SOCIAL ORIENTING AS A CONSTRUCT UNDERLYING JOINT ATTENTION AND IMITATION SKILLS DEFICITS IN PRESCHOOL CHILDREN WITH AUTISM

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ABSTRACT

SHAYE BENTON REAVIS: Social Orienting as a Construct Underlying Joint Attention and Imitation Skills Deficits in Preschool Children with Autism
(Under the direction of Gary B. Mesibov, Ph.D.)

This study examines the relationship between joint attention and imitation skills in preschoolers with autism by looking at a component skill within imitative behaviors: imitation of body movements, and its correlation with joint attention abilities. Based on a proposed model of social orienting, this study hypothesizes that imitation of body movements will be related to joint attention because both skill deficits require a child to focus attention towards another person. The deficit skill of children with autism to attend to another person is hypothesized to be at the core of social difficulties seen in these children, and therefore to account for deficits in both joint attention and imitation of body movements. If a relationship between joint attention and imitation of body movements is found, it will contribute to our understanding of social orienting as a construct underlying developmental processes in autism.

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INTRODUCTION

A pervasive and profound social impairment characterizes Autism Spectrum Disorder (ASD). Researchers interested in the social question in autism often study specific autism deficits that are suspected to be driven by social skills. One such skill is joint attention. An accumulation of research supports social cognitive processes underlying joint attention. Research is not conclusive, however, regarding concurrent and predictive links between joint attention and other autism deficits. An understanding of such interrelationships would inform our understanding not only of joint attention, but also of the central social impairment in autism.

One problem in the autism research literature is a lack of agreement on which deficits are rooted in social dysfunction. One line of research suggests that a subtype of imitation ability that involves imitation of a person also requires social cognitive understanding. Language is another skill believed to require social intellect. In addition, child characteristics such as severity of autism and age provide clues about the nature of the social impairment. For instance, children whose autism is more severe have poorer social skills. Social development in autism seems to improve over time, but gains are often not seen until later childhood or adolescence.

If social cognitive abilities underlie joint attention, associations should be found between joint attention, other deficit areas that require social understanding, and child characteristics linked to social processes. This project explores some of these interrelationships among joint attention, skill areas, and child characteristics that research identifies as being related to social development.

Social Impairment in Children with Autism

The earliest official documentation of social deficits in autism is found in Leo Kanner's 1943 landmark case studies of 11 autistic children, whom he noted had an "inability to relate…in the ordinary way, to people and situations from the beginning of life," and "extreme autistic aloneness" (1943, p. 242). One year later, Hans Asperger (1944) described another sample of children who were less severely affected overall, but presented with similar social disabilities, including problems with social interaction, eye contact, affective expression, and conversational skill. He characterized these children with a disturbance in the ability to form "a lively relationship with the whole environment" (1944; reprint 1991, p. 38).

Since then, clinical descriptions have pointed to social deviance as early as infancy, when infants fail to develop reciprocal eye contact or smiling with others (Volkmar & Klin, 1994). Infants with autism can seem equally comfortable with strangers as with parents, and compared to typical children, may demonstrate less affection towards other people (Volkmar & Klin, 1994). Retrospective parent reports indicate that children with autism can be hard to reach, tend to ignore others, and avoid eye contact (Ornitz, Guthrie, & Farley, 1978). Volkmar describes deviant social developmental processes in autistic children above and beyond developmental delay and low IQ (Volkmar & Klin, 1994). Wing and Gould have summarized these unusual social behaviors as "passive or odd" (1979). Social deficits are so central, in fact, that assessment instruments typically emphasize social factors (Parks, 1983; Schopler, Reichler, & Renner, 1988). Furthermore, the DSM-IV (1994, American Psychiatric Association, p. 74) specifies diagnostic criteria for autism that target social deficits. These criteria include:

> 1. Marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction.
>
> 2. Failure to develop peer relationships appropriate to developmental level.
>
> 3. A lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest).
>
> 4. Lack of social or emotional reciprocity.

Research supports clinical descriptions of social dysfunction in autism, although findings point to syndrome-specific patterns of strengths and weaknesses in social skills as opposed to a broad deficit in all types of social skill development (Mundy & Crowson, 1997). Specifically, children with autism have the most difficulty with nonverbal joint attention skills, while being more proficient in social turn-taking and nonverbal requesting skills (Adamson & MacAruthur, 1995; Baron-Cohen, 1989; Curcio, 1978; Loveland & Landry, 1986; Mundy, Sigman, & Kasari, 1994). This pattern of strengths and weaknesses makes it difficult to understand the nature of the underlying social difficulty. However, research points to specific social weaknesses for children with autism.

First, Hermelin & O'Connor reported that children with autism have abnormal responses to social stimuli. Autistic children fixate on social stimuli (e.g., faces) for shorter time intervals than children with mental retardation or typically developing children (Hermelin & O'Connor, 1970). Compared to controls, twelve month olds with autism orient to social stimuli less frequently than nonsocial stimuli. Specifically, they have less eye contact, briefer looks at others' faces, and nonresponsiveness to voice (Baranek, 1999; Dawson, Meltzoff, & Osterling, 1995; Osterling & Dawson, 1994, 1999; Osterling, Dawson, & Munson, 2002). Based on parent report, 12 month olds with autism have been distinguished from typically developing and mentally retarded control children on a quality of "autistic aloneness" (Dahlgren & Gillberg, 1989; Gillberg, Ehlers, Schaumann, Jakobsson, Dahlgren, Lindblom, et. al., 1990).

Children with autism also have problems orienting and working with tasks that involve social stimuli (Cucio, 1978; Dawson, et. al., 1995; DeMyer, Alpern, Barton, DeMyer, Churchill, Hingten, et. al., 1972). It was harder for children with autism than controls to distinguish adults from children and males from females based on faces and bodily features (Hobson, 1982). Older children and adolescents demonstrated poorer performance than controls at recognizing age-related features of people and animals in a card sorting task, even though they understood card sorting tasks in general and were good at sorting geometrical figures based on perceptual features (Hobson, 1983). Langdell compared groups of autistic, typical, and retarded children on their ability to recognize familiar faces from isolated features and inverted photographs. He found significant differences between the autistic and the other two groups in their ability to recognize peers and family members based on these facial features (1978). Taken together, these findings indicate that children with autism have more difficulty than control children with "person-oriented" aspects of tasks.

Finally, social impairments appear in many different areas of functioning for children with autism. These children are more likely to play by themselves in parallel and functional, as opposed to imaginative play and play with other children (Ungerer, 1989). Studies point to difficulty with the social use of language (Tager-Flusberg, 1981; 1989). For autistic children who develop language, social or pragmatic use is often deviant throughout life, and has been characterized as replete with irrelevant details, perseveration on a particular topic or conversation, inappropriate shifts to new topics, and ignoring conversation initiations of others (Eales, 1993; Tager-Flusberg, 1981; 1989). In general, autistic children have difficulty learning the "speaker-listener" social rules of conversation (Tager-Flusberg, 1981; 1989).

In summary, social informational processing input, learning, and application is difficult for children with autism. In order to study the nature of this social dysfunction, researchers can turn to specific deficits suspected to be driven by social impairment. Research supports the idea that joint attention may stem from underlying social abilities, thus being one of these crucial deficits.

Joint Attention and Social Dysfunction

Joint attention in typical development. Joint attention involves the ability to coordinate attention with another person through the use of eye contact and gestures, in order to share the affective or social experience of an object or event (Seibert, Hogan, & Mundy, 1982). Behaviors early in development that reflect this ability to coordinate attention include *referential looking*, in which a child looks back and forth between his caregiver and objects to share enjoyment of that object; *protodeclarative pointing*, in which a child points to show his caregiver an object, person, or event; and *showing*, in which a child hands an object to his caregiver to draw her attention to that object (Bakeman & Adamson, 1984; Butterworth, 1991; Corkum & Moore, 1995; Osterling, et. al., 2002; Scaife & Bruner, 1975). These early joint attention behaviors typically emerge from 9 to 18 months of age, as infants gradually learn to coordinate their attention and actions on objects with the attention and actions of other persons (Bakeman & Adamson, 1984; Scaife & Bruner, 1975).

Joint attention is distinguished from other infant looking-behaviors by several key aspects. First, joint attention is deliberate and communicative unlike coincidental eye contact that occurs between mother and infant from birth (Tomasello, 1995). Joint attention occurs when a child seeks out his mother's attention through visual and nonverbal gestures, in order to direct her attention to a third object or event. Hence, the infant learns how to actively influence another person's attentional focus. Second, joint attention involves the expression of affect, most commonly surprise, pleasure, or fear. This affect must be 'joint', or shared, such that infant and caregiver realize that the other is experiencing the same emotion.

Third, a child learns how to include a third party in the communicative exchange. As joint attention ability emerges, early dyadic attention-sharing, which involved mother and infant only, becomes a triadic attention-system, which involves mother, infant, and the object or event upon which they attend (Dunham & Moore, 1995). These three aspects of joint attention (intentionality, affective exchange, and shared awareness for a third party) make joint attention a foundational skill by which the infant develops social and affective intelligence. With the development of joint attention, the infant opens a major channel by which he will learn about his world, learn how others connect affect with experience, and develop an increasingly complex understanding of social, affective, and informational exchange. This foundational skill then becomes increasingly complex as the child grows older. Children learn to share attention with others not only for objects, but also for situations, abstract ideas, complex emotions, and subtleties of communicative exchange and symbolic meaning.

Several aspects of joint attention point to its social nature (Mundy, 1995; Mundy & Crowson, 1997; Tomasello, 1995). First, to engage in joint attention, a child must understand that the mother is both an active and intentional participant in this shared affective experience (Hobson, 1989; Tomasello, 1995). The child's realization of the mother's participation and intentionality confers to her the status of personhood. Likewise, the ability to share affect with another person makes joint attention a social ability. This social foundation of joint attention may explain why it is so difficult for children with autism to learn.

Joint attention in autism. Extensive research documents that children with autism are quite delayed in the development of joint attention above and beyond developmental level (Landry & Loveland, 1988; Loveland & Landry, 1986; Mundy, et. al., 1994; Mundy, Sigman, Ungerer, and Sherman, 1986; Sigman, Mundy, Sherman, & Ungerer, 1986; Wetherby, 1986). Results from various studies have found that measures of joint attention alone can identify 73-94% of autistic children from mentally retarded children matched on mental age or from children with other developmental disabilities (Lewy & Dawson, 1992; Mundy, et. al., 1986; 1994; Mundy, Sigman, & Kasari, 1990). A large body of research shows that children with autism are impaired in many aspects of joint attention, including lower levels of initiating and responding to referential looking, protodeclarative pointing, and showing (Mundy, et. al., 1986; 1994; Mundy, 1995).

Several studies have documented joint attention deficits in very young autistic children. Studies using retrospective videotaped analyses of infants later diagnosed with autism have shown deficits in protodeclarative pointing and showing for infants as young as 12 months old (Osterling & Dawson, 1994; Osterling, et. al., 2002). Two studies by Mundy et. al. (1994) found that 22 month-old children had deficits in joint attention, including fewer looks at the experimenter, fewer alternate gazes, and less pointing during interactive play with an experimenter, than typically developing or mentally retarded age-matched controls. Sigman & Kasari found that children whose mental ages ranged 18-24 months showed significantly fewer joint attention behaviors across three different contexts, including free-play with an adult, encountering an ambiguous situation, and being close to an adult experiencing distress, than in mentally aged-matched typically developing infants (1995).

A study by Stahl and Pry (2002) demonstrates joint attention deficits above and beyond cognitive abilities in 24 month olds. Here, the authors study joint attention along with a cognitive skill of set-shifting (shifting one's attention from one target to another), saying that in normal development, these two skills generally develop simultaneously since both utilize frontal lobe function. The authors show that in a sample of 15 autistic children with a mean mental age of 24 months, joint attention skills are delayed while set-shifting skills remain intact. This finding was in contrast to their control sample of typically-developing children, who showed strong correlations between the two skills. Finally, Adamson and Bakeman (1985) confirmed that 3 to 5 year old children with autism were less likely to engage in joint attention behaviors with an adult during object-focused play when the adult attempted to elicit interest from the children, as compared to control children with severe delays in expressive language.

Research shows that many higher-functioning autistic children eventually develop some joint attention skills (Dilavore & Lord, 1995; Mundy, et. al., 1994). Higher-functioning 5- and 6-year-old children with autism have been shown to learn to respond to joint attention bids from caregivers, although they often lack initiative to enact these behaviors (Dilavore & Lord, 1995; Mundy et. al., 1994). The majority of individuals with autism continue to show joint attention and social deficits throughout the lifespan, although studies estimate 17-47% of their samples improve on some social skills in adolescence and adulthood. Individuals showing the most improvement were those with higher IQs and academic and intervention opportunities (Gillberg & Steffenburg, 1987; Kobayashi, Murata, & Yoshinaga, 1992).

Communicative actions and gestures similar to those used in joint attention (e.g. eye contact, reaching) are observed in children with autism, although most researchers agree that these behaviors are more often used for instrumental purposes, such as requesting or refusing an object, rather than sharing affect about an object or experience (Baron-Cohen, 1989; Curcio, 1978; Mundy, et. al., 1986; Mundy, Sigman, & Kasari, 1993). Children with autism show these actions that appear the same on a descriptive level. However, autistic children fail to show these behaviors when the function is to share affect about a third party, object, or event. Children with autism do not always demonstrate an understanding that communicative partners have the status of personhood. Instead, they often use visual and gestural communication to treat the communicative partner as an instrumental agent to obtain a goal, rather than a social, interactive partner with whom they can share experiences (Curcio, 1978).

Thus, joint attention deficits are defined for children with autism because they lack the contribution of affect and intersubjectivity, and, by inference, the recognition and enjoyment of interaction with a social partner. Researchers agree that joint attention is social in nature; other prominent deficits are less understood.

Social Dysfunction and Developmental Linkages

Social ability has been noted to be associated with other developmental processes and child characteristics. Deficit areas believed to be influenced by social skills include imitation and language. Other child characteristics, such as the severity of autism symptoms and the child's age, have also been studied in relation to their impact on social competence. Each of these areas is discussed in turn.

Imitation in typical development. Imitation is a neonatal ability that occurs when the infant maps a perceived behavior of others to internal states or sensations (Gopnik & Meltzoff, 1993). Imitation is a fundamental skill that most agree is present for simple games by 9 months of age (Gopnik & Meltzoff, 1993) and for gestures and actions by 15-16 months (Bayley, 1969). Research indicates that the unfolding of imitation follows a steady progression in typical development, with infants imitating actions with greater variety, complexity, and novelty as they grow older (Killen & Uzgiris, 1990).

Some researchers believe that the capacity for overall imitation may be a precursor to social-cognitive understanding (Meltzoff & Gopnik, 1993; Rogers & Pennington, 1991). Traditional views have maintained that imitation reflects early abilities of infants to connect with other people (Hobson & Lee, 1999), which may reflect the infant's sense of intentionality. Infants may infer the intended actions of another and imitate those actions because they assume that the actions were purposeful, therefore stemming from a person (Tomasello, 1995). This hypothesis is supported by studies that have shown 14 month old infants to understand when imitation is being elicited versus when it is not. Infants at this age rarely imitate random acts but are more likely to imitate when an adult intentionally performs an action to be imitated (Meltzoff, 1988). Tomasello theorizes that infants could not discriminate so well if they did not recognize the communicative intent behind the actions (1995). These ideas propose that imitation requires a social component, in the infant's understanding that other people intentionally are communicating and connecting with him (Tomasello, 1995).

Imitation in autism. Research has documented a specific imitation deficit in children with autism by at least 36 months of age, above and beyond developmental delay (Stone, Ousley, & Littleford, 1997), as well as mental retardation and communication disorders (Stone, Lemanek, Fishel, Fernandez, & Altemeier, 1990). Early studies indicated that the imitation deficit was not due to motor impairments or an inability to display action sequences (DeMyer, et. al., 1972; DeMyer, Barton, Alpern, Kimberlin, Allen, Yang, et. al., 1974). In addition, imitation has been shown to be a deficit above and beyond other sensorimotor skills, which seem to be intact (Curcio, 1978; Dawson & Adams, 1984; Sigman & Ungerer, 1984). Imitation skills seem to improve with age for autistic children; however, the developmental progression has not been formally studied (Stone, et. al., 1997). Charman & Baron-Cohen (1994) found no differences in imitative skills between older autistic and mentally retarded children (mean CA = 12 years); however, many concur that imitation deficits remain at least through childhood (Rogers & Pennington, 1991; Smith & Bryson; 1994).

Based on research that indicates imitation may involve social variables, some researchers have proposed that basic imitation impairments in autistic children reflect their failure to connect psychologically with others (Meltzoff & Gopnik, 1993; Rogers & Pennington, 1991). If this were true, research would need to demonstrate that imitation reflects social abilities. Unfortunately, it has been difficult to explore the nature of this imitation deficit for several reasons. First, autistic children typically are not diagnosed until 2-3 years, so it is not known in what ways they differ in imitation development in the earliest years.

Second, imitation is a broad construct encompassing a variety of skills. Importantly, different types of imitation skills have been grouped together in examining predictive relationships with other areas of development, preventing hypotheses about underlying causes and possible categories of imitation subtypes (Roeyers, Van Oost, & Bothuyne, 1998; Stone, et. al., 1997). It is possible that different types of imitation exist depending on the parameters of the action, such that children with autism may be better at some types of imitation than others. These issues have made it difficult to determine the underlying cause of the imitative impairment, to understand subtypes and to theorize about predictive relationships and important developmental linkages that would place imitation's role in the developmental process (Roeyers, et. al., 1998; Stone, et. al., 1997).

Research suggests that imitation may be splintered into social versus nonsocial component skills. DeMyer and colleagues have shown that autistic children performed better imitating tasks of object manipulation than imitating actions (DeMyer, et. al., 1972; DeMyer, et. al., 1974). Here, 3 to 7 year old children with and without autism were compared on imitation of body movements, simple games, and motor-object actions. They showed relatively poorer performance on imitation of body movements than motor-object imitation, though they were impaired on both compared to the control group. Imitation of object manipulation was also noted to be less impaired than body gestures in a more recent study (Heimann, Ullstadius, Dahlgren, & Gillberg, 1992).

Stone, et. al. (1997) looked at the differences between imitation of actions on objects versus imitation of body movements. The authors found that preschoolers with autism were better at the former than the latter. They concluded that imitation of actions on objects was easier for these children because the acts did not require attending to another person. Although the authors also found this split in imitative skills for their typically developing sample, their autism sample showed poorer performance than their developmentally delayed sample, indicating an autism-specific difficulty.

Another study by Roeyers, et. al. (1998) attempted to elicit imitation of gestures and imitation of actions on objects in separate trials. Overall, autistic children failed both gesture and actions on objects trials compared with typically developing and developmentally delayed control children; however, they responded differentially to the two types of imitation relative to the comparison groups. Children with autism failed to imitate actions on objects because they either manipulated the object incorrectly or failed to imitate all of the steps and performed only the end result. In contrast, they often failed to imitate gestures because they did not even attempt the act.

Hobson & Lee (1999) found that adolescents with autism were able to imitate goal-directed actions on objects but failed to imitate when the action involved placing the object in a position relative to one's own body. During the body-oriented trials, adolescents with autism failed even to attempt imitation, as though they did not recognize the goal. Furthermore, even when they imitated the goal-directed actions on objects that were not placed in relation to the body, they were unable to imitate the style of the examiner (e.g., fast versus slow.) The authors concluded that the primary impairment is inability to imitate the *person.* They suggest specific aspects of imitation may promote connectedness and identification with other people, and these aspects preclude successful imitation for autistic individuals.

Taken together, these studies suggest that imitation may not be a unitary construct. Instead, specific variables may influence the successful completion of social versus nonsocial imitation. These studies suggest that children with autism are more successful when they imitate actions on objects. In contrast, they are more delayed on imitation that is person-focused, including imitation of body movements, understanding relationships among various parts of the body, or recognizing social aspects of imitation, such as the “style” of imitation. For the purposes of this study, we will refer to these types of imitation as “object-imitation” and “person-imitation”, respectively.

Given what is known about joint attention and imitation deficits in young children with autism, it seems that both deficits involve social components, making them difficult for autistic children. It is possible that the pattern of social deficits of the autism pathology described earlier underlies both person-imitation and joint attention. Based on research that indicates joint attention and person-imitation are both based in social abilities, these two skills should show a positive association in children with autism. Therefore, the first goal of this study is to determine the correlation of joint attention and person-imitation in a sample of preschool children with autism.

Language. The proper development and use of language requires social cognition. Overall, the use of language involves pragmatic and social abilities to engage and respond to communicative partners. In autism, it is the social aspects of language that are most disrupted (Tager-Flusberg, 1981; 1989). Many theorists, therefore, view language disruption as a reflection of social deficits of some type (Tager-Flusberg, 1981; 1989).

On a deeper level, the use of pragmatic language requires that a child first recognize others as persons with whom he can connect on a given topic. Likewise, the comprehension of language requires that a child realize others are trying to communicate a specific, intentional meaning to him. Tomasello (1995) argues for social aspects of language based on the idea that language use assumes an understanding that the communicative partner is an intentional agent. Thus, he theorizes that joint attention should be associated with language, because both require a recognition of intentionality and personhood for the communicative partner. Interestingly, typical children around the ages of 18 to 24 months begin to use language to direct adults' attention to third-party objects or events, similar to the way they use joint attention gestures at earlier ages (Tomasello, 1995). Tomasello believes that children with autism who are impaired in joint attention will be similarly impaired in language skills (Tomasello, 1995).

Research, in fact, supports the idea that language may be linked to joint attention by common social roots with findings that joint attention predicts later language use. Mundy, et. al., (1990) found predictive relationships between gestural joint attention and language level during 13 months in a sample of children with autism (mean CA=45 months) compared to a sample of children with mental retardation matched on MA and a sample with mental retardation matched on language level. Specifically, the authors found that nonverbal gestural communication was a significant predictor of language development in the autistic sample (Mundy, et. al., 1990). These findings that individual differences in joint attention predict language differences could be explained on the basis that joint attention skills reflect the emergence of social-cognitive processes that provide a foundation for the development of language (Mundy, et. al., 1990). This study will examine the association between language and joint attention ability, hypothesizing that joint attention can be modeled using language.

Autism Severity. As stated earlier in the introduction, a diagnosis of autism includes criteria for social impairment. Therefore, social impairment should be associated with severity of autism, such that greater severity should be related to greater social impairment. Therefore, autism severity scores should also predict joint attention.

Gender. Autism appears in boys more frequently than girls, with a ratio of 3-4 males per 1 female (Steffenburg & Gillberg, 1986; Volkmar, Szatmari, & Sparrow, 1993). A comparison of mean scores on autism severity indicates that as a group, females show more severe symptomatology, including more impaired social relationships, increased inappropriate body use, greater auditory sensitivity, and lower scores on nonverbal communication (Konstantareas, Homatidis, & Busch, 1989; Steffenburg & Gillberg, 1986; Volkmar, et. al., 1993). Interestingly, when intellectual differences are controlled and a comparison of symptoms is made between males and females matched on IQ, males show more severe symptoms (Konstantareas, Homatidis, & Busch, 1989).

This evidence indicates that although females are less frequently affected by autism, when they are they tend to be more often retarded, and hence, as a group show more severe symptomatology. However, a comparison of gender controlling for IQ indicates that for males, autism severity increases compared to females for equivalent IQ levels. Unfortunately, the small sample size of this study prevents an analysis of gender comparison controlled for IQ because there are not enough children to form similar groups on IQ. As a whole, then, females in this study should have more severe autistic symptomatology. Thus, gender should predict joint attention, such that females will show stronger prediction than males.

Chronological Age. Although some children seem to make joint attention gains in adolescence and adulthood (Gillberg & Steffenburg, 1987; Kobayashi, et. al., 1992), age does not seem to be a predictor of autism severity in early childhood (Loveland & Landry, 1986). Although it is possible that incremental gains are made in joint attention in preschool, research has not shown large changes between ages 3 to 3 ½, or 3 ½ to 4. Therefore, it is predicted that age should not predict joint attention in this sample.

Social Processes from a Developmental Perspective

This study purposes that joint attention along with several other cardinal deficits and child characteristics are related because of their identification in some way with underlying social processes. Mundy and Neal (2000) propose a model for understanding how a disturbance in a construct they call "social orienting" may disrupt joint attention in early development, creating a chain of events that affects other aspects of development. This model may serve as a framework to understand how social deficits contribute to any specific skill that develops from social developmental processes.

Social Orienting. Mundy and Neal define social orienting as the ability to orient visually, auditorily, and attentionally to a social partner (2000). These authors propose that individuals with autism have a central and cardinal deficit in social orienting that contributes to a severe impoverishment of social information processing input during infancy and preschool development (2000). When young children or infants with autism lack social orienting, they fail to receive social information processing input early in life. This lack of social information processing input then negatively feeds back in that there is insufficient input for neurological development that is necessary for further maturity of social cognition and social behavior (2000).

Mundy and Neal hypothesize that joint attention is a manifestation of this underlying social orienting deficit. A disruption in the development of joint attention is, in their opinion, the result of this pathological process of deviant social orienting (2000). At the same time, a lack of joint attention also becomes a critical agent in the developmental processes of autism in that any skills dependent on joint attention will not properly develop. By inference, any process that normally develops from a foundation of social orienting ability would also be disrupted. Given the many social deficits seen in autism, it is interesting to consider the idea that they stem from such a negative feedback developmental process. This model addresses a potential underlying developmental disturbance that might set in motion a chain of disrupted developmental events in the realm of social behavior.

Support for the Model of Social Orienting. The idea that complex social abilities might not develop appropriately without the foundation of earlier, critical social variables is echoed by theorists such as Bakeman and Adamson (1984), who argue for a phase-theory in normal social development. These authors suggest that an early social-development phase involves face-to-face exchanges of affective signals between infant and caregiver. These interactions result in acquired visual reciprocity, which is essential for the second phase, in which the infant shares attention with the caregiver regarding an object that is external to them both. The visual reciprocity and shared attention that develop during these two phases allow the infant to learn about his place within a social-dyadic interaction. These abilities open the door for the development of a third phase, which involves exchanging language with the caregiver about a third, external object. The authors claim that this language exchange cannot occur without the foundation of learned visual reciprocity and realization of third parties. Dunham & Dunham similarly point out that early joint attention behaviors do not in themselves indicate a child's ability to understand others' attentional states, but they do form a context to allow a child to learn about the attentional and intentional states of others (1995).

Research backs up the claim that initial social deficits could have major implications for later learning and receipt of information. In one study, adults' attempts to interact socially with autistic children were unsuccessful, after which the adults resorted to physical attempts to redirect and interact with the children (Adamson & MacArthur, 1995). Here, the children with autism ultimately received fewer opportunities to learn about attentional sharing and social exchange because interactional partners resorted to nonsocial methods of interaction. The authors emphasize that early social influences are bi-directional and deficits in one area can have major impacts on how and if at all, children subsequently receive necessary information for healthy development (Adamson & MacArthur, 1995). Research with other special populations also indicates that a deficit in early joint attention abilities may be detrimental to later social growth. Landry studied free-play between caregivers and high-risk preterm infants between 6 and 24 months; he discovered that infants within this group who showed greater joint attention deficits at baseline were less likely to initiate social interactions or respond to social bids at follow-up three years later (Landry, 1995).

Summary

Mundy and Neal propose that joint attention is a manifestation of a social orienting deficit, in that the ability to focus and attend to a social partner is a requirement for the execution of joint attention behaviors. Another documented area of difficulty is imitation for a person; person-imitation might also be a manifestation of this proposed, underlying social orienting deficit. If there is a true differentiation between person-imitation and object-imitation, such that the former is rooted in social processes, this might be reflected in an association with joint attention. Because research has not verified the distinction between person-imitation and object- imitation, this study will first explore the simple linear relationship between joint attention and person-imitation.

Secondly, a regression model will be developed to examine the variance accounted for in joint attention by variables believed to be linked to social processes. Person imitation will be used as a predictor variable in a regression analysis with joint attention as the outcome. Another skill area is language, which has been shown to require social understanding in order to be used effectively. Language should also predict variance in joint attention when included in a regression model. Child variables of severity of autism and gender have been shown to be related to the child's level of social ability; therefore, they should also predict variance in joint attention. Child age, however, should not predict variance in joint attention since it has been shown not to be associated with social development during the preschool time frame observed in this study.

<u>Hypotheses</u>

1. Children with autism will show performance discrepancies between the two types of nonverbal communication assessed by the Early Social Communication Scales (ESCS). Children will show significantly better performance on Behavior Requesting (BR), or nonsocial communication, than Joint Attention (JA), or social, communication abilities.
2. Children with autism will show performance discrepancies between the two types of imitation ability assessed by the Motor Imitation Scale (MIS). Children will show significantly better performance on Imitation of Actions on Objects ("object imitation") than Imitation of Body Movements ("person imitation").
3. Joint attention and Imitation of Body Movements ("person imitation") will be associated, such that Joint Attention will show a positive relationship with Imitation of Body Movements.
4. Child characteristics believed to require social orienting will predict variance in Joint Attention and can be modeled to better understand Joint Attention. Specifically, these

skills include Imitation of Body Movements, Total Language Ability, CARS score (autism severity), and Gender. Child Age, which is not believed to be associated with Joint Attention abilities during the preschool years, will not improve the fit when added into the overall model. In addition, skills not hypothesized to be based in social orienting, Imitation of Actions on Objects, will not improve model fit.

5. Gender will predict variance in Joint Attention such that girls, who will show lower overall functioning, will show stronger prediction for JA than boys.

CHAPTER 2

METHOD

Design

This study has been designed using a passive observational approach in its examination of interrelationships between joint attention and imitation constructs, and joint attention and multiple child characteristics. These relationships were examined at two time points. The purpose of examining these relationships is to draw inferences about common processes in variables that are found to be associated.

Participants

Eighteen preschool children diagnosed with autism participated in this investigation. The children attended one of 4 preschools in North Carolina: Baileywick Elementary, Raleigh, NC; UNC Chapel Hill TEACCH Preschool, Chapel Hill, NC; Huntingtowne Farms Elementary, Charlotte, NC; and UNC Ashville TEACCH Preschool, Ashville, NC. These preschools were selected because they were either direct extensions of TEACCH (Chapel Hill and Ashville) or the teachers had been trained through TEACCH (Baileywick and Huntingtowne Farms), and had previously indicated a willingness to be contacted for research recruitment. For the public schools (Baileywick and Huntingtowne Farms), proposals to collect data were submitted to Wake and Mecklenburg County School Districts, respectively, and approved prior to contact with teachers. Proposals were not required for the TEACCH preschools, given that they fell under the umbrella of the UNC system.

Inclusion and Exclusion Criteria. Children were included in this study if they attended one of the four autism preschools selected according to teacher consent. Children had to have a DSM-IV diagnosis of autism as reported by parent and teacher. Both males and females were included. All developmental levels were included. Children were excluded from this study if they would not be turning three or would be turning six during the course of the testing. Only one child was excluded based on age criteria.

Subject Demographic Characteristics. The mean age of children at the study's outset was 50 months, with subjects ranging in age from 32 to 62 months and a standard deviation of 10 months. Eleven Boys comprised 61% of the sample; seven girls, 39%. This gender distribution approximates the overall population of children with autism, as boys are reported to comprise 75% of the autism population. The ethnic distribution of this sample of children was as follows: African American=16.7%; Asian=11.1%; Caucasian=66.7%; Latino=5.6%. These percentages are roughly equivalent to the ethnic distribution of the population at large. Children's range of autism severity as measured by the CARS was 21.5 to 45, with a mean of 32 (mild-moderate autism), and a standard deviation of 6.9. Thirty-three percent of the sample had CARS scores in the non-autistic range; 33.3% in the mild-moderate autistic range; and 33.3% in the severely autistic range. Boys and girls in this sample did not differ significantly in their mean or median CARS scores, although the median CARS scores for females was somewhat higher than that for boys (boys' median=31; girls' median=35), indicating greater severity of autism symptoms for the girls. The CARS distribution for girls was also slightly larger than for boys (boys' range=24-41; girls=21-45).

Attrition. 4 children were lost at Time 2, bringing the Time 2 total to 14. One child was unable to participate at Time 2 due to lack of cooperation. Testing was attempted but discontinued due to intense tantrumming, and no data was able to be coded from his interaction. Of the other 3, one child from the Ashville TEACCH center was sick both times the examiner visited at Time 2. One child no longer attended the TEACCH Preschool in Chapel Hill due to lack of transportation. One child at Baileywick Elementary in Raleigh had been institutionalized and no longer attended the preschool. His family was lost to follow-up.

<u>Measures</u>

Motor Imitation Scale (MIS). (Stone, Ousley, and Littleford, 1997). The MIS assesses a child's imitation of both the manipulation of objects and of body movements. It consists of 16 items in which the examiner enacts either an object manipulation or body movement and then gives the child a chance to imitate the action. Three trials per item are allowed and scoring is based on a 3-point scale: 2 points for a passing response, point for an emerging, or partial response, and 0 points for a failure. The child's total score is calculated using the child's best score for each item; total scores range from 0 to 32. Delayed responses are not coded. Psychometric properties include demonstrated internal consistency for the total MIS score (alpha coefficient = .87); good internal consistency for each category of body imitation (alpha = .88) and object imitation (alpha = .76); and good test-retest reliability (alpha = .80) (Stone et. al., 1997).

The Early Social Communication Scales (ESCS). (Seibert, Hogan, & Mundy, 1982). The ESCS is a procedure that elicits nonverbal communication skills classified into one of three categories: joint attention behaviors, requesting behaviors, and social interactive behaviors, and rated according to frequency of occurrence. This measure is typically used with children whose mental ages range from 12 to 72 months. In this 15 minute procedure, the experimenter and child sit at a small table on which lie several toys, placed in view but out of reach of the child. The experimenter looks and points to wall posters, makes simple requests of the child with the toys, and presents the child with simple turn-taking games. The session is videotaped, after which the child's nonverbal behaviors are coded. The ESCS has been shown to have good internal consistency, test-retest reliability, and construct validity (Seibert, Hogan, & Mundy, 1982).

Preschool Language Scale – 3 (PLS-3). (Zimmerman, Steiner, & Pond, 1992). The Preschool Language Scale – 3 is a language test tapping a broad array of language skills, used with children ranging in age from birth to 7 years. The PLS-3 is composed of two subscales, Auditory Comprehension and Expressive Communication, which enable one to evaluate components of both receptive and expressive language, as well as an overall measure of language development. Constructs tapped by the PLS-3 include precursors to language development and aspects of communicative competence, including attention, vocal development, and social communication. The PLS-3 has been shown to have good internal consistency, test-retest reliability, concurrent, construct, and content validity (Zimmerman et. al., 1992).

Childhood Autism Rating Scale (CARS). (Schopler, Reichler & Renner, 1988). The CARS is a rating scale that is used to assess the severity of autistic symptomatology. The CARS contains 15 subscales that have items relevant to behavior seen in autism, including a child's ability to relate to others, communication, sensory functioning, emotional reactions, and resistance to change. Each scale is rated from 1 (typical for age) to 4 (highly abnormal for age, typical for severe autism.) These scores combine to form a composite score that ranges from 15 to 60. Scores of 30 or greater are considered indicative of autism: 30-37 = mild-moderate autistic symptomatology, 38-60 = severe autistic symptomatology. The CARS is not a diagnostic measure because severity of autistic symptoms does not necessarily correlate with diagnostic status. DSM-IV criteria specifies that children meet a number of criteria to receive an autism diagnosis. However, these symptoms may range from mild to severe in intensity. The CARS is a measure of the intensity of autistic symptoms; therefore, a child can receive a high CARS score based on severity of a few autistic symptoms and still not meet diagnostic criteria for autism; likewise, a child can receive a low CARS score based on low intensity of several symptoms, and yet meet DSM-IV criteria for autism. The CARS has been shown to have both high reliability and validity (Schopler et. al., 1988).

<u>Procedure</u>

Recruitment. Children for this study were recruited if they were enrolled in one of four preschools that agreed to participate following IRB approval of the project. Introductory letters, information about the study, and consent forms were sent home by the teachers to the parents. The parents then returned the consent forms to the teachers, who passed them on to the principal investigator. Parents were instructed to call the principal investigator or faculty advisor should they have any questions. No phone calls were received. Twenty packets were sent home; 19 were returned, and 18 out of those were accepted into the study. One child was not included because he was almost 6 years old and considered too old for this study.

Data Collection. Data collection for this study was originally conducted as part of a larger data collection project. Therefore, two data time points had already been collected, in January-February of 2001, and April-May of 2001, when this study's hypotheses were formalized. This study did not make hypotheses about longitudinal changes; nevertheless, the second data collection was retained for data analyses to serve as an additional observation of the same children[1].

Prior to each administration, the experimenter contacted the preschool to arrange the date of testing. The examiner visited classrooms and spent 1 to 1 ½ hours with each child, depending on the child's developmental level and tolerance for one-on-one work with an adult. During this time, the ESCS, MIS, and PLS-3 were administered. Tests were given in the order that worked best for the child. The PI worked with each child for as long as the child would sit still without showing signs of fatigue. Most sessions, therefore, were divided between two days, except for very low-functioning children who reached a ceiling on all measures within a short period of time. Frequent breaks (walk down the hall, bathroom) were provided. Some children left the table during testing or had trouble sitting still. These children were redirected back to the play interaction and encouraged to continue. The PI videotaped all sessions for later scoring by trained coders.

Scores on the Childhood Autism Rating Scale (CARS) were gathered from the TEACCH center for children who had been evaluated at TEACCH. Children who had not been evaluated at TEACCH or who did not receive CARS scores at TEACCH were scored based on behavioral observations during testing and observational coding of videotapes after testing by the Principal Investigator.

Videotaping was conducted using a camera that required Hi-8 tapes; therefore, all tapes were copied into VHS format using equipment at Frank Porter Graham Child Development Center for coding.

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[1] Throughout this paper, Time 2 data is treated as a second, additional observation of this sample. However, see p. 45-46 for comments on using additional time points in future research, to address hypotheses about development of these deficit areas over time.

Training of Coders. Two undergraduate students were recruited to code the ESCS, and one undergraduate student was recruited to code the MIS. Two of the students received course credit for their assistance and the other one served as a volunteer. All coders were blind to the study's hypotheses for the duration of the project.

The two ESCS coders attended training sessions led by Mary Crowson, Ph.D., a postdoctoral fellow who had received her graduate training under the direction of Peter Mundy, Ph.D., the author of the ESCS. The PI met with Dr. Crowson and the two undergraduate coders for 1 ½ hours weekly for 4 weeks to learn the ESCS scoring system. Training tapes included the standard training tapes developed by Peter Mundy, Ph.D., and a practice tape that was recorded using the child of a graduate student. Following this initial training, the PI alone led weekly meetings with the undergraduate coders to establish inter-rater reliability on the study tapes. First, each member coded two of the study tapes independently. The group then met to achieve consensus on coding discrepancies and to discuss and resolve difficult coding issues. For a minimal number of problematic rating discrepancies, the PI consulted Peter Mundy for his expertise on coding the ESCS with autism populations. These portions of the tapes were then re-watched by the coders with the final coding decisions and rationale in mind. At this point, it was felt that the coders had enough knowledge to code on their own.

Sessions were assigned randomly to coders. Six sessions, or 20%, were randomly selected to serve as reliability tapes. These tapes were coded by the undergraduates and the PI. Intraclass correlation coefficients of absolute agreement (CI=95%) were estimated based on a two-way mixed model (1 random factor=observations; 1 fixed factor=raters). ICCs for total and composite scores were calculated. ICCs ranged from .63 to .99, indicating overall excellent agreement among raters. The score with ICC=.63 was a rating for high level joint attention behaviors, which were so rare in this sample that they were only observed a handful of times. This code was not used in subsequent analyses. When combined with low level joint attention for an overall joint attention composite, ICC improved to .99; therefore, only composite scores were used in analyses. ICC estimates and confidence intervals for total and composite scores are presented in Table 1.

The PI then trained a third undergraduate to code MIS sessions. After training, the undergraduate coder and the PI coded 6 sessions (20% of total sessions) independently, establishing 88% absolute agreement on each session (The remaining 2 out of 16 items differed by only 1 point).

CHAPTER 3

RESULTS

Exploratory Analyses

Boxplots, stemplots and descriptive measures were used to explore the parameters of the variables for this particular sample, and to compare this sample to data reported in the literature. First, stemplots display the general shape of the sample distributions along the first four variables of interest: Joint Attention (JA), Behavior Requesting (BR), Imitation of Body Movements (IBM), and Imitation of Actions on Objects (IAO) (See Figure 1). Joint Attention and Imitation of Body Movements, variables thought to be socially-based, are skewed to the right, with Joint Attention much more pronounced. An outlier appears for Joint Attention only, both at Time 1 and Time 2, identified as Cases 11 and 10, respectively. In contrast, Behavior Requesting and Imitation of Actions on Objects, variables believed not to require strong social skills, are more normally distributed at both time points with the exception of Imitation of Actions on Objects at Time 2, which shows a left-skew.

Table 2 presents descriptive statistics for Joint Attention and Imitation of Body Movements. Total ranges for the two variables within each measure are similar. For Time 1, Joint Attention range=0-39 and Behavior Requesting range=3-36; for Time 2, Joint Attention range=0-45; Behavior Requesting range=5-47. For Imitation at Time 1, Imitation of Body Movements range=0-16; Imitation of Actions on Objects range=0-15; at Time 2, Imitation of

Body Movements range=0-14; Imitation of Actions on Objects range=2-14. Although these ranges are similar for variables within measures, medians reveal greater discrepancies. Selected as measures of central tendency because of skew and outliers in Joint Attention, medians are lower for Joint Attention than Behavior Requesting at both time points (e.g., Joint Attention median=10.8 versus Behavior Requesting median=18.6 at Time 1; at Time 2, Joint Attention median=13.3 versus Behavior Requesting median=26.8; similarly, Imitation of Body Movements median at Time 2=6.5, versus Imitation of Actions on Objects median=9.5). Boxplots (Figure 2) also reveal this disparity, showing that the interquartile range of Behavior Requesting shares little overlap with Joint Attention. Although Imitation of Body Movements and Imitation of Actions on Objects have great overlap at Time 1, the interquartile range of Imitation of Actions on Objects increases relative to Imitation of Body Movements at Time 2, producing greater distance between the distributions.

Table 2 also provides a comparison of data between time points to suggest a slight increase in nonverbal communication skill (e.g., Joint Attention at Time 1=5.5, versus 8.5 at Time 2; Behavior Requesting at Time 1=16.5 versus 21.5 at Time 2.) However, stable performance is observed for imitation ability (e.g., Time 1 Imitation of Body Movements=7.5, versus 6.5 at Time 2; Time 1 Imitation of Actions on Objects=8.0, versus 9.5 at Time 2.) Finally, Table 3 provides a comparison of this sample to published data on the Early Social Communication Scales (ESCS) and Motor Imitation Scales (MIS) at different ages. As can be seen, this sample does not differ dramatically from published data on other autism samples; therefore, the differences seen here between types of nonverbal communication and types of imitation ability, as well as changes and stability over time are taken as representative of other autism research samples. The following statistical analyses address each hypothesis.

Core Analyses

Hypotheses 1 and 2. Hypothesis 1 states that children with autism will show performance discrepancies between two types of nonverbal communication as assessed by the Early Social Communication Scales (ESCS). Children will show significantly better performance on Behavior Requesting (BR), or nonsocial communication, than Joint Attention (JA), or social communication abilities. Hypothesis 2 states that children with autism will show performance discrepancies between two types of imitation ability as assessed by the Motor Imitation Scale (MIS). Children will show significantly better performance on Imitation of Actions on Objects (IAO), or 'object-imitation,' than Imitation of Body Movements (IBM), or 'person-imitation'.

Paired sample t-tests were used to address the first and second hypotheses by looking at statistically significant differences between variables within each measure. The decision to use a paired sample t-test was based on literature indicating that typically-developing children at this age perform fairly equivalently on the two types of nonverbal communication and on the two types of imitation ability, and thus have mean difference scores of 0 between the subskills on both measures (Stone, Ousley, & Littleford, 1997; Seibert, Hogan, & Mundy, 1982). The null assumed mean difference scores for study children would be similar to mean difference scores for typically-developing children, or 0. All children received an equal number of trials on the ESCS, and therefore had an equal number of opportunities to display the two types of nonverbal communicative behaviors. Similarly, all children received an equal number of trials on the MIS, and therefore had equal opportunity to display the two types of imitation behaviors.

For Hypothesis 1, results indicated a significant difference between types of nonverbal communication, with children scoring significantly lower on Joint Attention than Behavior Requesting both at Time 1: $t(17) = -3.609$, $p < .01$ and Time 2: $t(13) = -4.599$, $p < .0001$. For Hypothesis 2, results showed a significant difference between types of imitation ability only at Time 2, $t(13) = -2.716$. $p < .05$, with the null not rejected at Time 1.

Hypothesis 3. Hypothesis 3 states that Joint Attention (JA) and Imitation of Body Movements (IBM) will be associated, such that Joint Attention (JA) will show a positive relationship with Imitation of Body Movements (IBM).

Scatterplots and correlations were used to address Hypothesis 3. A scatterplot of Joint Attention and Imitation of Body Movements revealed much scatter at both Times 1 and 2, with slight evidence of a positive linear association barring the presence of two outliers (See Figure 3). Cases 10 and 11 are marked in both plots based on their identification as outliers in the distribution of Joint Attention at Time 1 (Case 11) and Time 2 (Case 10). Nevertheless, bivariate correlations between the two variables failed to reach significance both at Times 1 and 2, neither with nor without outliers. Thus, a linear association between Joint Attention and Imitation of Body Movements was not found.

Hypothesis 4. Hypothesis 4 states that child characteristics believed to require social orienting will predict variance in Joint Attention (JA) and can be modeled to better understand Joint Attention. Specifically, these skills include Imitation of Body Movements (IBM), Total Language Ability (TLA), CARS score (CAR), and Gender (GEN). Child Age (AGE), which is not believed to be associated with Joint Attention abilities in this age group, will not improve the fit when added into the overall model. In addition, skills not hypothesized to be based in social orienting, Imitation of Actions on Objects (IAO), will not improve model fit.

First, preliminary scatterplots and a correlation analysis were used to explore potential linear relationships between Joint Attention and the predictor variables (see Figures 4 and 5). A visual analysis of these figures indicates: 1) Joint Attention does not have a strong linear relationship with any of the predictor variables; 2) Two extreme outliers, cases 10 and 11, continue to present in the scatterplots and are marked on each; 3) Girls in this sample showed a greater range of frequencies in Joint Attention behaviors than boys both at Times 1 and 2 (See plots of Gender and Joint Attention in Figures 4 and 5).

Table 4 lists correlations between predictors that attained significance. Scatterplots of these relationships with least-square regression lines are presented in Figures 6 and 7. The presence of co-linearity between many predictors suggests that the behavior of Joint Attention will be best modeled with fewer, rather than more, predictors. Outlier cases 10 and 11 are marked on the scatterplots to observe their relative movement within each relationship. Figures 6 and 7 show that Cases 10 and 11 follow atypical patterns, with high overall nonverbal communication for both Joint Attention and Behavior Requesting at Times 1 and 2. Although Case 10 has low scores on Language and Imitation skill, this child has one of the lowest CARS (autistic symptomatology) scores. Although these patterns were unusual, it was determined that these cases, both females, contributed meaningful information. Based on the PI's knowledge of these children, it was confirmed that their assessments had gone smoothly, without behavior problems, and their data were generally consistent from Time 1 to Time 2. Therefore, they were retained for initial analyses.

Hypothesis 4 was addressed using a variety of regression models, and Poisson regression was ultimately selected as the best fit for these data[2]. Model estimation assumed a Poisson distribution because Joint Attention was measured as a frequency count of independent and rare events, namely counts of social nonverbal communicative gestures, or joint attention behaviors, in an autistic population. These counts were observed and coded during a 15-minute interval; thus, a multiplicative (Poisson), rather than additive (linear), approach best predicts expected counts of this variable. The Joint Attention distribution has a strong right skew with few observations as the frequency increases, typical of Poisson distributions. A Poisson model that allowed for overdispersion was used to account for the greater variance of this sample relative to its mean. A larger variance to mean ratio often indicates heterogeneity of subjects (Long, 1997), which is likely in this study given the small sample size and nature of the autism diagnosis[3].

Model development consisted of several steps. First, individual variables were used to predict Joint Attention to determine unique predictive power. No single variable achieved significance. Second, information about unique predictive power and co-linearity between predictors guided a series of models that were tested with overall contrasts and examination of individual parameter estimates. Results indicated that Imitation of Body Movements and Gender provided the most predictive power when used together to explain variance in Joint Attention. The overall contrast for this model was significant, χ^2 (1, 13) = 5.53, $p < .05$, with both predictors attaining significance: IBM, $\chi^2 = 4.42$, ($p <.05$), and GEN, $\chi^2 = 6.50$, (p <

[2] Hypothesis 4 was re-run using multiple regression. Results were generally consistent with those using Poisson regression. Poisson was ultimately selected as a best fit, for reasons given above, and therefore believed to be the most sensitive in detecting relationships within these data.

[3] Autism is believed to consist of a heterogenous population for multiple reasons, including broad DSM-IV-TR diagnostic criteria and multiple etiological factors. The reader is referred to pp.41-43 for a more complete discussion of these issues.

.05). See Table 5 for model description. To address the second part of Hypothesis 4, Child Age and Imitation of Actions on Objects were added into the model. Neither predictor improved model fit, as hypothesized.

A second series of Poisson models was developed to test Hypothesis 4 at Time 2. Results indicated that CARS score and Gender best predicted variance in Joint Attention when included together at Time 2. An overall contrast for the final model reached significance: χ^2 (2, 11) = 9.77 ($p < .01$), with both predictors attaining significance: CAR, χ^2 = 5.68, ($p < .05$), and GEN, χ^2 = 4.27, ($p < .05$). Child Age and Imitation of Actions on Objects, again, did not improve model fit. See Table 5.

Hypothesis 5. Hypothesis 5 states that Gender will predict variance in Joint Attention such that girls, who will show lower overall functioning, will show stronger prediction for Joint Attention than boys.

Independent sample t-tests and separate Poisson regression models for boys versus girls were used to address Hypothesis 5. First, independent sample t-tests were run on all variables, including the dependent variable, Joint Attention, and all predictor variables to examine differences between girls and boys. No significant differences in the means for girls versus boys were found for any variable. A comparison of descriptive statistics indicates that girls have a lower median for Total Language and a higher median for CARS score. Though not significant, these differences suggest that girls in this sample may have been somewhat lower functioning as a group than boys, as predicted for overall group differences.

Poisson regression models were estimated for boys versus girls to discover whether prediction would be different based on these two groups. Results at Time 1 indicated a significant overall model for girls, χ^2 (3, 1) = 6222.80, $p<.0001$, with three significant predictors, Imitation of Body Movements, Total Language Ability, and Child Age. At Time 2, results also revealed a significant overall model, χ^2 (4) = 42.75, p < .0001, with four significant predictors, Imitation of Body Movements, Total Language Ability, Child Age, and CARS score. For boys, neither Time 1 nor Time 2 data resulted in a significant model of estimation. See Table 6 for models for girls versus boys. Therefore, prediction was better for girls than for boys, as predicted by Hypothesis 5.

Additional Analyses

Removal of Single Outliers. Poisson models were re-run without Outlier Cases 10 and 11 in order to determine their relative importance to the overall model fit and appropriateness in the population under study. First, Case 11 was removed only from Time 1 and Case 10 only from Time 2 data. Time 1 results indicated no models or predictors that attained significance without Case 11; however, Gender continued to exert an influence on Joint Attention when included in models, with estimates only slightly less than with all observations. In addition, Gender approached significance when included in a model with Imitation of Body Movements. For Time 2, no model reached significance without Case 10; however, a model that included Imitation of Body Movements and Child Age approached significance, demonstrating a best fit to the data.

Removal of Outliers from Both Time Points. The next analyses removed both outliers from data at Time 1 and Time 2. Results indicated the model of best fit at Time 1 used CARS score and Imitation of Body Movements to predict Joint Attention, with the overall contrast approaching significance and CARS score attaining significance as a predictor. At Time 2, no predictors reached significance, but a best model was fitted with Imitation of Body

Movements and Child Age, the overall model fit approaching significance. See Table 7 for a comparison of models of best fit with and without outliers.

Removal of outliers underscores the influence of Gender in this sample. An examination of the outliers 10 and 11 reveal that both are girls who present with similar patterns of high levels of social nonverbal communication and low levels of imitation and language ability, a pattern not predicted for this sample. Removal of these cases, which also increased the ratio of boys to girls to over 2:1 in the sample, causes Gender to become much less significant, but other variables, particularly Child Age and CARS score, to begin to exert more influence in explaining the behavior of Joint Attention.

CHAPTER 4

DISCUSSION

Summary of Findings

The purpose of this study was to examine interrelationships between joint attention, imitation, and child characteristics theorized to be based in social ability. Specifically, a body of research suggests that a subtype of imitation, dubbed ‘person-imitation,’ is based in social processes. This study hypothesized that joint attention, also believed to be based in social skill, would be associated with person-imitation. Next, this project sought to examine relationships between child characteristics, including person imitation, language, and autism severity, believed to be related to social processes, and joint attention by including these characteristics in regression analyses modeling the behavior of joint attention.

This study found that, first, children with autism performed significantly more poorly on joint attention, or social nonverbal communication, than behavior requesting, or nonsocial nonverbal communication, even though these two types of communication are expressed using similar gestures (eye contact, pointing, reaching, giving). Secondly, children with autism performed more poorly on imitation of body movements (person imitation), theorized to be require social understanding, than imitation of actions on objects (object imitation), theorized as less socially-based, at Time 1 (though not significant) and significantly more poorly at Time 2. Overall, children with autism showed a pattern of using gestures for nonsocial purposes more frequently than for social, and were more successful imitating actions that focused on objects than actions that required focus on a person.

These two disparate behaviors, joint attention and imitation of body movements, were tested for a linear relationship because they were both believed to be rooted in social developmental processes. However, no linear relationship was confirmed. Potential reasons for this finding include: first, the Poisson nature of the joint attention distribution resulted in a floor effect of many 0s, 1s, and 2s. This low variability likely clouded the correlation analysis. Second, this finding suggested that the picture of underlying social processes was more complex than linear associations between all variables influenced by social ability. Not finding a simple linear association indicates that joint attention is probably linked to multiple variables in such a way as to result in a complex developmental picture. Finally, it was possible that an unidentified variable was confounding the results.

The next set of analyses looked at a more complex picture of multiple predictors explaining variance in the behavior of joint attention. Time 1 results indicated there was a gender effect, with girls performing more than twice the frequency of joint attention behaviors as boys. Imitation of Body Movements was also a significant predictor, although in the unexpected direction. In fact, when looking at the entire sample, as children demonstrated more joint attention, they showed lower scores on imitation ability.

Time 2 data revealed the same Gender effect, along with higher CARS scores for fewer Joint Attention behaviors, as previously expected. Taken together, Time 1 and Time 2 findings indicate that: 1) Gender is a strong predictor of joint attention, such that girls show two to three times more joint attention behaviors than boys; furthermore, the influence of gender may have been underestimated, such that it may create an interaction with joint attention, which confounds the results when the entire sample is included in the analysis; 2) although at different time points, both Imitation of Body Movements and CARS scores were significant predictors of joint attention, as expected; 3) Language was not a significant predictor, contrary to prediction; 4) Neither Age nor Imitation of Actions on Objects were significant predictors, as expected. A discussion of each of these findings follows.

Gender as a significant predictor. The significance of Gender indicates the possible presence of an interaction between Gender and Joint Attention, such that the pattern of Joint Attention and other variables may be different for boys versus girls. Specifically, girls showed more joint attention behaviors than boys. Given the larger range of functioning levels within the girls' sample, it is possible that this finding was influenced by a more restricted range of scores (resulting in less variability and less of an effect) for the boys.

Imitation of Body Movements and CARS score as significant predictors. Findings on the total sample also indicated two significant predictors that were expected: Imitation of Body Movements and CARS score. CARS score, as a predictor found for Time 2, was in the expected direction, with children having higher CARS scores (greater autism severity) while showing fewer joint attention behaviors. This relationship was in the expected direction at Time 1 but not significant. Imitation of Body Movements, although a significant predictor of joint attention at Time 1, was not in the expected direction. Instead, it was seen that children with higher counts of joint attention performed more poorly on imitation of body movement tasks. It was suspected that these results could have been influenced by the two outliers, both of which showed unusually high counts of joint attention.

Language was not a significant predictor. One possibility for this finding is the confounding of expressive with receptive language abilities. The hypothesis targeted here theorized that language requires social ability in pragmatics and understanding content, and therefore would be a significant predictor of joint attention. However, language assessments target more than just the social use of language, such as vocabulary acquisition and word count, areas that children with autism find easier than social usage. As a result, language scores may reflect broad language ability, and therefore, may not be a sensitive enough measure of social use of language to determine its relationship with joint attention. A measure of social use of language may be a better predictor of joint attention.

Age and IAO were not significant predictors. As expected, Child Age and Imitation of Actions on Objects did not improve prediction when added into the model for the entire sample. Research indicates that joint attention does not improve greatly during the preschool ages, and therefore should not predict joint attention. These findings supported this line of thinking. In addition, research suggests that object-oriented imitation does not require social understanding, and therefore would not be a significant predictor of joint attention. This was also concordant with these findings.

A final set of analyses was run to address Hypothesis 5, looking at model estimation for boys versus girls. This analysis was carried out first by looking at gender differences on variables to be included in the model. As is generally true in autism samples, girls in this sample were shown to be somewhat lower functioning than boys, having overall higher CARS scores and lower language scores. Girls and boys did not differ on any other variables of interest. Second, separate regression analyses were carried out for girls and boys. Results were striking in that for girls, joint attention could be predicted from their ability to imitate body movements, their language score, and their age. At Time 2, joint attention frequency for girls could be predicted from their ability to imitate body movements, their language ability, their age, and their level of autism severity. When boys were examined in regression analyses alone, no significant predictors were found to explain their pattern of joint attention. These results conform to what was predicted about gender, that girls as a whole are more severely affected, lower functioning which leads to poorer social abilities, which was then hypothesized to more strongly predict joint attention. These findings of stronger prediction for girls supports this idea.

These findings must be considered with caution, however, because the sample of girls used in this analysis was quite small and therefore not as reliable. In fact, chi squares obtained from these contrasts were unusually large, suggesting that the effects seen here may be due to random error rather than an extremely strong effect. However, findings conform to what was expected in the predicted directions, and therefore could be considered as preliminary evidence for the presence of an interaction between Gender and Joint Attention. An interaction was not tested due to the small sample size and probability of not achieving enough power to detect a true effect. Yet, the suggestion from these data is that there are gender differences in joint attention as well as different patterns of symptoms between boys and girls.

Gender Effect

Gender differences found for this sample, although preliminary, suggest that gender differences should be examined in future studies. An examination of the range of CARS and language scores, two indices of general functioning level, indicates that girls in this sample were lower functioning than boys. This was predicted, as girls in the general population are expected to show more mental retardation as a group than boys with autism (Konstantareas, Homatidis, & Busch, 1989; Steffenburg & Gillberg, 1986; Volkmar, Szatmari, & Sparrow, 1993). It therefore follows that girls would show different pattern of symptoms than boys.

The girls in this sample, however, also differed in ways unexpected. Girls showed a wider range of unusual patterns of other developmental variables. First, although girls had overall lower functioning levels, the two children with lowest autism severity (lowest CARS scores) were also girls. However, these two girls did not show the same symptom pattern, as one had high joint attention behavior and the other low. Secondly, the two outlier cases with high joint attention scores, 10 and 11, were both girls, who showed low levels of functioning (with lower language and imitation ability and higher CARS scores). This pattern was also not expected. Given the constraints of the small number of girls in this study, further analyses targeting symptom patterns within subgroups could not be done. However, an examination of individual girls with unusual, unexpected patterns suggests that girls with autism may comprise a heterogenous group of subtypes of autism. For example, it may be possible that some girls with autism show classic patterns of DSM-IV symptoms, but have generally higher social skills (i.e., better joint attention abilities) than boys. Other girls may have autism secondary to another developmental disability, resulting in the lower CARS scores.

Following the main analyses, additional analyses were run to examine the influence of the two outliers identified in the joint attention distribution. It was noted that these outliers were both females with unusually high frequencies of joint attention, although lower language and higher CARS scores. With the outlier removal, analyses on the total sample indicated that Gender is reduced as a significant predictor, which would be expected since the removal of two out of 7 girls greatly decreases the influence of girls in the gender factor. With the reduction of Gender, however, one also observes that other variables become more significant. The relationship between Joint Attention and Imitation of Body Movements becomes positive instead of negative, and Child Age becomes more influential.

These findings were generally consistent with previous results that had included the outliers, barring the difference in direction of association between joint attention and imitation of body movements. When looking at only the sample of girls, however, it can be seen that imitation of body movements has a positive association with joint attention. Therefore, it was determined that this slight negative association seen in the total sample was error due to the confounding of gender and that a clearer picture of association could be seen when the sample was split by gender.

In summary, children with autism in this sample had more difficulty with skills that research suggests are based in social skill, than abilities thought to require less social understanding. The behavior of joint attention cannot be understood by its relationship to a single variable, such as imitation of body movements. Instead, multiple variables based in social skill are related to joint attention. In fact, an examination of the interrelationships of child characteristics believed to be based in social skill opens the door to a complex picture of joint attention as being understood *only* in the context of *multiple* developmental processes that in turn are collinear. Furthermore, the pattern differs for boys versus girls. The picture is multidimensional not easily visually constrained. However, it confirms a long held suspicion that autism is not a simplistic developmental process but the result of multiple variables that influence one another.

This study lends some support for the idea that an underlying deficit, common to these interrelated characteristics, is social in nature. Certainly, the variables that best explained joint attention when included together in the model - imitation of body movements and CARS score - both have social contributions, as research suggests. The variables that did not explain joint attention - imitation of actions on objects and child age - are thought to relate less to social phenomena. The complexity with which these may be related could be explained by Mundy and Neal's theory of social orienting and negative feedback of deviant, early joint attention processes that disrupt social and affective learning; it could also be explained by Bakeman and Adamson's phase-theory of learning, in which early, basic social interactions provide a foundation for learning and by which later learning does not occur if early stages are disordered in some way. Joint attention, imitation of body movements, and CARS score were shown to be related through various regression models. A social foundation for these skills is only one explanation for a common underlying deficit. Yet, research suggests social foundations for each of these developmental areas. Therefore, this study provides support for the idea that social constructs, such as social orienting, may be the common underlying disruption of these related developmental processes.

Limitations

Heterogeneity. Heterogeneity in autism populations results from multiple sources and poses a problem for generalizability of research findings. However, the small sample size in this study precludes an examination of these potential subtypes of autism. Even though sample characteristics were comparable to the population at large, caution in generalizing should be exercised due to the likelihood of heterogeneity and the small sample size. It is difficult to know whether the particular profiles of autism seen in this small sample are similar to those of the general autism population.

There are multiple potential sources of heterogeneity in autism samples. There are diagnostic issues, as Autistic Spectrum Disorder (ASD) as defined by the DSM-IV is a broad construct. In addition, the etiology of autism is not well understood, meaning that autism may be one syndrome or it may be a description of a collection of syndromes that present with similar symptoms.

First, there are diagnostic issues that can contribute to heterogeneity. A DSM-IV diagnosis of Autistic Disorder requires six criteria from three areas of functioning. However, within this diagnosis, children's symptoms could more strongly relate to one of the three realms, being more communication-focused, sensory-focused or present mostly in the social area. In fact, earlier researchers such as Wing and Gould (1979) wrote about potential underlying subtypes of autism within the DSM-IV diagnosis. Before these subtypes are defined, findings may be confounded by having underrepresented samples in any given subtype. The best way to ensure having a generalizable research sample, then, is to balance children within the sample across potential combination of symptoms. This is difficult to do without adequate measures of symptom subtypes. Another way to address this problem is to have samples large enough to assume that random variation within the sample balances as error. However, incidence rates are often small in any given catchment area, resulting in small research samples that lack representation of all symptom combinations of children.

Finally, children who do not meet criteria for AD are diagnosed with the broader, less well-defined Pervasive Developmental Disorder NOS (PDDNOS). These children are often referred to as being along the "Autism spectrum", are assigned to autism classrooms based on closest fit for education and intervention, and are often referred to as "autistic". Therefore, it is imperative that research studies verify accurate diagnoses in autism classrooms before recruiting children for research projects. Autism diagnoses in this study were verified by parent and teacher report. It might be useful in future studies to request copies of psychological reports to sort out any children who may have been diagnosed as PDDNOS but are more generally considered to be autistic.

In addition to diagnostic issues, etiological issues may also contribute to heterogeneity. Similar to other disorders in the DSM-IV, diagnostic criteria are in flux and could change depending on research findings and clinical consensus on classification. Autism is far from being fully understood, and it is likely that diagnostic criteria are somewhat umbrella terms that capture a broader array of disorder than a unitary construct known as autism. As long as children are diagnosed using DSM-IV, this is not a problem, as a research sample drawn from this population can be generalized to all children diagnosed with autism. However, it is important to note that this population designated as having autism is not definitive, and knowledge gained through research and clinical work about this disorder may provide new information as to the nature of true underlying (and potentially multiple) disorders.

Sample size. Caution should be used when interpreting the findings of this study because of the small sample size. As indicated in the section on heterogeneity, the variation in symptom presentation in this sample may also be viewed as “error” due to small sampling size. To find an effect in such a small sample could be the result of a large effect size. Because findings were generally consistent with hypotheses and other studies that have looked at some of the questions presented here, it is concluded that this study found true effects of predictors explaining variance in the dependent variable joint attention. However, it should also be recognized that variation in the behavior of these variables could also be due to small sample size. For example, the lack of finding a linear association between joint attention and imitation of body movements could be due to small sample as well as low variability in joint attention. A larger sample is needed to increase variability and increase power, and to replicate these findings.

Future Directions

First, future research should continue to examine the link between joint attention and person-imitation, focusing on gender differences. In addition, some girls seemed to show stronger social communication skills relative to boys, despite lower functioning levels. Their deficits in autism may have to do more with sensory and communication issues, leading to a very different pattern of autism symptoms. A logical next step in this process would be to model an interaction between Gender and Joint Attention using a much larger sample, to test the hypothesis of gender differences.

If gender differences are consistently found, they could have implications for early diagnosis and intervention. For example, if girls are shown to have better joint attention skills, then for a girl who already has mastered basic social reciprocity, person-to-person interaction can more readily be used to teach language skills. For a boy not exhibiting rudimentary social nonverbal gestures, sensory or object-oriented approaches might be used to obtain his attention so that gestures can be taught. Etiologically, gender differences at the social level may indicate a different, x-linked subtype of autism. Or, gender differences seen in autism may represent general differences in social skill seen in typically developing children that, whether inborn or socially-constructed, impact at the level of developmental disabilities, causing the disorder to look different in boys versus girls.

Secondly, future research should work on recruitment of larger sample sizes in order to detect small effects of developmental variables that may need more sensitive assessment tools to measure, for instance, the difference between receptive and expressive language or growth and change in variables that change slowly over time for autistic children. Measures of joint attention should focus on observation of subtle behaviors that reflect social and nonsocial nonverbal communication skills, to increase variability in children and improve power to detect associations.

Third, many big areas of research remain open venues for study. Precursors of joint attention should be targeted in research, specifically before ages 3 and 4, to try to understand developmental pathways of this variable. The association between joint attention and other child characteristics should continue to be explored. Factor analytic studies should examine grouping of symptoms to better understand subtypes of autism. Longitudinal research is needed to better understand how symptoms change as children mature and develop. To address longitudinal hypotheses, multiple data points should be collected so as to allow enough time for maturation of developmental processes and enough data to develop linear models of developmental. For example, a longitudinal study could be developed to look at joint attention abilities at 3 years, 3.5 years, and 4 years. Finally, it is not known in what ways autistic symptoms interact with other variables peripherally related to autism, such as cognitive functioning, physical impairments, personality factors, and other psychopathology such as attention or emotion disorders.

Conclusion

In summary, children with autism present with a challenging picture of symptom presentation that is difficult to study because of several factors, including difficulty of the population to assess because of behavioral problems; difficulty in recruiting due to low incidence; clarity of diagnostic history in individual children; and etiological diversity and potential subtypes, resulting in a heterogenous population. These issues contribute to the challenges in understanding how a complex array of symptoms interact and fit together to produce autistic behavior, and what developmental progressions these symptoms take.

This study attempted to examine interrelationships among some symptoms that commonly present in children with autism. A theory of social orienting was presented as a potential explanation of causal factors. Support was obtained for the association of some symptoms theorized to have a social-basis. Therefore, this study supports the idea that social processes are fundamentally at the root of a complex array of developmental processes and symptoms that result in a behavioral picture diagnosed as autism.

Table 1. Intraclass correlation coefficients for Early Social Communication Scales

Composite Score	ICC	95% Confidence Interval
Initiating Joint Attention: low level	.99	.95 -.99
Initiating Joint Attention: high level	.63	-2.9 - .99
Total Joint Attention	**.99**	**.96 - .99**
Initiating Behavior Requesting: low level	.93	.32 - .99
Initiating Behavior Requesting: high level	.97	.71 - .99
Total Behavior Requesting	**.91**	**.02 - .99**

Table 2. Descriptive statistics for four distributions at Times 1 and 2

Time 1

Measure[4]	Variable[5]	Median	Mean	Range	IQR[6]	Outliers
ESCS	JA	5.5	10.8	0-39	12.75	Case 11; freq=39
ESCS	BR	16.5	18.6	3-36	19.5	none
MIS	IBM	7.5	7.8	0-16	10.0	none
MIS	IAO	8.0	8.2	0-15	10.0	none

Time 2

Measure	Variable	Median	Mean	Range	IQR	Outliers
ESCS	JA	8.5	13.3	0-45	19.25	Case 10; freq=45
ESCS	BR	21.5	26.8	5-47	18.25	none
MIS	IBM	6.5	6.0	0-14	8.25	none
MIS	IAO	9.5	9.3	2-14	7.25	none

[4] Measures reported here include Early Social Communication Scales (ESCS) and the Motor Imitation Scale (MIS).

[5] Variables reported here include Joint Attention (JA), Behavior Requesting (BR), Imitation of Body Movements (IBM), and Imitation of Actions on Objects (IAO).

[6] IQR = Inner-quartile range

Table 3. Means for ESCS and MIS composite scores for autistic, developmentally delayed, and typical children: Comparison with published data

Early Social Communication Scales

	This Study	Published Data[7]		
	Autistic	**Autistic**	**MR**	**Typical**[8]
Mean (CA-mos)	50	38/47	37/44	14/25
Joint Attention	10.8	7/14	14/21	16/18
Behavior Requesting	18.6	9/19	14/20	19/25

Motor Imitation Scale

	This Study	Published Data		
	Autistic	**Autistic**	**DD**	**Typical**
Mean (CA-mos)	50	31.3	31.1	18.1
Range (CA-mos)	32-62	26-36	24-39	14-27
IBM (mean)[9]	7.8	2.6	6.1	4.1
IAO (mean)	8.2	7.2	11.3	11.1

[7] These data were collected with two groups: low mental age and high mental age, hence the two difference values reported.

[8] Data reported for typical children here indicate small discrepancies between the two subscales within each measure. Data analyses addressing Hypothesis 1 compared sample children to typical children assuming difference scores of 0. The 0 difference scores are reported in the literature for typical children who are the same age as the children with autism in this study (Seibert, Hogan, & Mundy, 1982; Stone, Ousley, & Littleford, 1997), although specific scores are not reported. The data reported in this table are for typical children younger than preschool age, who are documented not to have equivalent scores yet on the subscales within both the ESCS and MIS.

[9] Although medians were selected as the best measure of central tendency for this study sample based on outlier cases, means are reported here for comparison to published data, which reported only mean scores for the MIS.

Table 4. Significant correlations between predictor variables

Time 1

	IBM	IAO	TLA	CAR	AGE
IBM r p	.	.736** .001	.604** .007	-.208 .220	.788** .000
IAO r p	.736** .001	.	.768** .000	-.467* .034	.832** .000
TLA r p	.604** .007	.768** .000	.	-.400* .050	-.770** .000
CAR r p	-.208 .220	-.467* .034	-.400* .050	.	-.326 .101

* p < .05
** p < .01

Time 2

	AGE
TLA r p	.760** .001

* p < .05
** p < .01

Table 5. Poisson regression models of best fit, all observations

Time 1 Model: χ^2 (1, 13) = 5.53, p < .05*

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	2.3554	0.3417	1.6856, 3.0252	47.51	<.0001**
IBM	-0.0727	0.0346	-0.1405, -0.0049	4.42	.0355*
GEN	0.9467	0.3712	0.2192, 1.6742	6.50	.0108*

* p < .05
** p < .01

Time 2 Model: χ^2 (2, 11) = 9.77, p < .01**

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	4.2902	0.9959	2.3385, 6.2419	18.56	<.0001**
CAR	-0.0749	0.0314	-0.1365, -0.0133	5.68	.0171*
GEN	0.9632	0.4663	0.0492, 1.8771	4.27	.0389*

* p < .05
** p < .01

Table 6. Poisson regression models comparing girls versus boys at times 1 and 2

Girls

Time 1 Model: χ^2 (3, 1) = 6222.80, p < .0001**

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	14.8531	0.1679	14.5240, 15.1823	7822.37	<.0001**
IBM	0.2678	0.0041	0.2597, 0.2759	4188.30	<.0001**
TLA	0.1431	0.0027	0.1377, 0.1485	2714.87	<.0001**
AGE	- 0.3497	0.0050	-0.3596, -0.3399	4800.67	<.0001**

Time 2 Model: χ^2 (4) = 42.75, p < .0001**

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	111.8622	31.3513	50.4147, 173.3096	12.73	0.0004**
IBM	2.5813	0.7151	1.1797, 3.9829	13.03	0.0003**
TLA	1.7090	0.5308	0.6686, 2.7495	10.36	0.0013**
AGE	-3.5153	1.0607	-5.5943, -1.4363	10.98	0.0009**
CAR	0.5694	0.2271	0.1243, 1.0145	6.29	0.0122*

* p < .05
** p < .01

Boys

Time 1 Model: χ^2 (4, 5) = 6.05, p < .1953

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	-7.4045	4.7368	-16.6884, 1.8795	2.44	0.1180
IBM	-.0373	.0855	-.2049, .1302	.19	0.6622
TLA	.0351	.0266	-.0872, .0170	1.74	0.1867
CAR	.1887	.1101	-.0270, .4044	2.94	0.0864
AGE	.0822	.0440	.0041, .1685	3.48	0.0620

Time 2 Model: χ^2 (4, 1) = 4.06, p < .3976

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	-11.1916	8.4636	-27.7798, 5.3967	1.75	.1861
IBM	.1884	.1137	-.0345, .4113	2.74	.0977
TLA	-.0757	.0508	-.1752, .0239	2.22	.1363
CAR	.2386	.1840	-.1220, .5993	1.68	.1946
AGE	.1175	.0686	-.0170, .2519	2.93	.0868

* p < .05
** p < .01

Table 7. Poisson regression models without outliers

1. Time 1 without Case 11 and Time 2 without Case 10

Time 1 Model: χ^2 (2, 12) = 2.99, p < .22

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	2.1836	0.3770	1.4446, 2.9225	33.54	<.0001**
IBM	-0.0428	0.0409	-0.1229, 0.0374	1.09	0.2955
GEN	0.6859	0.4290	-0.1550, 1.5267	2.56	0.1099

Time 2 Model: χ^2 (2, 7) = 4.24, p < .12

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	-1.5426	2.2611	-5.9742, 2.8890	0.47	0.4951
IBM	0.1018	0.0629	-0.0214, 0.2251	2.62	0.1054
AGE	0.0536	0.0355	-0.0160, 0.1231	2.28	0.1311

* p < .05
** p < .01

2. Times 1 and 2 without both Cases 10, 11

Time 1 Model: χ^2 (2, 11) = 4.72, p < .09

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	-0.4696	1.1862	-2.7946, 1.8553	0.16	0.6922
IBM	0.0131	0.0364	-0.0582, 0.0844	0.13	0.7189
CAR	0.0707	0.0334	0.0051, 0.1362	4.47	0.0346*

Time 2 Model: χ^2 (2, 7) = 4.24, p < .12

Parameter	Estimate	Standard Error	95% Confidence Limit	χ^2	Pr > χ^2
Intercept	-1.5426	2.2611	-5.9742, 2.8890	0.47	0.4951
IBM	0.1018	0.0629	-0.0214, 0.2251	2.62	0.1054
AGE	0.0536	0.0355	-0.0160, 0.1231	2.28	0.1311

* p < .05
** p < .01

Figure 1. Stem-and-Leaf Plots for four distributions[10] at Times 1 and 2

Time 1

JA	BR	IBM	IOA
0. **00003344** 0. **56899** 1. **4** 1. **89** 2. **4** 2. 3. 3. **9**	0. **33** 0. **789** 1. **111** 1. **58** 2. **14** 2. **589** 3. **4** 3. **56**	0. **002224** 0. **6788** 1. **022** 1. **666**	0. **1134** 0. **55579** 1. **0013** 1. **555**

Time 2

JA	BR	IBM	IOA
0. **001124** 0. **7** 1. **04** 1. **59** 2. **03** 2. 3. 3. 4. 4. **5**	0. 0. **5** 1. **2** 1. **568** 2. **012** 2. **9** 3. **144** 3. **9** 4. 4. **7**	0. **000144** 0. **67888** 1. **224** 1.	0. **23** 0. **56889** 1. **0123344** 1.

[10] Four distributions examined here at times 1and 2 include Joint Attention (JA), Behavior Requesting (BR), Imitation of Body Movements (IBM), and Imitation of Actions on Objects (IAO).

Figure 2. Boxplots for four distributions at Times 1 and 2

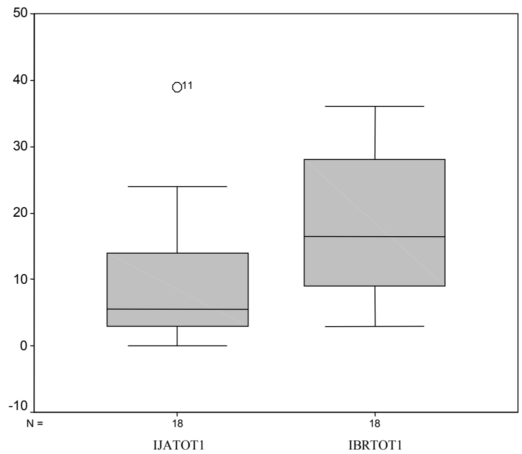


Fig. 2.1 Distribution of JA and BR, Time 1

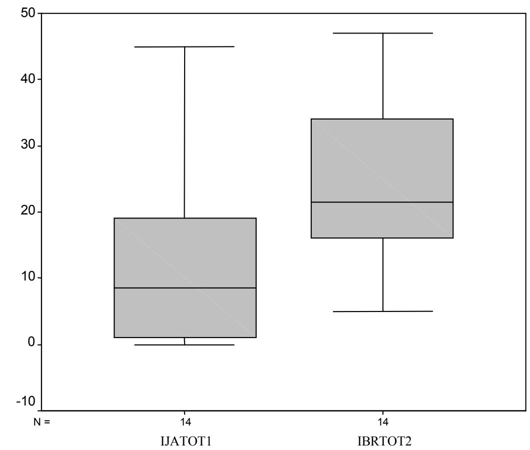


Fig. 2.2 Distribution of JA and BR, Time 2

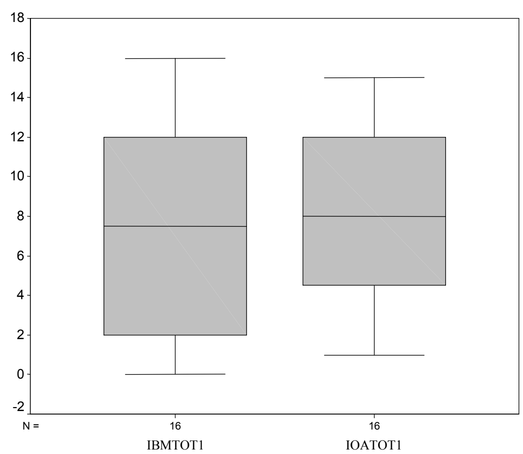


Fig. 2.3. Distribution of IBM and IOA, Time 1

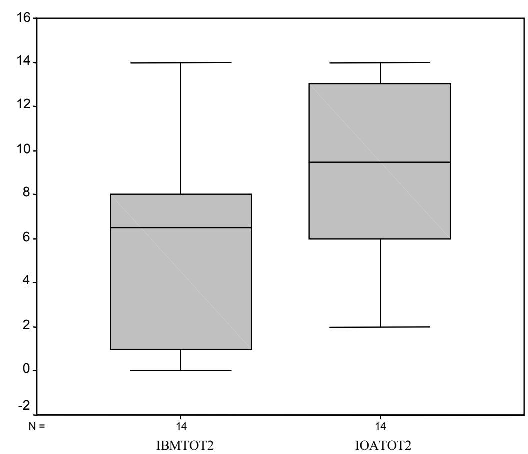
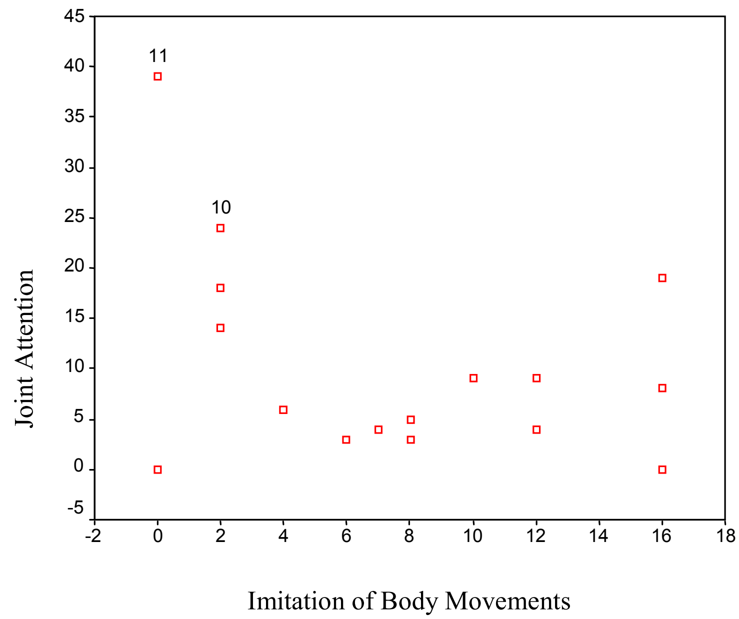
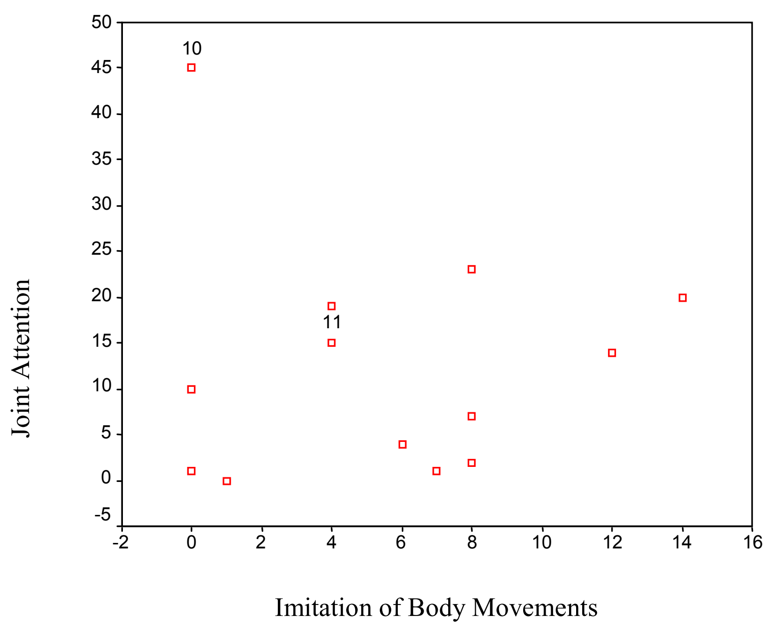


Fig. 2.4. Distribution of IBM and IOA, Time 2.

Figure 3. Scatterplots of Joint Attention and Imitation of Body Movements at Times 1 and 2



Time 1



Time 2

Figure 4. Scatterplots of joint attention with predictor variables at Time 1

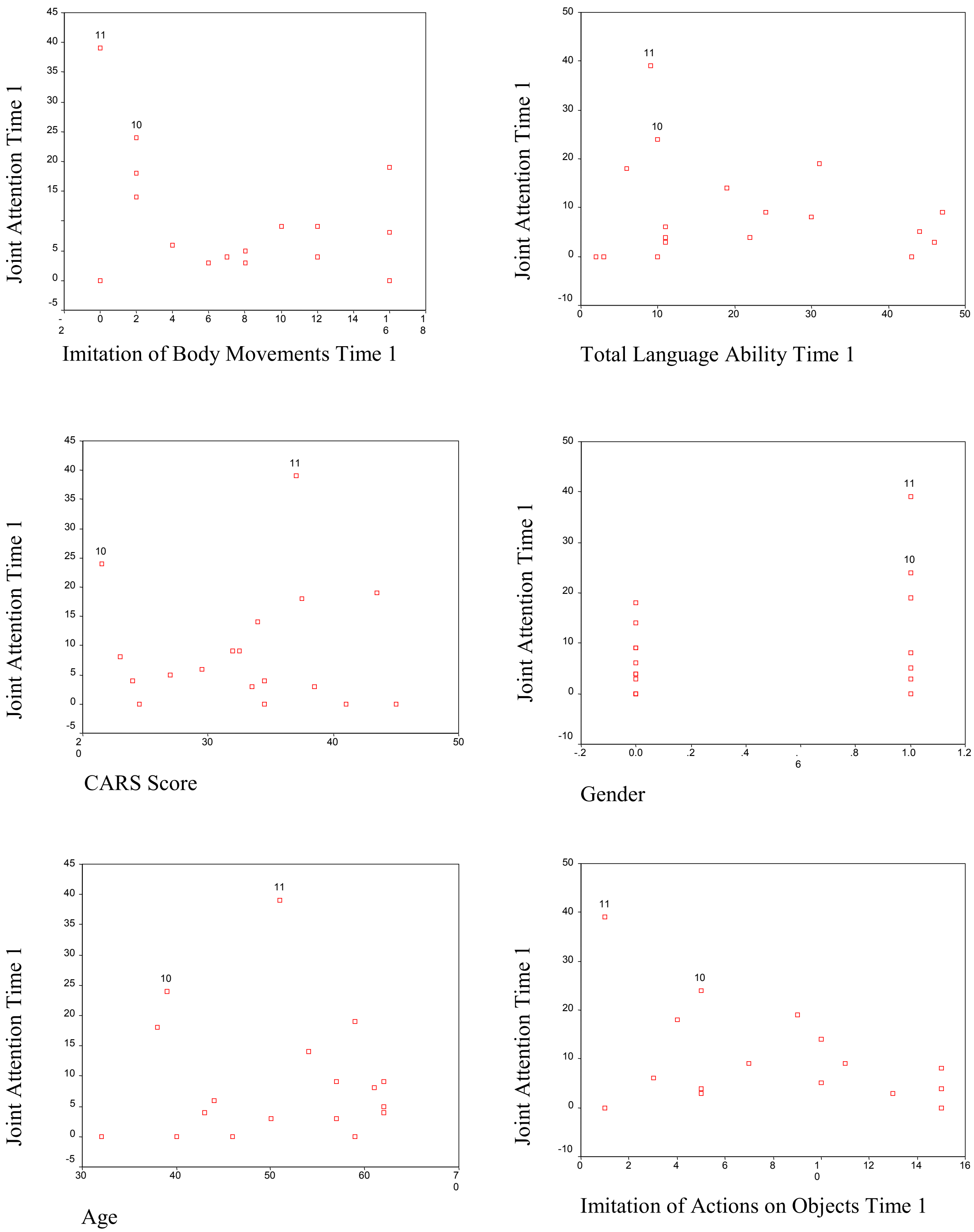


Figure 5. Scatterplots of joint attention with predictor variables at Time 2

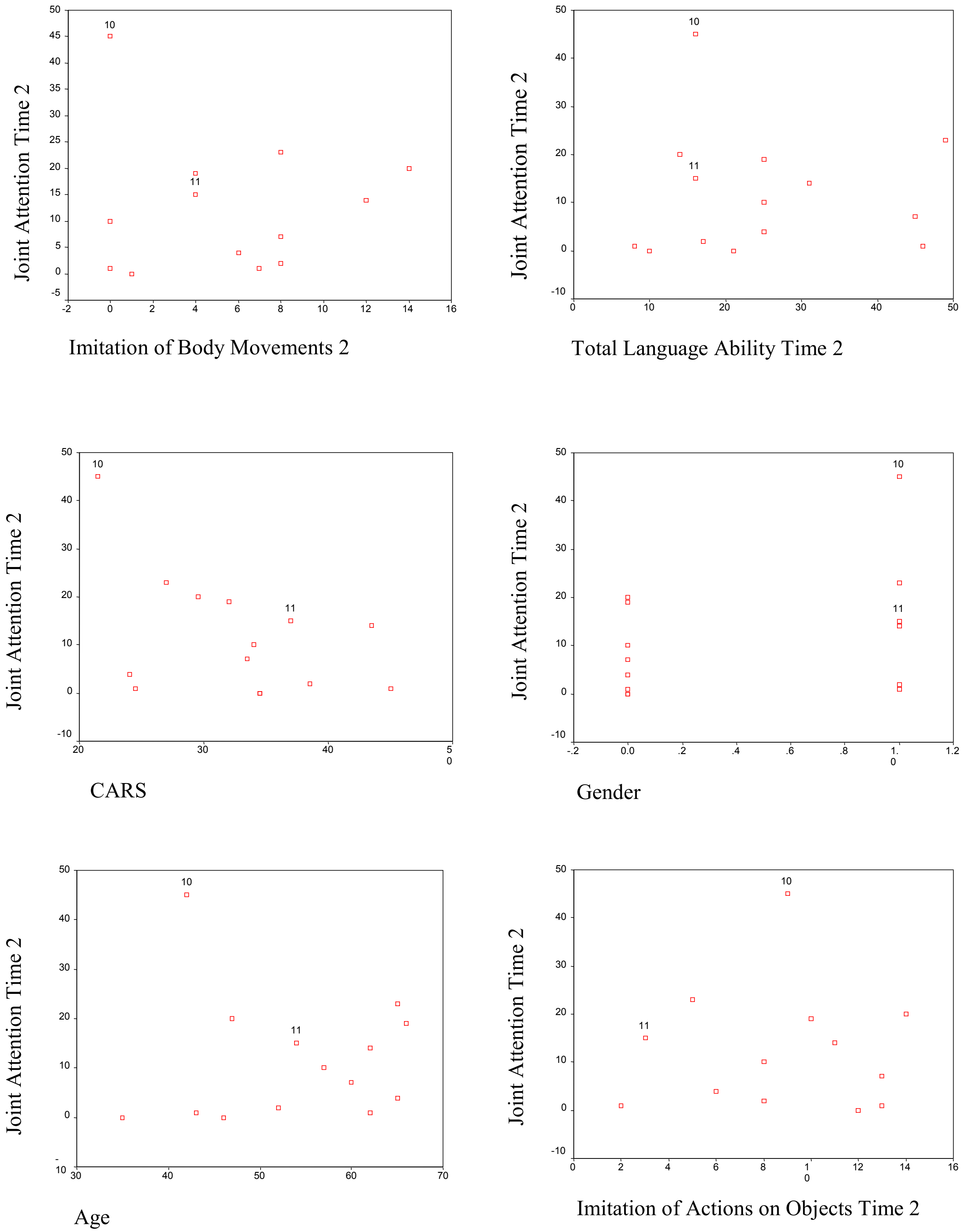


Figure 6. Scatterplots of predictor variables that attain statistical significance in bivariate correlations

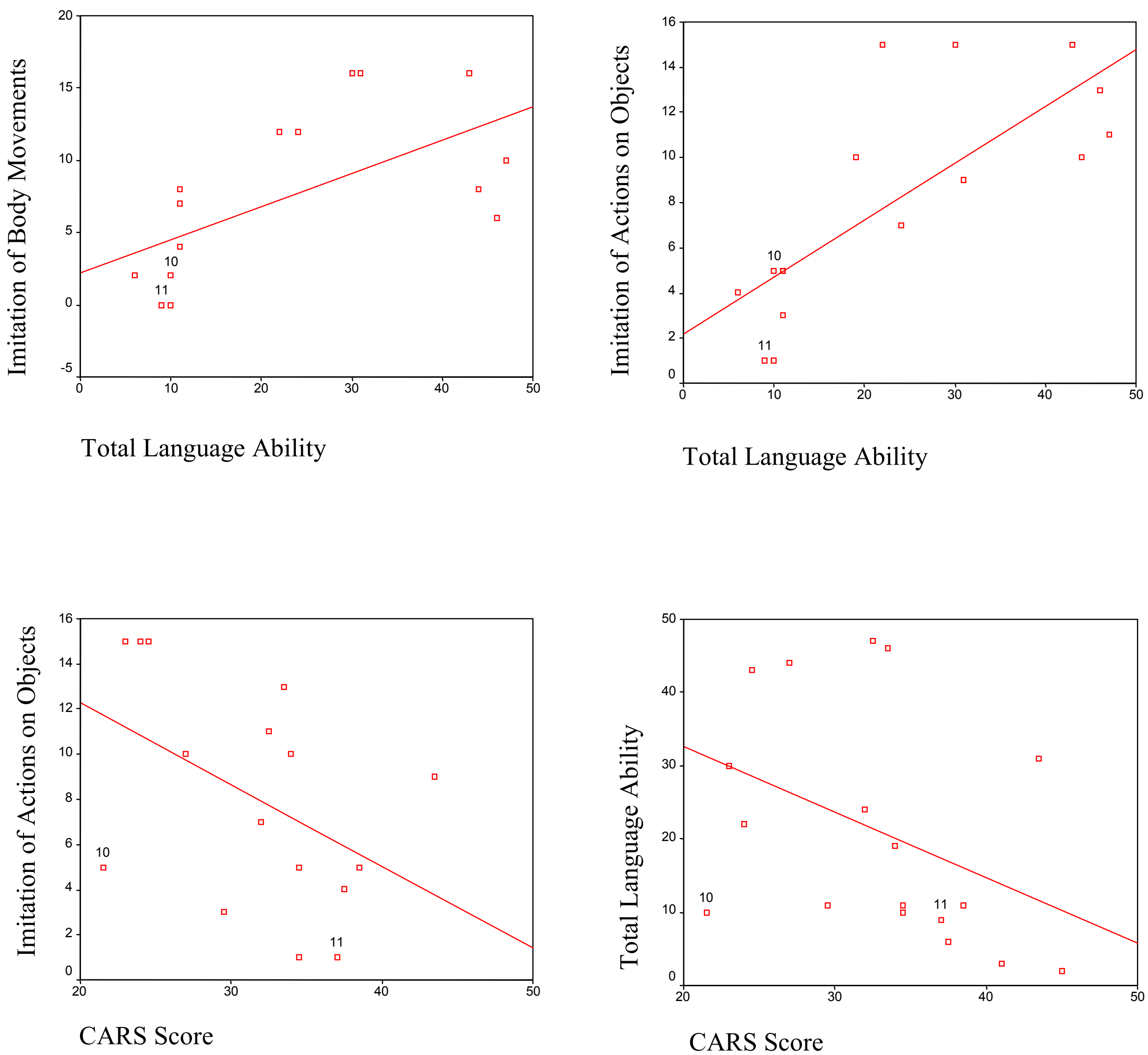
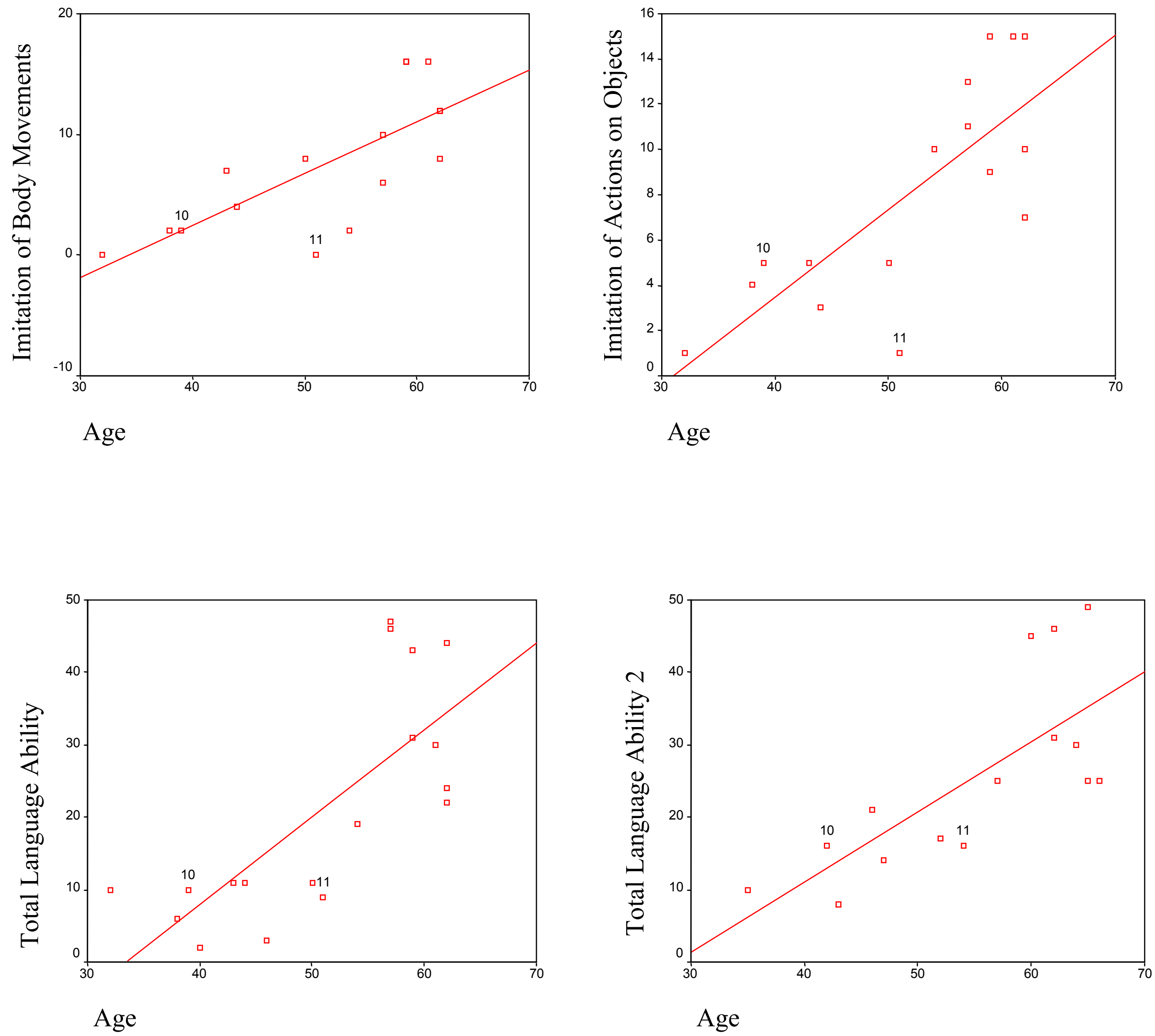


Figure 7. Scatterplots of predictor variables that attain statistical significance in bivariate correlations[11]



[11] Time 2 variables are indicated with the addition of a 2 following the label.

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