while the relation between nonsocial orienting and EA when considering high RJA was $\beta = -.07$, $p = .69$. Using the Sobel equation, results indicated that there was a statistically significant effect of high RJA on the relation between nonsocial orienting and EA, $Z_{med} = -1.98$, $p < .05$. In the third model, low RJA was tested as a mediator of the association between total orienting and EA. The relation of total orienting with EA was $\beta = -.36$, $p < .05$, while the relation between total orienting and EA when considering low RJA was $\beta = -.1$, $p = .49$. Using the Sobel equation, results indicated that there was a statistically significant effect of low RJA on the relation between total orienting and EA, $Z_{med} = -2.13$, $p < .05$.

**Associations with Autism Severity**

To determine whether social and nonsocial orienting and total orienting scores were associated with severity of autism symptoms, the average number of trials to response for each dimension and the total DOT were correlated with scores from the CARS. Results revealed that correlations between social orienting and CARS scores were statistically significant, $r(29) = .37$, $p < .05$. Correlations between total DOT scores
and CARS scores were also statistically significant, $r(29) = .50, p < .01$. Correlations between nonsocial orienting and CARS scores were similar but did not reach statistical significance, $r(29) = .35, p < .06$. These findings indicate that children with higher ratings of autism symptomatology required more trials to orient to DOT stimuli than those with lower ratings of autism symptomatology.
CHAPTER IV
DISCUSSION

The present study attempted to create a new orienting measure for use with young children with autism, to replicate and extend previous findings of social and nonsocial orienting impairments in young children with autism, and explore the association between orienting and the development of language through joint attention in children with ASD. Toward this end, the DOT, an orienting measure divided into social and nonsocial dimensions, was developed and tested in a younger sample of children than in previous studies. A discussion of the findings is presented below, beginning with a discussion of the support for the DOT as a measure of orienting for young children, followed by a discussion of how the hypotheses were and were not supported by the findings, then, by a discussion of the implications of the results for theoretical accounts of early impairments in autism. Finally, limitations and future directions are discussed.

Support for the DOT

The DOT was developed to include a range of social and nonsocial stimuli appropriate for young children. Results revealed strong psychometric properties of the total DOT scale. Specifically, ratings of interrater reliability were strong for scoring orienting responses and response latencies. Internal consistency measures were also strong for the entire DOT, and for the social dimension of the DOT. Internal consistency
was less strong for the nonsocial dimension of the DOT, which may reflect the diverse
range of stimuli in that dimension. Performance on the DOT was not associated with
mental age, but was correlated with chronological age, reflecting the younger age of the
typically developing children compared to children with autism. These findings suggest
that the DOT may be an appropriate measure to assess orienting behavior in young
children. Future use of the DOT could add more detailed analysis of children’s behavior
in addition to the variables examined in the present study.

Support of Hypotheses

As predicted, impairments in both social and nonsocial orienting were found for
young children with autism compared to both children with developmental delays and
children with typical development. In contrast to previous reports, the social orienting
impairments were not found to be more severe than the nonsocial orienting impairments.
The present study also examined whether response latencies were longer for children
with autism than for other groups. Results indicated that when orienting responses
occurred, latencies were not significantly longer for the ASD group than other groups,
and that there were no significant differences between latencies for social or nonsocial
stimuli. Although some children were not included in this analysis due to providing no
orienting responses, it was interesting that when a stimulus item elicited an orienting
response on a particular trial, the response time was not delayed for the ASD or DD
groups relative to the TD group. Taken in combination with the findings from analyses
of average trials, it can be concluded children with autism need more repetitions of trials
or prompts to respond to a stimulus, but that on the trial when they do respond, they do so as quickly as other groups.

These findings replicate previous research with slightly older children that demonstrated group differences in both social and nonsocial orienting. Children with autism oriented to a smaller proportion of items and required more prompts to orient than control groups for both social and nonsocial dimensions of the DOT. The present study did not find that the social orienting impairments were more severe in children with autism than the nonsocial orienting impairments as have previous studies with older children (Dawson et al., 1998, 2004). This lack of significant interaction may relate to the smaller sample size, and reduced power to detect this interaction in the present study. However, the pattern of responses across dimensions was quite similar for children in the ASD and DD groups (See Figures 2 – 5), suggesting the nonsignificant finding was not due to reduced power. This finding may be due to the younger age of the sample. The average mental age of children with ASD in the present study was 20 months, compared to an average mental age of 25 months in the most recent study by Dawson and colleagues (2004). Perhaps as children with autism mature, the differences between social and nonsocial orienting performance in the different groups become more pronounced.

Although not a primary aim of the present study, analyses were conducted to examine differences in groups’ performance on visual and auditory DOT items. Results revealed an interaction effect that indicated the ASD group required approximately the same number of trials for visual and auditory stimuli. In contrast, the DD and TD groups oriented in fewer trials to auditory versus visual stimuli. This finding is not surprising,
as research has shown cognitive profiles in autism that include strengths in performance on visual tasks relative to auditory or verbal tasks (Happe, 1994). Further, popular techniques used to educate children with autism incorporate visual structure as a core treatment feature based, in part, on the idea that children with autism have relative strengths in visual processing compared to auditory processing (Mesibov, Shea, & Schopler, 2004).

Findings from this study also indicated that social and nonsocial orienting DOT scores were associated with different developmental variables, suggesting these DOT dimensions likely measured different skills. Nonsocial orienting was associated with measures of responding to joint attention and expressive language. A mediation model described the association between nonsocial orienting, RJA, and expressive language, suggesting that nonsocial orienting may be important in language development because these skills are important in learning RJA skills. Social orienting, as measured by the DOT, was not associated with measures of joint attention or language, but was associated with severity of autism symptoms in the ASD sample, suggesting that weaker social orienting skills may be associated with a more global level of impairment in autism. Finally, using the total DOT scores, significant associations were found with RJA, expressive language, and severity of autism symptoms, suggesting that stronger performance on the entire DOT was associated with stronger RJA and language skills, as well as less severe autism symptoms.

The lack of association between social orienting and both joint attention measures and language measures in the ASD group was the most surprising finding from this study. Previous studies have shown that social orienting skills are positively correlated
with RJA, IJA, and language in children with autism (Dawson et al., 1998, 2004). The reason for the contrasting findings in the present study remains unclear. A majority of children with autism oriented to fewer than 50% of social items from the DOT, and several oriented to no social items. However, there were children with ASD who oriented to all items, indicating that within a sample of children with ASD, there is considerable variability in social orienting behavior. Dawson et al. (2004) also found considerable variability in children with ASD, though the range of scores was not reported. Interestingly, the children who oriented more readily to social stimuli in the present study were not necessarily the children who initiated or responded to joint attention with others most frequently, nor were they using the highest number of words. For example, five children with ASD oriented to all social stimuli and each of these five oriented on the first or second presentation of these stimuli. Two of these five children used fewer than 10 words. In contrast, two of the four children who did not orient to any social stimuli used more than 10 words.

The lack of association between social orienting and joint attention skills could also be explained in part by the low ESCS scores of children with ASD in the present study. At two years of age, children with autism rarely engage in joint attention behaviors, even at the level of alternating gaze to share enjoyment with another about an object (Mundy et al., 1990; Mundy et al. 1986; Sigman et al., 1986; Stone et al, 1997). The use of a shortened version of the ESCS may have contributed to the lower numbers. In the standard scoring of the ESCS, frequencies of IJA behaviors are coded across all ESCS items. In the present study, these behaviors were only coded on the IJA trials. Because all children did not receive the same number of trials, proportion scores were
used rather than frequency scores. This change in coding along with the shortened administration may have decreased the variability among children on this measure. In addition, as children develop more joint attention skills, it is possible that the association with social orienting would become stronger.

For RJA, there were differences in the way tasks were completed that may be important to consider when interpreting the findings, or lack of findings. Because children with autism were unlikely to initiate eye contact, the ESCS examiner made every effort to establish eye contact with the child prior to initiating an RJA trial (e.g., turn head and point to poster on the wall). These efforts included the examiner clapping near her eyes to attain attention and holding up preferred items near the eyes to attain attention. The latter method was used frequently for children who did not readily attain eye contact. In contrast, during the DOT, social items were presented one time approximately every 15 seconds. The examiner did not exert additional effort to attain the child’s attention on later prompts as during the ESCS. The ESCS efforts to make eye contact during RJA trials may be more reflective of natural settings that those in the DOT. When a parent needs her child to pay attention, she calls his name louder and louder each time, and may add physical prompts to get the child’s attention. Perhaps a more natural measure of social orienting would have yielded different results.

Unmeasured confounding variables may also be important to consider for future research. Potential confounding variables include children’s level of engagement when stimulus items were presented and children’s visual disengagement and attention shifting skills. Efforts were made to keep children engaged with toys during the presentation of DOT stimuli. However, some children remained engaged with one toy exclusively in a
perseverative way for the entire administration while others engaged with a variety of toys. For some children, Examiner 1 needed to provide frequent redirection to toys, while for others they did not. Perhaps the ability to engage with objects flexibly is important in how a child orients to stimuli in his/her environment.

An additional confounding variable may have been the distinction between visual disengagement and attention shifting. Orienting, as measured in the present study was more a measure of disengagement of visual attention rather than shifting attention because the examiner only presented items when children were already engaged with toys. However, no reliability data were collected regarding children’s engagement when stimuli were presented, making it difficult to know on what percentage of trials were children fully engaged in activities with toys. As a result, it is impossible to conclude whether the DOT always measured visual disengagement.

**Implications for Social versus Attentional Theories of Autism**

The findings of both social and nonsocial impairments are most consistent with studies of visual disengagement, as studies of attention shifting with children inconsistently demonstrate impairments in attention shifting to nonsocial stimuli. A recent study using a computer paradigm that elicited visual disengagement and attention shifts found that visual disengagement skills but not attention shifting skills were impaired in children with autism relative to children with developmental delays (Landry & Bryson, 2004). A different study using a more naturalistic measure of children’s spontaneous attention shifts (e.g., attention shifts coded during a free play activity) found
children with ASD to shift attention less frequently only to and from social stimuli (Swettenham et al., 1998). Future studies should measure in a standard way children’s focus of engagement when stimulus items are presented during the DOT. Visual disengagement abilities should be important in the development of RJA and IJA, as timing of disengagement may be quite important for social development because of the nature of social interactions (Murray & Trevarthan, 1986). Specifically, timing is important in gaining and maintaining the attention of another, in responding to others, and in developing an understanding of others. Measuring engagement skills, disengagement timing, and attention shifting may all be important to determine where problems occur in autism and which skills are most related to joint attention development.

The findings from the present study support theories of social orienting impairments in children with autism. However, the lack of a specific social impairment found may provide support for theories that suggest general attentional deficits are the core impairments that lead to social orienting impairments in children with autism. Harris et al. (1999) suggested that general orienting deficits in early childhood could lead to decreased social learning opportunities and impaired joint attention skills. Landry and Bryson (2004) also suggested that impairments in visual disengagement may underlie social impairments in autism. While the present study did not test social theories against attention theories, the findings are supportive of more general orienting impairments than those that are purely social in nature.
Limitations and Future Directions

There are several limitations to the present study. First, the sample size was limited. This limited sample may have played a role in the nonsignificant interactions found between groups and DOT dimensions. A second limit in the analyses of group differences was the high scores in the TD and DD groups. Eighty percent of typically developing children oriented to all nonsocial items, and 50% percent oriented to all social items. A majority of children in the DD group (75%) oriented to all nonsocial items, and 25% oriented to all social items. Further, most typically developing children oriented the first time a nonsocial item was presented (See Figure 2). For this reason, it is impossible to determine whether the lack of significant interaction between DOT dimension (social vs. nonsocial) and diagnostic group was due to ceiling effects in the control groups, particularly for the nonsocial dimension.

Future research should examine in more detail how object engagement skills influence performance on the DOT. First, were children who more readily and flexibly engaged with toys more or less likely to disengage and shift their gaze when DOT stimulus items were presented to them? Were these tendencies different for social versus nonsocial stimuli? Second, it may be that the different number of toys a child engaged with was important. Shifting attention between different toys, rather than focusing on one toy for a fifteen minute period may reflect better skills in shifting attention. Future research should also address the roles of disengagement and shifting attention in social and nonsocial orienting to determine whether there are different patterns for the two attention behaviors for the different types of stimuli, and whether one feature of attention
is more important in joint attention and language development. Finally, further
examination of sensory modality will be important to determine whether there are
different patterns of associations with joint attention and language for orienting to stimuli
presented to different sensory systems.
APPENDIX A

Pilot study: Measure development

The goal of this pilot study was to develop a measure of social and nonsocial orienting for use with young children. Pilot testing addressed several important issues such as how the final measure should be administered, which stimulus items should be included, where items should be presented, and how the measure should be scored.

Participants

12 typically developing children participated in pilot testing aimed at developing a measure of social and nonsocial orienting (The Dyadic Orienting Test; DOT). The children were recruited from the Susan Gray School at Vanderbilt University, and were between the ages of 12 and 42 months. Parents of these children were informed of the pilot testing through a handout that was sent home with the children.

Procedures

Each child participated in 2 twenty-minute free play sessions. In these free play sessions, each child played with a variety of age appropriate toys with examiner 1 (E1). During this time, E1 sat at a table or on the floor with the child, and encouraged engagement with a variety of toys. Experimenter 2 (E2) presented stimulus items and scored the child’s responses. See Table 1 for a complete list of pilot stimulus items. These items were presented in random order, alternating between social and nonsocial stimuli. Presentations were in different locations (e.g., to the front, left, and right of the child’s face), and these locations were recorded to determine whether children responded differently to items presented in different locations. Because research with both infants
and adults has demonstrated left-hemisphere biases for location (Posner et al. 1998), the location of item presentation was recorded. Response rates for items presented in different locations were compared.

Each item was presented for 3 trials, regardless of the child’s responses. E2 waited 15 seconds between each trial. E2 waited approximately 1 minute between presenting new items. Some variation in the timing occurred, as E2 only presented items when the child was actively involved with either a toy or E1. When each item was presented, E2 recorded the child’s response on the score form.

*Stimulus items*

A range of social and nonsocial stimulus items were presented. They represented 14 social, 15 nonsocial, and 6 stimuli that could be considered social and nonsocial. See Table 1 for a list of items in each category. Within all domains, some items were visual, some auditory, and some were both visual and auditory. Within the social domain, some contained verbal information (i.e., name called) while others did not (i.e., clapping hands).

*Scoring*

During pilot testing, all scoring was coded live as sessions were not videotaped. First, the total amount of time of administration was recorded. Response patterns were examined to determine whether there was a point at which children became habituated to stimuli and decreased their response rates. Results determined whether the final measure would be administered during one time block or in separate smaller blocks dispersed throughout an assessment day. Second, E2 recorded the location of each stimulus presentation relative to the direction the child was facing. Third, E2 recorded each
child’s responses in the 15 seconds following each stimulus presentation. Responses were coded on a scoring grid. For each item, E2 recorded the following: whether the child oriented to the stimulus, which behaviors were used to orient, and whether the response was immediate (within 2 seconds) or delayed. Finally, any problems noted with specific items were noted on score forms.

**Criteria for inclusion in final measure**

Items were judged in several areas. First, items that elicited orienting responses from a majority of children were kept. Specifically, only those items which elicited responses from at least 60% of children were considered for inclusion. Second, items were chosen to represent each category listed in Table 1. Finally, only items that were practical to administer were retained for use in the final measure.

**Results**

The list of 35 items was narrowed to 14 items after the completion of pilot data collection. Five items were cut for response rates under 60% (green lamp, rope light, entering the room, exiting the room, and sitting next to the child). Five items were cut because of difficulties with administration (hand over hand, touch child’s shoulder, fan, car drives, and TV static). From the remaining items, 14 were chosen. The seven social items included: wave hand, call name, say Wow!, say Oh No!, clap hands, stomp feet, and cough. The cough item was not included in pilot testing, but was recommended by a dissertation committee member and added to the DOT. The seven nonsocial items included: bouncy ball, star light, car ignition, radio static, phone ring, jack-in-the-box, and shaking rattle. The percentages of children in the pilot study who oriented to these social and nonsocial items were 85% and 89%, respectively.
**Appendix A:** Table 1. Stimulus item descriptions for pilot testing DOT.

<table>
<thead>
<tr>
<th>Social</th>
<th>Visual</th>
<th>Auditory</th>
<th>Visual and auditory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wave hand</td>
<td>Verbal:</td>
<td>Enter room</td>
<td></td>
</tr>
<tr>
<td>Sit by child</td>
<td>Name call</td>
<td>Exit room</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wow!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oh no!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Look at me!</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other name</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonverbal:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clap hands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Click tongue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snap fingers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“beep beep”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stomp feet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonsocial</td>
<td>Rope light display</td>
<td>Phone ring 1</td>
<td>Remote control car</td>
</tr>
<tr>
<td></td>
<td>Star light</td>
<td>Phone ring 2</td>
<td>drives</td>
</tr>
<tr>
<td></td>
<td>Green lamp</td>
<td>Car horn</td>
<td>TV with sound</td>
</tr>
<tr>
<td></td>
<td>Silent TV static</td>
<td>Car ignition sound</td>
<td>Bouncy balls fall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Noisemaker</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radio static</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Music</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fan</td>
<td></td>
</tr>
<tr>
<td>Social and</td>
<td>Wear puppet on hand</td>
<td>Blow bazooka</td>
<td>Jack-in-the box</td>
</tr>
<tr>
<td>Nonsocial*</td>
<td>Put funny hat on head</td>
<td>Party blower</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rattle</td>
<td></td>
</tr>
</tbody>
</table>

*Scored using nonsocial scoring grid.
APPENDIX B

Dyadic Orienting Test

Materials and Administration instructions

This scale measures children’s responses to a variety of social and nonsocial stimuli. It is to be administered during a free play context by 2 experimenters. Below is a description of the responsibilities of each experimenter, scoring instructions, and stimulus items.

MATERIALS/STIMULUS ITEMS

Free play toys: Stacking blocks

Two small books
Pop-up toy
Letter blocks
Mr. Potato Head

Other preferred toys can be used or substituted

Stimulus items*: NONSOCIAL

Lamp in the shape of a star
Bouncy balls
Remote control radio
Remote control car
Jack-in-the-box
Rattle
Noisemaker (makes phone ring sound)
SOCIAL

Wave hand toward child
Call child’s name
Clap hands
Stomp feet
Cough
“Wow!”
“Oh no!”

*Stimulus items will not be in the child’s reach.

ADMINISTRATION INSTRUCTIONS

General instructions:

Two examiners are needed for administration of the DOT. Examiner 1 sits with the child and presents a variety of toys to encourage engagement in a free play setting. Examiner 2 will present the stimulus items, and record responses.

Examiner 1 instructions:

Sit at the table or on the floor with child, preferably behind the child. Present toys to the child to encourage engagement with materials. Keep verbal demands to a minimum, and do not use the child’s name. It is okay to label and talk about the toys, but do not comment on any social or nonsocial item. When these items are presented, maintain a straight face, and do not respond unless the child directs your attention to the stimulus. Continue efforts to engage the child with toys throughout the administration of the stimulus items making efforts not to draw attention away from the stimulus items.

Examiner 2 instructions:
1) Set up

- Per randomization results, items will begin either on right or left side of child. R or L is from the child’s perspective.

- Before administration, set items at the appropriate side of the room, ensuring to set remote controls at opposite sides as necessary.

- The star and radio both use the remote control plug-in device. Whichever is administered first should be set up first. Never plug either directly into wall.

- Try to keep items out of view of child (jack-in-box, balls, rattle). The star and radio are okay to be in view.

2) Administration

- Remain as uninvolved as possible

- Between trials and items, look at your papers or away from the action at the table as much as possible

- Items can be administered up to three times
  - Wait 10-15 seconds between trials for each item
  - Wait 1 minute between the last trial of one item and the 1st trial of the next item

- When alternating sides of the room be as quiet as possible

- Try to prevent lots of people coming in and out of the room during the DOT. As this is somewhat inevitable, adjust time accordingly if the child becomes distracted by a person coming into the room.

- For person with child, encourage them NOT to use child’s name
• Also encourage person with child to keep direction of focus toward middle of table

• For all items, wait until the child is actively engaged with a toy and looking toward the center. Do not look directly at the child’s eyes. If the child looks toward you before you present an item, wait an additional 15 seconds before administering the item.

**Social items**

Name  Call child’s name one time.

Wow  Say “Wow!” in an excited tone one time.

Oh No  Say “Oh no!” in a negative tone one time.

Clap  Clap hands five times.

Wave  Wave hand left to right approximately five feet from the child. Ensure that your wave is within the line of vision of the child, but remains to the left or right side.

Stomp  Stomp feet five times in place as if stomping into a room.

Cough  Cough for a few seconds.

**Nonsocial items**

Ignition  Car ignition sound- Use remote control from across the room to start ignition (top right button). Sound will stay on approximately five seconds and stop automatically. Check car before beginning to see if it is turned on. Once on, be careful with remote control to not hit other button at incorrect time.
Jack  Jack-in-the-box. Once the child has oriented, you can stop. You may want to reset it so that you can do 3-5 second intervals for each trial.

Star  Plug star light into adaptor and into wall (try to set up ahead of time). Set star on chair so that light will be around eye level for the child. Use remote control from across room to turn light on for 3 to 5 seconds.

Static  Plug radio into adaptor and into wall. Use remote control from across room to turn static on for 3 to 5 seconds.

Rattle  Shake rattle about 3 to five feet from child, at eye level.

Phone  Press top right button on remote control for 3 to 5 seconds.

Balls  Place balls either on shelf or away from view. Bounce them in the direction of child. You cannot control where they go, but try to direct them to hit the table near where the child is playing. Try to make your involvement (from the child’s perspective) as minimal as possible.

3) Videotaping instructions:

- Have camera close to face to be able to see response

- Zoom out for 7 items so that start time is viewable:
  - Wave
  - Star
  - Rattle
  - Jack-in-the-box
  - Stomp
  - Clap
- It is fine not to have videotape, as you will have time between trials to check camera

4) Scoring:

- For each trial, the stimulus will be presented up to 3 times to elicit an orienting response. Once the child has oriented using one of the behaviors listed in the table, complete the response form.
  - Circle Yes or No to indicate whether the child oriented
  - Check all behaviors used to orient
  - If behavior is not listed, check other and make a note of behavior (ex., imitated sound, gestured)
  - Circle whether the response was immediate (within 2 seconds) or delayed (2+ seconds) from time of stimulus presentation.

- The target response is a head turn in the direction of the stimulus. If the child responds with anything other than this behavior, repeat item until child displays the target response or until 3 trials have been presented.

- If the child looks at a person in response to a nonsocial item, it is only a target response if that person is near the nonsocial stimulus (on the same side of the room).

- If there are any questions, make a note on your protocol.

- If mistakes are made, and items are presented out of order, make note on protocol to indicate these problems.

5) Problems

- Tired/fussy child
- If you can only do a few items, do the following (listed in order of priority):
  - Name
  - Jack-in-box
  - Clap
  - Rattle
  - Star
  - Static

- Make sure to alternate left and right

- Nonsocial items don’t work
  - If remote controls aren’t working for plug-in item, you can plug directly into the wall yourself when it is time to administer that item
  - If phone sound doesn’t work, use the car horn sound on the remote control car (you can tell which button this is by picture on remote)
  - If car remote isn’t working, try moving closer to car. If it still isn’t working, use alternative sound from phone remote (they are listed- don’t use music)
REFERENCES


