The Relationship Between Gestures and Language Skills in Children
with Autism and 22q13 Deletion Syndrome

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Abstract

The relationship between gestures and language skills was investigated in 18 children with autism and 28 children with 22q13 Deletion Syndrome. The objectives of this study were to examine whether children with autism and 22q13 Deletion Syndrome have similar patterns of association between language and gestures, and which types of gestures (early deictic and ritualized request gestures or late recognitory and symbolic gestures) are most associated with language skills in these groups. Children with autism and 22q13 Deletion Syndrome differed in their patterns of association between language and gestures. However, while the production of early gestures was significantly less than that of late gestures in both groups, no difference was found in the relationship between language skills and early versus late gestures. Findings from this study have important implications for the current understanding of how gestures are involved in the comprehension and production of language in atypical populations as well as for clinical assessment, educational curriculum, and intervention programs.
Résumé

La relation entre les gestes non-verbaux et les capacités linguistiques a été investiguée chez 18 enfants atteints d’autisme et 28 enfants avec le syndrome de suppression 22q13. Les objectifs de cette étude étaient d’examiner si les enfants avec l’autisme et le syndrome de suppression 22q13 ont des modèles d’associations semblables entre les gestes non-verbaux et les capacités linguistiques réceptives et expressives. De plus, il y eu une investigation pour connaitre quels types de gestes non-verbaux étaient le plus significatif pour prédire les capacités linguistiques. Les résultats ont démontré que le modèle d’association entre les gestes non-verbaux et le langage diffère entre les enfants avec l’autisme et les enfants avec le syndrome de suppression 22q13. Toutefois, aucune différence n’a été observée dans la relation entre les types de gestes non-verbaux et les habilités linguistiques. Les résultats de cette étude ont des implications importantes pour la compréhension actuelle de la façon dont les gestes sont impliqués dans la compréhension et la production du langage chez les populations atypiques ainsi que pour l'évaluation clinique, des programmes éducatifs, et des programmes d'intervention.
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Introduction

Gestures are produced by individuals from all cultural and linguistic backgrounds and emerge in children before the development of language (Iverson & Goldin-Meadow, 1998). These spontaneous hand movements are not random; they convey information that complement and even supplement information relayed in verbal communication (Iverson & Goldin-Meadow, 1998). Although there are now many studies describing the relationship between gestures and the language system in typically developing children, relatively little is known about the nature and development of the gesture-language system in children with developmental disorders involving specific profiles of language delay and/or impairment (Iverson, Longobardi, & Caselli, 2002).

The current study examines the association between expressive and receptive language skills and the use of gestures in children with autism and 22q13 Deletion Syndrome. Specifically, it examines whether children with autism and 22q13 Deletion Syndrome have similar patterns of association between language and gestures, and which types of gestures (early or late) are most associated with receptive and expressive language skills in each group.

The literature review will first describe autism and 22q13 Deletion Syndrome. Next, research on language development in typically developing children, children with autism, and children with 22q13 Deletion Syndrome will be summarized, followed by a review of gesture development in these populations. The association between gestures and language skills will then be discussed in typically developing children, followed by a review of the proposed theories for gesture’s role in language development, and possible dissociations between language and gesture in this population. Finally, literature on the association between language and gestures in children with autism will be reviewed, followed by an examination of the research investigating the use of gestures as an intervention for language development in this population.
Literature Review

Autism Disorder

Autism is a heritable, complex neurodevelopmental disorder characterized by distinct impairments in the areas of social interaction, speech development, and range of interests and activities (DSM-IV-TR; American Psychiatric Association [APA], 2000). Autism is one disorder in a broad spectrum of disorders known as autistic spectrum disorders (ASD) that share these essential features but vary in their degree of severity and/or age of onset. Within this spectrum, there are currently five diagnoses: Autistic Disorder, Asperger’s Disorder, Pervasive Developmental Disorder - Not Otherwise Specified, Rett Disorder, and Childhood Disintegrative Disorder. In North America, Autistic Disorder is diagnosed using standardized and structured diagnostic instruments the Autism Diagnostic Observation Schedule-Generic (ADOS-G) and the Autism Diagnostic Interview-Revised (ADIR).

ASDs are now recognized as one of the most common neurodevelopmental disorders. The most recent Autism and Developmental Disabilities Monitoring (ADDM) Network data affirm that between 1 in 80 and 1 in 240 children with an average of 1 in 110 have an ASD (Centers for Disease Control and Prevention, 2009). In other words, approximately 1% of all children have an ASD. Researchers believe that autism may have many genetic and non-genetic causes. In some instances, autism is a feature of an identifiable genetic condition; however, often no specific cause can be determined.

Phelan-McDermid Syndrome (22q13 Deletion Syndrome)

Phelan-McDermid syndrome (PMS or 22q13 Deletion Syndrome) is a microdeletion syndrome that results from the loss of genetic material from the terminus of the long arm of one copy of chromosome 22 (Cusmano-Uzog, Manning, & Hoyme, 2007). This disorder is
characterized by neonatal hypotonia, global developmental delay, normal to accelerated growth, absent to severely delayed speech, and dysmorphic features (Phelan, 2008). Researchers have found 22q13 deletion to be second to 1p36 deletion as the most common terminal deletion leading to a clinically significant chromosomal disorder (Phelan, 2008).

22q13 Deletion Syndrome is diagnosed using cytogenetic, molecular cytogenetic, and/or molecular demonstration of the loss or disruption of chromosome region 22q13.3, which contains the SHANK3/PROSAP2 gene. The SHANK3 gene is involved in the regulation and production of protein that builds the synapses in the brain and facilitates dendritic spine maturation. Breakpoints (or mutation) on the SHANK3 gene result in the inactivation of one copy of the gene, while the functional copy does not produce enough required protein (haploinsufficiency). Researchers propose that this haploinsufficiency of the SHANK3/PROSAP2 gene is responsible for the major neurological features of 22q13 Deletion Syndrome (Wilson et al., 2003). The deletion occurs with equal frequency in males and females; however due to lack of clinical specificity, the syndrome is under diagnosed and its prevalence remains unknown (Phelan, 2008; Philippe et al., 2008).

Hypotonia, feeding problems, and moderate to severe developmental delay are often the early presenting symptoms of 22q13 Deletion Syndrome (Phelan, 2008). Common physical characteristics include long eye lashes, large ears, relatively large hands, dysplastic toenails, full brow, dolicocephaly (elongated head), full cheeks, bulbous nose, and pointed chin (Phelan, 2008). Behavioural characteristics include poor eye contact, stereotyped movements, decreased socialization, and absent to severely delayed language skills (Phelan, 2008).

Most individuals with 22q13 Deletion Syndrome have moderate to profound intellectual impairments (Phelan et al., 2001; Wilson et al., 2003). Phelan and colleagues (2001) found that
15 of 20 children in their sample demonstrated severe to profound intellectual impairment on a measure of cognitive ability. Wilson and colleagues (2003) reported that all participants in their sample \( n = 56 \) showed moderate to profound intellectual impairment, with an overall mean mental age of 23 months. Table 1 summarizes the clinical characteristics of 22q13 Deletion Syndrome.
Table 1

*Clinical Characteristics of 22q13 Deletion Syndrome*

<table>
<thead>
<tr>
<th>Cognitive &amp; Language Characteristics</th>
<th>Fine and Gross Motor Skills</th>
<th>Behavioural Problems</th>
<th>Physical Features/Other Medical conditions</th>
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<tr>
<td>Moderate to profound cognitive impairments (Phelan et al., 2001; Phelan, 2008; Wilson et al., 2003)</td>
<td>Hypotonia</td>
<td>Stereotypic movements and interests</td>
<td>Normal to accelerated growth</td>
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<td>Absent/atypical expressive language (Cusmano-Ozog et al., 2007; Manning et al., 2004)</td>
<td>Deficits in motor functioning</td>
<td>Repetitive self-stimulatory actions</td>
<td>Dolicocephaly (elongated head)</td>
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<td>More developed receptive language (Cusmano-Ozog et al., 2007; Phelan, 2008)</td>
<td>(Phelan et al., 2001)</td>
<td>Poor eye-contact</td>
<td>Long eyelashes</td>
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<td></td>
<td></td>
<td>Self-injurious/aggressive behaviour</td>
<td>Dysplastic ears</td>
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<td></td>
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<td>Chewing of non-food items</td>
<td>Hypoplastic toe nails</td>
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<td></td>
<td></td>
<td>Tongue thrusting</td>
<td>Ptosis (droopy eyelids)</td>
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<td></td>
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<td>(Phelan et al., 2001; Phelan, 2008)</td>
<td>Relatively large hands</td>
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<td>Mild seizures</td>
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<td>Decreased sensitivity to pain</td>
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**22q13 Deletion Syndrome as a subtype of autism spectrum disorders.** Several studies have shown that 22q13 Deletion Syndrome and ASD have overlapping features such as language impairments, stereotyped and maladaptive behaviours, and intellectual disabilities (Cohen et al., 2005; Cusmano-Uzog et al., 2007; Phelan et al., 2001; Manning et al., 2004). Phelan and colleagues (2001) reported that 17 of the 18 participants with 22q13 Deletion Syndrome scored in the autistic range on the Childhood Autism Rating Scale (CARS). In another study, Manning and colleagues (2004) reported that 5 of 11 participants with 22q13 Deletion Syndrome have autistic-like features such as a lack of socialization and repetitive self-stimulatory actions. Jeffries et al. (2005) reported that 23 out of 27 of the participants met the criteria for autistic disorder on the Social Communication Questionnaire (SCQ). Recent genetic studies also found that a proportion of children with ASD have a mutation on SHANK3, a gene located at 22q13.3 (Durand et al., 2007; 2008; Leboyer, 2008). Together these data support the hypothesis 22q13 Deletion Syndrome is a subtype of ASD (Cohen et al., 2005; Durand et al., 2007).

**Language Development in Typically Developing Children**

Language can be defined as “any symbol system for the storage and exchange of information” (Coplan, 1995, p. 91). It is commonly described in terms of expressive and receptive abilities, whereby expressive language refers to the use of words to meaningfully communicate a message to others, and receptive language refers to the comprehension of spoken, written, or signed language (Coplan, 1995). The early communicative skills believed to be involved in language acquisition include receptive language skills (e.g., Tomasello & Bates, 2001), gesture use (e.g., Acredolo, & Goodwyn, 1988; Bates, Benigni, Bretherton, Camaioni & Volterra, 1979; Iverson & Goldin-Meadow, 2005), and the development of phonetic and
articulation skills (e.g., Tomasello & Bates, 2001). In typically developing children, these early language skills develop early and follow a rapid trajectory.

As infants develop, they acquire a range of cognitive skills and a developing ability to segment speech into meaningful units (Lieven, 2006). Children comprehend language early on and by 7 to 9 months of age, they can selectively attend to their own name when spoken by an adult (Coplan, 1995). They produce their first recognizable words between 10 and 18 months of age (Fenson et al., 1994; Lieven, 2006) and can respond to one-step commands without a gestural cue from an adult at about 12 months (Coplan, 1995). Between 18 and 20 months, the development of expressive vocabulary accelerates, and typically developing children experience what is referred to as the "vocabulary burst" (i.e., a rapid increase in the number of new words used) (Thal & Tobias, 1994). This stage is an important turning point in development as children can now understand the referential nature of words as opposed to learning them by association (Nazzi & Bertoninci, 2003). This growth in vocabulary is often accompanied by word combinations and an increase in multiword utterances (Thal & Tobias, 1994). Parallel to the development of expressive language, receptive skills also mature and by 24 months of age toddlers are able to follow novel two-step commands (Coplan, 1995). The period of 18 to 24 months is also when toddlers begin to develop conversational ability, and begin to understand the "conversational obligation" to answer speech with speech (Tager-Flusberg et al., 2005).

Grammatical skills begin to grow rapidly between the ages of 24 to 30 months, and utterance length also increases (Thal & Tobias, 1994). In general, the preschool period (from 2 to 5 years) is the time during which typically developing children’s language evolves from simple two-word utterances to fully grammatical forms (Tager-Flusberg et al., 2005). Although children have acquired most of the sentence structure of their language by the age of five,
and conversational abilities continue to develop into the school years (Tager-Flusberg et al., 2005).

In typically developing children, language skills emerge early on in development and follow a rapid trajectory. Although individual differences exist, the acquisition of language is a remarkably organized process (Tager-Flusberg et al., 2005).

**Language Development in Children with Autism**

There is enormous variation in the timing and patterns of language development in children with ASD (Tager-Flusberg, Paul, & Lord, 2005). Language skills range from no speech to little functional communication to relatively well-developed syntactic capabilities and expressive language skills (Wilkinson, 1998). A small proportion of children with ASD do not show any significant delays in the onset of language milestones. However, most individuals with autism begin to speak late and develop speech at a slower rate than typically developing children (Le Couteur et al., 1989).

Many studies have shown that as early as 12 months of age, young children with autism are less responsive to their names or to someone speaking (Lord, 1995) and are also less responsive to their mother’s voice compared to typically developing children (Klin, 1991). Between two to three years of age, the development of communication in children with autism is generally characterized by reduced frequency and diversity of forms of communication such as complex babbling, gestures, words, and word combinations (Landa, 2007; Mitchell et al., 2006).

Retrospective studies have found that many children with autism lose language skills during the second and third year of life (e.g., Luyster et al., 2005; Ozonoff, Williams, & Landa, 2005; Short & Shopler, 1988). Regression of language skills occurs most commonly between 18 and 24 months of age, and in about 20% to 33% of all cases of autism (Luyster et al., 2005).
Most research examining language skills of children with autism focus on expressive language skills, as opposed to receptive language skills. Some studies suggest that expressive language abilities are relatively spared compared to receptive abilities (e.g., Bartak, Rutter, & Cox, 1975; Charman, Drew, Baird, & Baird, 2003), while others suggest no difference between expressive and receptive language skills (e.g., Jarrold, Boucher, & Russell, 1997; Kjelgaard & Tager-Flusberg, 2001). Rutter, Mawhood, and Howlin (1992) propose that the reported advantage in expressive language skills in children with autism may reflect difficulties in testing comprehension skills due to lack of social responsiveness. Charman and colleagues (2003) examined early language development in preschool-age children with autism using the parent report measure, The MacArthur Communicative Development Inventory (CDI). They found that, despite being significantly delayed in both word comprehension and production compared to typically developing children, word production was more advanced than word comprehension in children with autism. Paul et al. (2004) suggest that receptive language skills are depressed relative to expressive skills in the second year of life, although this gap narrows in the third to fourth year and receptive skills become almost equal to expressive skills.

Thus, there is great variation in the development of language skills in children with ASD (Tager-Flusberg et al., 2005). Although it is well established that most individuals with autism acquire language later and at a slower rate than typically developing children, research on receptive language skills in this population is inconsistent.

**Language Development in Children with 22q13 Deletion Syndrome**

Severe language deficits are a hallmark of 22q13 Deletion Syndrome; however, few studies to date have examined language development in this population. Manning and colleagues (2004) reported that all 11 individuals with 22q13 Deletion Syndrome in their study had severe
expressive speech delay. Jeffries et al. (2005) replicated these findings and reported absence or severe delay in language in 26 out of 26 children with 22q13 Deletion Syndrome. Phelan et al. (2001) found that all 36 children in their sample had global developmental delay and language skills consistent with their general cognitive abilities.

Cusmano-Ozog et al. (2007) summarized findings from several studies and found that severe language impairment with little to no speech or significant speech delay is present in nearly all individuals with 22q13 Deletion Syndrome. They report that some children may begin to babble and develop limited vocabulary but that many lose these language skills as they get older. Although loss of language skills is common, most individuals can communicate by other means, such as a communication board. Cusmano-Ozog and colleagues found that receptive language skills exceed expressive language, and that individuals are often able to follow one-step commands.

**Gesture Development in Typically Developing Children**

Gestures are produced by individuals from all cultural and linguistic backgrounds and emerge in young children before they acquire language (Bates, 1976; Iverson & Goldin-Meadow, 1998). However, researchers have found that gestures do not develop uniformly. Different types of gestures show different developmental trajectories (Guidetti & Nicoladis, 2008; Nicoladis, 2002). One of the reasons for this is that gestures are defined and classified differently across studies (Guidetti & Nicoladis, 2008; Mayberry & Nicoladis, 2000). As well, stable identification and measurement of gesture use in children can be difficult to obtain (Guidetti & Nicoladis, 2008). Although researchers may use different classification systems for children’s gestures, there are commonalities across systems (Guidetti & Nicoladis, 2008). Gestures can be broadly divided into “early” and “late” gestures, with early gestures being those
that typically develop before 12 months of age (deictic and ritualized request gestures) and late gestures those that develop after 12 months of age (recognitory and symbolic gestures) (see Fenson et al., 2007).

**Early gestures.** Typically developing children’s earliest gestures emerge at around 10 months of age, the same time that word comprehension begins to develop. These gestures are known as deictic gestures and include actions such as directing adult attention to objects by holding them up or giving them to an adult, and pointing at objects to indicate interest or need (Bates, 1976; Rowe, Özcalışkan, & Goldin-Meadow, 2008). These showing, giving, and pointing gestures indicate referents in the immediate environment (Iverson & Goldin-Meadow, 2005). They are primitive in terms of their representational sophistication, as the referential meaning is clear only if the viewer follows the gesture’s path to its target (Goodwyn, Acrodolo, & Brown, 2000). Deictic gestures are one of the most frequent types of gestures observed in children’s spontaneous behaviour from infancy to about four years of age (Guidetti & Nicoladis, 2008).

Ritualized request gestures develop in children between 9 and 12 months of age. Ritualized requests include behaviours such as reaching with an open-close grasping motion, placing an adult's hand on an object to move or request it, and pulling at an empty hand to obtain something (Bates et al., 1979). These gestures differ from deictic gestures in that their function is to request objects as opposed to using objects as a method of obtaining adult attention (Capone & McGregor, 2004).

Bates et al. (1979) categorized infants’ early deictic and ritualized request gestures according to the purposes in which children use them to intentionally communicate with adults. Gestures that request adult behaviour to help obtain an object or a goal (e.g., placing an adult's hand on an object to move or request it or opening and closing hand to request an object) are
labelled imperative gestures. Gestures that request adult’s attention (e.g., holding up an object to give or show it to an adult) are labelled declarative gestures.

**Late gestures.** At around 12 months of age, gestures related to play begin to develop (Capone & McGregor, 2004). These play schemes are typically referred to as recognitory gestures. Examples of recognitory gestures include a child carrying out an action on a toy or depicting a toy in terms of its function, such as pretending to drink from an empty cup. These gestures are instrumental in that the referent (i.e., the toy or object) is being manipulated. Researchers have debated whether this type of gesture appropriately represents proper gestures, as it does not necessarily meet communicative and symbolic status criteria (Acredolo & Goodwyn, 1988). Tomasello, Striano, and Rochat (1999) argued that while 12-month-old infants can readily imitate adult actions on objects, they do not understand these gestures or intend them the same way as adults. However, McCune-Nicolich (1981) argued that play schemes illustrate an infant’s capacity for symbolic representation in similar ways to spoken words. The child’s appropriate use of objects distinguishes these actions from the earlier undifferentiated responses of younger children and signals an emerging representational capacity (Fenson, Kagan, Kearsly, & Zelazo, 1976; Fenson et al. 2007).

Another type of gesture, representational/symbolic gesture, emerges between 12 and 24 months and has many labels such as iconic, empty-handed, or referential gestures (Capone & McGregor, 2004; Nicoladis, 2002). Representational gestures can be defined as gestures that symbolically represent objects, events, desires, and conditions in order to communicate with others (Acredolo & Goodwyn, 1988). These typically appear in children’s gestural repertoire by 24 months of age and are usually accompanied by similar-meaning speech (McNeill, 1985; Nicoladis et al., 1999). Representational gestures differ from deictic gestures “in that they
symbolize a precise referent and their basic semantic content remains relatively stable across different situations” (Iverson, Capirci, & Caselli, 1994, p. 25). Representational gestures also differ from recognitory gestures because they do not typically manipulate a referent (such as a toy or object), as is the case with recognitory gestures (Capone & McGregor, 2004). However, some researchers postulate that later play schemes such as a child pretending to be a parent (e.g., feeding a stuffed animal or putting stuffed animal to bed) are among the first types of true symbolic gestures (e.g., Fenson et al., 2007). Goodwyn, Acredolo, and Brown (2000) operationally defined symbolic gestures using the following criteria:

(a) spontaneous use by the child (i.e., not following direct modeling or elicitation), (b) occurrence in a stereotyped form, and (c) use in reference to multiple exemplars of the underlying concept beyond the specific context in which the item was initially taught. For example, the use of a panting gesture for “dog” has to be extended beyond labelling just the family dog, and use of a gesture for “more” has to be extended beyond a particular routine such as asking for more cookies (p. 90).

Examples of symbolic gestures include flapping arms to represent a bird's flight and blowing to indicate that something is hot because they carry meaning in their form to symbolize a referent, and that form does not change with context (Capone & McGregor, 2004).

Another important milestone in the development of gestures occurs during the 3 to 5 year age range (Goodwyn, Acredolo, & Brown, 2000). Researchers have documented a change across this time period in how children represent an action in pantomime, such as brushing one's teeth or writing with a pencil (e.g., Boyatzis & Watson, 1993; O'Reilly, 1995). Boyatzis and Watson (1993) examined gestures in 3 and 5 year old children and found that older children produce more imaginary object gestures and fewer body-part-as-objects (BPO) gestures. In addition, 3-
year-olds can easily imitate BPO but not imaginary object pantomimes. In other words, younger children tend to depend on a body part to represent the actual tool (e.g., they will use their index finger as a toothbrush). However by 5 years of age, children's representational abilities have matured and children are able to produce the action by itself as if the tools were being used (e.g., moving their hands as if holding a toothbrush) (Goodwyn et al., 2000). By this time, children are skilled enough at distancing a symbol from its referent that they do not seem to need a concrete symbol of the tool (Goodwyn et al., 2000).

In typically developing children, gestures emerge early on in development and follow a predictable trajectory (Capone & McGregor, 2004). The first intentional use of communication is via deictic and ritualized request gestures, followed by symbolic play schemes and representational gestures. It is clearly established that gestures become more symbolic and decontextualized as children age. Table 2 summarizes early and late gestures as measured by the MacArthur Communicative Development Inventory.
Table 2

Early and Late Gestures as Measured by the MacArthur Communicative Development Inventory

<table>
<thead>
<tr>
<th>EARLY GESTURES</th>
<th>LATE GESTURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(First Communicative Gestures &amp; Early Games and Routines)</td>
<td>(Actions with Objects, Pretending to be Parent, &amp; Imitating Other Adult Actions)</td>
</tr>
<tr>
<td>10 months</td>
<td>9-13 months</td>
</tr>
<tr>
<td>Deictic gestures (showing, giving, pointing) e.g., “extends arm to show something he/she is holding”; “points at some interesting object or event”</td>
<td>Ritualized request gestures e.g., “extends arm to be picked up”; “requests something by extending arm and opening and closing hand”</td>
</tr>
<tr>
<td>Conventional or protosymbolic gestures e.g., “shakes head no”; “waves bye-bye”</td>
<td></td>
</tr>
</tbody>
</table>

Gesture Development in Children with Autism

Although gestural communication develops early and in sequence in typically developing individuals, this is not the case in individuals with autism (Buffington, Kranz, McLannahan, & Poulson, 1998). In general, children with autism demonstrate a disordered pattern of communication that includes deficits in the use and understanding of nonverbal forms of communication (Stone, Ousley, Voder, Hogan, & Hepburn, 1997).

**Early gestures.** Researchers have found that children with autism differ from typically developing children both quantitatively (e.g., Landry & Loveland, 1989; Mundy, Sigman, & Kasari, 1990) and qualitatively in their use of gestures (e.g., Wetherby & Prutting, 1984; Wetherby, Yonclas, & Bryan, 1989). Researchers have compared communication skills in
children with autism to developmentally matched children and have found that the two groups communicate for different reasons and use different nonverbal behaviours to communicate (Stone et al., 1997). Gestures in children with autism are often isolated acts in that they are less integrated with utterances than in typically developing prelinguistic children (Landa, 2007).

Ricks and Wing (1975) were among the first researchers to identify the specific impairments in declarative gestures (gestures to direct attention) in contrast to relatively more spared development of imperative gestures (requesting gestures) in children with autism. These findings were confirmed by several researchers who showed that although children with autism can communicate for the purpose of requesting objects or actions, they communicate less often for the purpose of establishing joint attention, or directing another person's attention toward an object to indicate interest (Mundy, Sigman, Ungerer, & Sherman, 1986; Mundy et al., 1990; Sigman et al., 1986; Wetherby & Prutting, 1984; Wetherby et al., 1989).

**Late gestures.** Although many researchers have examined early deictic gestures in children with autism, little research has been conducted on the development of late recognitory and representational gestures in this population. Many children with autism have a limited ability to develop symbolic or pretend play (Wetherby, Prizant, & Hutchinson, 1998). While pretend play and gestures are not considered to be identical social-communicative skills, many play schemes involve the use of symbolic gestures (see Acredolo & Goodwyn, 1988, for a review). Caselli (1994) argued that the actions used in symbolic play schemes qualify as gestures, as they are frequently used by the child to communicate in many situations and contexts in which words are produced.

Wing et al. (1977) first directly examined pretend play in autism and found decreased frequency of spontaneous pretend play in this population. These findings were replicated by
Sigman and Ungerer (1984), who found that children with autism showed less diverse functional play, particularly directed toward dolls, and less symbolic play both spontaneously and after cueing. It is now established that children with autism show significant deficits in symbolic play and limited abilities in functional play (Rutherford & Rogers, 2003; Rutherford, Young, Hepburn, & Rogers, 2007; Sigman & Ungerer, 1984; Wetherby & Prutting, 1984).

Mitchell et al. (2006) found that children with ASD produced fewer early and late gestures (as measured by the CDI) at 12 months compared with non-ASD siblings and typically developing children. However this study did not examine the difference between early and late gesture development. More research on early versus late gesture development needs to be conducted in order to tease apart the qualitative differences in gesture impairment in this population.

**Gesture Development in Children with 22q13 Deletion Syndrome**

Many studies have described the clinical features of 22q13 Deletion Syndrome in detail (e.g., Phelan et al., 2001; Manning et al., 2004); however no studies to date have examined the development of nonverbal forms of communication such as gestures in this population.

Hypotonia (poor muscle tone) is present in approximately 97% of individuals with 22q13 Deletion Syndrome (Phelan et al., 2001; Phelan, 2008). Hypotonia leads to later atypical motor functioning such as delayed gross and fine motor milestones. Researchers have found that in children with Down syndrome, poor muscle tone contributes to delayed motor development, which “restricts opportunities to explore and learn about the environment in order to form the foundation of language content” (Marder & Cholmáin, 2006, p. 497). Thus, infants with low muscle tone may experience constraints in developing the cross-modal imitation skills that facilitate gestures and word learning (Marder & Cholmáin, 2006). Based on these findings,
children with 22q13 Deletion Syndrome are hypothesized to have impairments in gestures. More research is needed to better understand the nature of gesture impairments in children with 22q13 Deletion Syndrome and how this is related to the development of language in this population.

**Association Between Gesture and Language in Typically Developing Children**

Across development, gestures are thought to serve several functions, including those of communication, compensation, and transition to language production (Capone & McGregor, 2004). In typically developing populations, gestures and language development parallel each other and share underlying symbolic abilities (Capone & McGregor, 2004). However, a growing body of evidence suggests that gestures not only parallel language but may also facilitate its development (Capone & McGregor, 2004).

The earliest correlations between language and gesture occur at 9 to 10 months, when infants begin to understand words and begin to communicate using both words and gestures (Thal & Tobias, 1994). Researchers have found correlations between receptive language and the use of early deictic gestures such as giving, pointing, and showing (Bates et al., 1979; Thal & Tobias, 1992); gestural play routines such as pattycake (Bates et al., 1979); and late recognitory gestures (Bates et al., 1979). As well, researchers have found correlations between expressive language and the use of both deictic and representational gestures (Acredolo & Goodwyn, 1988; Capirci et al., 1996). Table 3 summarizes the associated language and gesture milestones in typically developing children.

**Receptive language and gestures in typically developing children.** Fenson et al. (1994) examined the relationship between gestures and language skills in typically developing children between 8 and 16 months of age, and found strong correlations between gestures and language comprehension ($r = .54$), but not between gestures and language production ($r = .28$).
when controlling for mental age. This pattern may due to the order in which these skills typically emerge in children; however, Fenson and colleagues suggest that gestures may serve as a bridge between language comprehension and language production with gestures scaffolding language from comprehension to production.

**Receptive language and early gestures.** Deictic gestures emerge along with first signs of language comprehension around 9 to 10 months of age (Thal & Tobias, 1992; 1994). A specific link between pointing gestures and receptive language skills was proposed by Harris, Barlow-Brown, and Chasin (1995), who found a significant correlation between the first production of pointing and comprehension of object names in 10 to 11 month old babies. Similar findings were obtained by Butterworth and Morrisette (1996), who found that age of pointing was correlated with the number of animal sounds understood at 14 months. Studies with older children have found this same relationship. For example, Morford and Goldin-Meadow (1992) showed that pointing gestures facilitated children's comprehension of simple spoken sentences in children 15 to 29 months of age. Tfouni and Klatzky (1983) found these same results in children 35 to 50 months of age.

**Receptive language and late gestures.** Gestures and receptive language continue to be correlated into the preschool years (Capone & McGregor, 2004). A longitudinal study by O'Reilly, Painter, and Bornstein (1997) examined the relationship between overall receptive language development and symbolic gestures in typically developing children 24 to 48 months of age and found that the ability to engage in a play scheme at 24 months was related to receptive language abilities at 36 months. This is consistent with recent findings by Rowe and colleagues (2008), who found that the number of different meanings children conveyed with their gestures at 14 months was significantly related to the size of their receptive vocabularies at 42 months.
This relationship held even after controlling for the number of different spoken words that the children produced at 14 months. Thus, there is evidence supporting the facilitating function of both early and late gestures in receptive language skills in typically developing children.

Expressive language and gestures in typically developing children. Gestures are also correlated with the development of expressive language skills. Many studies have shown that gestures not only facilitate but also predict later expressive language skills (e.g., Acredolo & Goodwyn, 1988; Iverson & Goldin-Meadow, 2005). However, there is no consensus as to whether early deictic or late recognitory and representational gestures are most predictive of later expressive language skills.

Expressive language and early gestures. Evidence for a link between early pointing gestures and language acquisition has been obtained in a number of longitudinal studies. A study by Camaioni, Castelli, Longobardi, and Volterra (1991) demonstrated that pointing at 12 months strongly predicted later language production at 20 months in Italian speaking toddlers. Iverson and Goldin-Meadow (2005) examined early gesture use and vocabulary development in English speaking toddlers and found that specific items that will enter a child’s verbal lexicon can be predicted based on that child’s earlier gestures. Specifically, children produced a deictic pointing gesture for an object an average of 3 months before producing the word for that object. As well, children who were first to produce gesture-plus-word combinations were also first to produce two-word combinations. Based on these findings, Iverson and Goldin-Meadow suggest that “early gestures may be paving the way for future language development” (p. 367).

A longitudinal study by Iverson, Capirci, Volterra, and Goldin-Meadow (2008) examined gesture and speech production in typically developing Italian and American children between the ages of 10 and 24 months. They found that while Italian and American children differed in the
composition of their early gesture repertoires (American children produced primarily deictic gestures and relatively few representational gestures, whereas Italian children produced a larger repertoire of representational gestures), this difference did not influence when Italian and American children first used gestures along with speech. In both cultures, gesture-speech combinations predicted the onset of two-word utterances. However, both Italian and American children used deictic gestures almost exclusively in their gesture-word combinations. These results suggest that deictic rather than representational gestures are essential to gesture-word combinations. Together, these findings support the hypothesis that early gestures play a predictive role in later language development.

Expressive language and late gestures. Contrary to findings by Iverson et al. (2008), other studies have found that iconic gestures are related to children’s future expressive language development. Acredolo and Goodwyn (1988) found that children who produced more symbolic (iconic) gestures at 19 months had larger vocabularies at 24 months than children who produced fewer symbolic gestures. These findings were replicated by Capirci et al. (1996), who found that single gestures and gesture-word combinations produced at 16 months of age were significantly correlated with total vocal production at 20 months. In particular, there was a significant relationship between the combinations of representational gestures with representational words at 16 months and total vocal production at 20 months. However, the study has limited generalizability due to its small sample \((n = 12)\) of Italian speaking children.

Some studies suggest that iconic gestures are more dependent on competent speaking abilities than deictic or conventional gestures (Nicoladis, 2002). Nicoladis, Mayberry, and Genessee (1999) examined the relationship between gestures and language proficiency in English-French bilingual children 24 to 42 months and found that iconic gestures were tightly
linked to the development of spoken language, whereas deictic gestures were not. Specifically, the rate of iconic gestures was correlated with proficiency in each language as measured by MLU (Mean Length Utterance; the average number of words per utterance). Likewise, researchers suggest that it is typically deictic or conventional gestures (as opposed to iconic gestures) that compensate for weak or absent language (Nicoladis, 2002), suggesting that the use of iconic gestures is more strongly associated with expressive language skills. Thus, there is evidence supporting the predictive function of both early and late gestures in expressive language skills in typically developing children, although there is no consensus as to which type of gestures is the most predictive of later language skills.

**Conclusions.** Researchers have shown that children’s gestures are related to both receptive and expressive language skills in typically developing children (Rowe, Özcalişkan, & Goldin-Meadow, 2008). The evidence presented supports the “integrated system” hypothesis (Goldin-Meadow, McNeill, & Singleton, 1996; McNeill, 1985), which proposes that gesture and speech form an integrated communication system for the single purpose of linguistic expression. However, there is little agreement as to the function of gestures within this system. As evidenced by their association to receptive and expressive language, gestures may serve both a facilitating and predictive function in language development in typically developing children. To date, there is no consensus as to whether early deictic or late recognitory and representational gestures are most predictive of later language skills.
<table>
<thead>
<tr>
<th>Age</th>
<th>Language Milestones</th>
<th>Correlated Gestures</th>
<th>Example of gesture</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-13 months</td>
<td>Word comprehension</td>
<td>Deictic gestures (giving, showing, pointing)</td>
<td>Directing adult attention to objects by holding them up or giving them, pointing at objects to indicate interest or need (Bates, 1976; Rowe, Özçalişkan, &amp; Goldin-Meadow, 2008)</td>
<td>Bates et al., 1979; Masur, 1982; Thal &amp; Tobias, 1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ritualized request gestures</td>
<td>Reaching with an open-close grasping motion, placing an adult's hand on an object to request its movement, or pulling at an empty hand to get something (Bates et al., 1979)</td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td>Word production</td>
<td>Recognitory gestures (play schemes)</td>
<td>Carrying out an action on a toy or depicting a toy in terms of its function, such as pretending to drink from an empty cup or to sniff a pretend flower (Capone &amp; McGregor, 2004)</td>
<td>Bates, 1979; Bates et al., 1979</td>
</tr>
<tr>
<td>12-24 months</td>
<td>Word production, word combinations</td>
<td>Representational gestures (representational, symbolic, iconic, empty-handed, or referential gesture)</td>
<td>Flapping arms to represent a bird's flight or blowing to indicate that something is hot (Capone &amp; McGregor, 2004)</td>
<td>Acredolo &amp; Goodwyn, 1988</td>
</tr>
</tbody>
</table>
How does gesture play a role in language development? Although researchers have established the predictive value of gestures on later expressive language skills, there is no unified theory as to why this is. One theory put forth is that gestures reflect skills responsible for vocabulary learning (Rowe, Özçalişkan, & Goldin-Meadow, 2008). In other words, gestures may act as a signal that children are ready to build their vocabulary, but do not play a direct role in the process (Rowe, Özçalişkan, & Goldin-Meadow, 2008). Some researchers hypothesize that children’s readiness to learn a word (as evidenced by their gestures) elicits particular responses from their caregivers which facilitates vocabulary learning (e.g., Goldin-Meadow et al., 2007). This hypothesis is supported by past research findings that showed that mothers' labelling responses to pointing significantly predicted the size of their children's object-naming vocabularies (Masur, 1982). More recently, Goldin-Meadow et al. (2007) examined maternal responses to their child’s gestures and speech and found that all mothers translated their children’s gestures into words, which may provide well-timed models for how one- and two-word ideas can be expressed in speech. Thus, gestures may act as a mechanism by which children point out their thoughts to their caregivers, who in turn calibrate their speech to those thoughts, potentially facilitating language-learning.

Alternatively, gestures may also play a more direct role in vocabulary learning by providing children with the opportunity to refer to objects whose labels they are not yet able to express in speech (Sauer, Levine, & Goldin-Meadow, 2010). In this view, gestures are a part of the learning mechanism itself, as they are thought to facilitate cognitive changes in children (Rowe, Özçalişkan, & Goldin-Meadow, 2008). Gestures are suggested to act as a “cognitive crutch” (Goldin-Meadow, 2000, p. 232) because they allow children to explore ideas that may be difficult or developmentally inappropriate for them to think through verbally.
Gestures may facilitate language acquisition by allowing children to elicit input targeted to their level, which in turn, shapes their learning environments (Sauer et al., 2010). On the other hand, gestures may play a more direct role in language acquisition by providing children with the opportunity to refer to objects whose labels they are not yet able to express using words (Sauer et al., 2010).

**Dissociation between language and gesture in typically developing children.**

Although the development of language and gestures is considered to be parallel, some researchers suggest that there are important dissociations within language which have an effect on certain gestures. The critical variable in determining the dissociation between language and gesture seems to be the presence and amount of contextual support that is available (Bates & Dick, 2002).

Researchers (e.g., Bates, Bretherton, Snyder, Shore, & Volterra, 1980; Bates et al., 1989) have found a significant dissociation between language comprehension and language production in the early stages of development, and that each of these appears to be associated with a different type of gesture (Thal & Tobias, 1994). For example, Bates et al. (1979) showed that in 13-month-old children, language production is correlated with single recognitory gestures with limited contextual support, whereas language comprehension is correlated with single and multiple gestures in a familiar script. In other words, language and gestures are related in different ways depending on the amount of contextual support and whether the focus is language comprehension or language production.

The role of context on the correlation between language and gestures has important methodological implications. Researchers have shown that the nature and direction of the correlation between language and gesture depends on how these are measured (Bates & Dick,
2002; Bretherton & Bates, 1984; Bretherton et al., 1984). Specifically, the link between word comprehension and gesture production is most apparent when they are assessed in a strongly supporting context, such as naturalistic observations and/or parent report (Bates & Dick, 2002). This is because under these conditions, word comprehension and gesture production dissociate from word production, whereas under experimental conditions (i.e., little or no contextual support), both word comprehension and gesture production are correlated with word production (Bates & Dick, 2002).

These findings emphasize the fact that associations between language skills and gestures found at one point in development may not be there at an earlier point and may not be found again at a later point (Thal & Tobias, 1994). They also point to importance of considering context when assessing the correlation between gesture and language.

**Association Between Gesture and Language in Children with Autism**

Although numerous studies have found that children with autism differ from typically developing children both quantitatively and qualitatively in their use of gestures (Buffington et al., 1998), few researchers have examined the association between language and gestures in this population. Recent research findings suggest that the developmental relationship between speech and gesture in ASD is similar to typically developing children, while allowing for a delay (Sowden, Perkins, & Clegg, 2008). However these conclusions are based on two case studies and thus the results cannot be generalized to all children on the autism spectrum. To date, there is little empirical research that has examined the value of gestures in predicting language development in children with autism.

Charman and colleagues (2003) examined the pattern of development of word comprehension and expression, and production of early and late gestures in preschool children
with ASD. They found that children with ASD had higher levels of gesture production than word comprehension compared to typically developing children, although the acquisition of gestures was not consistent across the five subcategories of gestures (as measured by the CDI). The production of early gestures (deictic, ritualized request, and conventional gestures) was significantly more delayed than that of late gestures (recognitory, early symbolic, and representational gestures). Given their deficits in symbolic play schemes and symbolic gestures, these findings contradicted expected findings that children with ASD would show most difficulties in the late as opposed to early gestures (Charman et al., 2003). Additionally, when examining the association between language and gestures, Charman et al. found similar patterns to typically developing children (see Fenson et al., 1994). Specifically, Charman and colleagues found strong concurrent correlations between gestures and language comprehension \((r = 0.54)\) but not between gestures and language production \((r = .04)\) in preschool children with ASD when controlling for mental age. Charman and colleagues concluded that similar to typically developing children, gestures may act as a bridge from word comprehension to word production in children with ASD.

In a recent study, Luyster et al. (2008) investigated the relationship between language acquisition and nonverbal methods of communication in 164 toddlers (18 to 33 months of age) with ASD. They found that both receptive and expressive language skills were significantly correlated with a range of general and social cognitive variables and motor skills. Significant predictors of receptive language included gestures, non-verbal cognitive ability, and response to joint attention. For expressive language, the most significant predictors were non-verbal cognitive ability, gestures, and imitation. Luyster and colleagues concluded that gesture use was the most robust social cognitive predictor of receptive and expressive language skills.
Specifically, moderate to strong correlations were observed between receptive language skills and gestures ($r = .65$), and expressive language and gestures ($r = .55$). These findings suggest that gestures may be “the most significant social communication predictor of overall language” in children with autism spectrum disorders (Luyster et al., 2008, p. 1435). However, researchers used only one of the five gesture sections on the MacArthur-Bates Communicative Development Inventories (CDI; Fenson et al., 2007) to measure the core construct “gesture mastery”. Items in this section include early deictic and ritualized request gestures; however they exclude the later recognitory and symbolic gestures found in the last three sections of the CDI.

Although it is established that children with autism differ from typically developing children in the type and frequency of gestures used, the relationship between language and gestures in this population is not clearly understood. More research in this area needs to be conducted in order to examine the relationship between specific types of gestures and language in this population.

**Intervention for language development**

Children with ASD have been found to be responsive to interventions that target specific skills and behaviours (National Research Council [NRC], 2001, as cited by Tager-Flusberg et al., 2009). Many studies have demonstrated the effects of early intervention on language development for children with ASD (see Rogers & Vismara, 2008, for a review). It is especially important to examine and better understand the positive effects of intervention on language development, as the acquisition of spoken language is one of the most important variables predicting better outcomes in later childhood and adulthood (Tager-Flusberg et al., 2009).

**Gesture as an intervention for language.** Past research has found that efforts to increase gesture use in typically developing toddlers have led to increases in receptive and expressive
language skills (e.g., Acredolo & Goodwyn, 1988; Iverson & Goldin-Meadow, 2005). Work with clinical populations, including children with specific language impairment (Ellis Weismer & Hesketh, 1993), Down syndrome (Abrahamsen, Cavallo, & McCluer, 1985), and autism (Buffington, Krantz, McClannahan, & Poulson, 1998) shows that gestures can be used to compensate for deficits in expressive language and may facilitate language learning (Capone & McGregor, 2004). Despite this, few investigators have examined the effectiveness of gesture as a part of intervention protocols (Capone & McGregor, 2004).

Whalen and Schreibman (2003) taught children with autism to initiate showing and pointing gestures using a combined structured and naturalistic approach. The researchers found that these skills generalized to both structured and unstructured assessments with the experimenter and the children’s mothers. The children also showed an increase in other social-communication skills, including spontaneous speech, social initiations, imitation, and play (Whalen & Schreibman, 2003). Although it is important to consider the study’s small sample size ($n = 4$), these results still suggest that gestures can be taught to children with autism and that teaching the use of gestures can have an effect on the development of other social-communication behaviors. More research with larger samples is required in order to better understand the value of using gestures in language-based interventions.

**Objectives and Rationale of Current Study**

Gestures are related to both receptive and expressive language skills in typically developing children (Rowe, Özçalişkan, & Goldin-Meadow, 2008). However, there is little agreement as to the function of gestures within the language-gesture system. The association between gestures and receptive language supports the facilitating function of gestures and the association between gestures and expressive language supports the predictive function of
gestures on language development. There is no consensus on whether early deictic or late
recognition and representational gestures are most associated with expressive language skills in
typically developing children.

Although there are now many studies that describe the relationship between gestures and
the language system in typically developing children, relatively little is known about the nature
and early development of the gesture-language system in children with developmental disorders
involving specific profiles of language impairment. Researchers have proposed that early deictic
and conventional gestures, and not late representational gestures, compensate for weak or absent
language (Nicoladis, 2002). However no study to date has specifically examined early versus late
gestures in children with language impairments.

The current study builds on findings by Charman et al. (2003) and Luyster et al. (2008)
and examines the association between expressive language skills, receptive language skills, and
the use of gestures in children with autism and 22q13 Deletion Syndrome. Specifically, this
study examines whether children with autism and 22q13 Deletion Syndrome have similar
patterns of association between language and gestures, and which types of gestures (early deictic
and ritualized request gestures or late recognition and symbolic gestures) are most associated
with language skills in these groups.

It is expected that gestures will be associated with language skills in children with autism.
Previous research findings by Fenson et al. (1994) and Charman et al. (2003) suggest that
gestures are associated with receptive language skills (and not expressive language skills) in both
typically developing children and children with ASD. However, Luyster et al. (2008) found that
gestures were associated with both receptive and expressive language skills in children with
ASD. Given the lack of consensus within the small number of research studies on children with
autism, no prediction can be made on whether gestures will be associated with receptive and expressive language skills, or only receptive skills in children with autism. Furthermore, given the lack of research examining early versus late gestures in this population, it is not possible to predict whether early or late gestures will be most associated with language skills in children with autism.

To date, there is no research examining language and gestures in children with 22q13 Deletion Syndrome. However, many studies have shown that autism and 22q13 Deletion Syndrome have overlapping features, which include speech and language disorders, stereotyped and maladaptive behaviours, and intellectual disabilities (Cusmano-Ozog et al., 2007; Phelan et al., 2001; Manning et al., 2004). Given their similar deficits, children with 22q13 Deletion Syndrome are expected to show similar patterns of association between language and gestures as children with autism.

There are several important reasons for investigating language and nonverbal communication in children with autism and other disorders such as 22q13 Deletion Syndrome. Research has established that both children with autism (Tager-Flusberg et al., 2005) and children with 22q13 Deletion Syndrome (Cusmano-Ozog et al., 2007) have variability in their language skills. As well, language and gestures are correlated in both typically developing children and in children with autism, with gestures possibly enhancing language development (Capone & McGregor, 2004). To date, there is no research examining language and gestures in children with 22q13 Deletion Syndrome. Given the variability in language skills and the known link between language and gestures, examining language-related skills such as gestures can help identify markers for different language outcomes in both children with autism and children with 22q13 Deletion Syndrome. As well, studying children with autism and 22q13 Deletion Syndrome.
 Syndrome will contribute to the broad understanding of the association between gestures and language by providing information about the development of gestures in the face of specific profiles of language delay and/or impairment.

Previous research suggests that the factors that are important for language development in children with ASD are similar to those observed in typically developing children (Luyster et al., 2008). As well, some research findings suggest that children with 22q13 Deletion Syndrome are a major subtype of children with ASD (Durand et al., 2007; Philippe et al., 2008). An examination of the association between gestures and language in children with autism and 22q13 Deletion Syndrome will address questions about whether the association between gestures and language in children with autism is qualitatively similar or dissimilar to that observed in children with 22q13 Deletion Syndrome and typically developing children.

Finally, efforts to increase the production of gestures in typically developing toddlers have led to increases in receptive and expressive language skills (e.g., Acredolo & Goodwyn, 1988; Iverson & Goldin-Meadow, 2005). Examining the relationship between language and gestures in children with autism and 22q13 Deletion Syndrome might aid in designing more effective early interventions that facilitate language development in these populations. Understanding the role of gestures in the development of language is especially important because the emergence of spoken language is one of the most important variables predicting better outcomes in later childhood and adulthood (Lord & Venter, 1992; Tager-Flusberg et al., 2009).


Current Study Hypotheses

1. Gestures will be associated with language skills in children with autism.
   Given the lack of consensus within the small number of research studies on children with autism, no prediction can be made on whether gestures will be associated with both receptive and expressive skills, or only receptive language skills in children with autism. Furthermore, given the lack of research examining early versus late gestures in this population, it is not possible to predict whether early or late gestures will be most associated with receptive and expressive language skills in children with autism.

2. Children with autism and children with 22q13 Deletion Syndrome will show similar patterns of association between language and gestures.

Method

Participants

There were a total of 46 participants in this study: 18 children with a confirmed prior diagnosis of autistic disorder and 28 children with a genetic confirmation of 22q13 Deletion Syndrome between 3 to 17 years of age. A validated diagnosis of autism includes a prior evaluation based on an ADI-R, ADOS, and DSM-IV diagnostic criteria. A validated diagnosis of 22q13 Deletion Syndrome includes cytogenetic, molecular cytogenetic, and/or molecular demonstration of loss or disruption of chromosome region 22q13.3 which contains the SHANK3/ProSAP2 gene (Phelan, 2008). Children with 22q13 Deletion Syndrome were chosen as a comparison group because of their overlapping features with autism such as speech and language impairments, stereotyped and maladaptive behaviours, and intellectual disabilities. As well, recent evidence suggests that 22q13 Deletion Syndrome may be a subtype of ASD (Durand et al., 2007; Philippe et al., 2008). All children with autism were recruited from the Montreal,
Quebec area through advertisements placed in a Montreal Newspaper and Toronto, Ontario area through advertisements placed on autism support websites. All children with 22q13 Deletion Syndrome were recruited from an external database of families with 22q13 Deletion Syndrome available to the laboratory of Dr. Steven Shaw (The Resilience, Pediatric Psychology, and Neurogenetic Connections Laboratory). Participants must have scored 70 or less on the Communication Scale of the Developmental Profile 3 (DP-3; Alpern, Boll, & Shearer, 2007) in order to be included in the study. All families of children with autism and 22q13 Deletion Syndrome speak English as a first language in the home.

Children with autism included 14 boys and 4 girls. Children with 22q13 Deletion Syndrome included 11 boys and 17 girls. The mean chronological ages of children with autism and children with 22q13 Deletion Syndrome were 83.4 months and 103.2 months, respectively; mean mental ages were 34.7 months and 21.6 months, respectively (see Table 4). Children with autism and children with 22q13 Deletion Syndrome did not differ significantly in chronological age, $t(44) = -1.539, p = ns$, but differed in mental age as measured by the age equivalent score on the cognitive scale of the DP-3, $t(44) = 2.63, p = .012$. Boys and girls did not differ in their mean mental ages in the autism group, $t(16) = .12, p = ns$, or in the 22q13 Deletion Syndrome group, $t(26) = -1.84, p = ns$. 
Table 4

Socio-Demographic Characteristics of Children with Autism and 22q13 Deletion Syndrome.

<table>
<thead>
<tr>
<th></th>
<th>Autism</th>
<th>22q13 Deletion Syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Males (#)</td>
<td>14</td>
<td>-</td>
</tr>
<tr>
<td>Females (#)</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Chronological Age (mts)</td>
<td>83.40</td>
<td>37.98</td>
</tr>
<tr>
<td>Mental Age (mts)</td>
<td>34.70</td>
<td>17.93</td>
</tr>
</tbody>
</table>

Materials

Parents or legal guardians of children with autism and 22q13 Deletion Syndrome completed four questionnaires: one developmental questionnaire, one demographic questionnaire, and three verbal and nonverbal communication questionnaires.

Demographic information. Parents completed a demographic questionnaire consisting of questions about their child’s diagnosis/diagnoses, medication use, services and/or therapy received, and languages understood and spoken in the home. This questionnaire was completed online using the survey design tool Survey Monkey. This program guarantees that all responses are kept private and confidential and that the web links sent to participants are encrypted using the Verisign certificate Version 3, 128 bit encryption.

Intellectual ability. The Developmental Profile 3 (DP-3; Alpern et al., 2007) is a norm-referenced parent/caregiver checklist that screens for developmental delay. This questionnaire
was used to determine participants’ eligibility and to measure participants’ mental ages. The Communication scale consists of 34 questions that measure expressive and receptive communication skills. Participants with standard scores of more than 70 on the Communication scale were excluded from the study. The Cognitive scale consists of 38 questions which measure perception, concept development, number relations, reasoning, memory, classification, time concepts, and related mental acuity tasks. Standard scores on this scale were used to measure participants’ mental age.

**Gestures and language skills.** The MacArthur Communicative Development Inventory (CDI; Fenson et al., 2007) is a norm-referenced parent/caregiver questionnaire that assesses early verbal and non-verbal communication skills in children between the ages of 8 and 30 months. There are two versions of this measure: (a) the Words and Gestures version (CDI-WG), intended for typically developing children between 8 and 16 months of age, and (b) the Words and Sentences version (CDI-WS), intended for typically developing children between 16 and 30 months of age. The CDI is widely used in research with typically developing children and some atypical samples, as it is the parent report scale of early language competence with the most complete standardization data (Charman et al., 2003). As well, it has fair agreement with standard observational assessments and direct testing (Fenson et al., 2007; Luyster, Qiu, Lopez, & Lord, 2007).

The CDI-WG was used to measure receptive language (defined as words understood), expressive language (defined as words produced), and early and late gestures. The early gestures section (A = first communicative gestures, B = games and routines) includes deictic gestures (e.g., “extends arm to show something he/she is holding”), ritualized request gestures (e.g., “extends arm to be picked up”; “requests something by extending arm and opening and closing
hand”), and conventional or protosymbolic gestures (e.g., “waves bye-bye on his/her own when someone leaves”), all which emerge by 12 months of age in typically developing children (Fenson et al., 2007). The late gestures section (C = actions with objects, D = pretending to be a parent, E = imitating other adult actions) includes recognitory gestures (e.g., “puts telephone to ear” and symbolic/representational gestures (e.g., pretends to be parent by “putting stuffed animal to bed”, “blows to indicate something is hot”), all which emerge between 12-24 months of age in typically developing children (Fenson et al., 2007). The CDI-WS was used to measure later expressive language skills such as words produced, sentences produced, and sentence complexity.

The Receptive-Expressive Emergent Language Test-Third Edition (REEL-3; Bzoch, League, & Brown, 2003) is a norm-referenced parent/caregiver checklist designed to assess communication and language skills in typically developing children from birth to 36 months of age. This questionnaire was adapted for children with disabilities and used as a secondary measure of expressive and receptive language skills. Given that the CDI and REEL-3 may assess receptive and expressive language skills differently, they will be treated as separate variables in the analyses.

A problem encountered in the assessment of children with certain developmental disabilities is that they often have low levels of language comprehension and production and thus many standard language measures may not be appropriate (Charman et al., 2003). Previous research suggests that the CDI is an appropriate instrument to use with populations that have developmental delays and disabilities (e.g., Charman et al., 2003; Mervis & Robinson, 2000). The CDI is a particularly useful measure for children with ASD, as it addresses the floor effects that may be encountered when using standardized, observational measures of receptive and
expressive language (Luyster et al., 2007). As well, this measure contains a vocabulary checklist based on parent report, which makes it appropriate for children who may not demonstrate the full range of their language skills during a laboratory-based assessment (Luyster et al., 2007). The mean mental ages and mean communication mental ages of the participants in this study required measures that assess early verbal and non-verbal development. Thus, while all three of the above measures usually assess typically developing children ages 0 to 36 months, their application was modified in order to be used with children with autism and 22q13 Deletion Syndrome.

Procedure

Upon a confirmed diagnosis of autism and 22q13 Deletion Syndrome, participants who expressed interest in taking part in this study were contacted and mailed a consent form and screener questionnaire. Upon receipt of the signed consent form and screener questionnaire, eligible participants were sent a link to an online demographics questionnaire. Participants were then sent a package consisting of three questionnaires that assess language and gestures.

Results

To examine the relationships between gestures and language skills, partial correlations between receptive language skills, expressive language skills, early gestures, and late gestures were computed for children with autism and 22q13 Deletion Syndrome. Mental age was correlated with receptive language, expressive language, and gestures. Specifically, mental age was correlated with REEL-3 receptive language skills, $r(18) = .57, p < .05$, CDI receptive language skills, $r(18) = .75, p < .001$, REEL-3 expressive language skills, $r(18) = .75, p < .001$, CDI expressive language skills, $r(18) = .80, p < .001$, and late gestures, $r(18) = .69, p < .001$, in children with autism. Mental age was also correlated with REEL-3 receptive language skills, $r(28) = .80, p < .001$, CDI receptive language skills, $r(18) = .86, p < .001$, REEL-3
expressive language skills, $r(28) = .78, p < .001$, CDI expressive language skills, $r(18) = .65, p < .001$, early gestures, $r(28) = .80, p < .001$, and late gestures, $r(28) = .82, p < .001$, in children with 22q13 Deletion Syndrome. Thus, mental age was treated as a covariate and controlled for when computing the correlations.

**Group Differences in Language and Gestures**

Overall, children with autism and 22q13 Deletion Syndrome had comparable levels of language and gestures (see Table 5). Both groups had similar mean levels of REEL-3 receptive language, $t(44) = 1.12, p = \text{ns}$, CDI receptive language, $t(44) = 1.78, p = \text{ns}$, REEL-3 expressive language, $t(44) = .92, p = \text{ns}$, CDI expressive language, $t(44) = 1.54, p = \text{ns}$, early gestures, $t(44) = 1.67, p = \text{ns}$, late gestures, $t(44) = 1.10, p = \text{ns}$, and total gestures, $t(44) = 1.41, p = \text{ns}$. Both children with autism and children with 22q13 Deletion Syndrome had significantly higher levels of late gestures than early gestures, $t(17) = -5.87, p < 0.001$ and $t(27) = -5.22, p < 0.001$, respectively.
Table 5

Mean Levels of Receptive Language, Expressive Language, and Gestures in Children with Autism and 22q13 Deletion Syndrome.

<table>
<thead>
<tr>
<th></th>
<th>Autism</th>
<th>22q13 Deletion Syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>REEL-3 receptive language</td>
<td>38.78</td>
<td>13.82</td>
</tr>
<tr>
<td>REEL-3 expressive language</td>
<td>32.38</td>
<td>11.83</td>
</tr>
<tr>
<td>CDI receptive language</td>
<td>245.67</td>
<td>121.69</td>
</tr>
<tr>
<td>CDI expressive language</td>
<td>136.50</td>
<td>154.71</td>
</tr>
<tr>
<td>Early gestures</td>
<td>9.89</td>
<td>3.53</td>
</tr>
<tr>
<td>Late gestures</td>
<td>21.78</td>
<td>10.27</td>
</tr>
<tr>
<td>Total gestures</td>
<td>31.67</td>
<td>12.73</td>
</tr>
</tbody>
</table>

In the autism group, boys and girls did not differ in their mean levels of REEL-3 receptive language, \( t(16) = .65, p = \text{ns} \), CDI receptive language, \( t(16) = -.051, p = \text{ns} \), REEL-3 expressive language, \( t(16) = .19, p = \text{ns} \), CDI expressive language, \( t(16) = -.343, p = \text{ns} \), early gestures, \( t(16) = .24, p = \text{ns} \), late gestures, \( t(16) = .38, p = \text{ns} \), or total gestures, \( t(16) = .38, p = \text{ns} \). However, in the 22q13 Deletion Syndrome group, boys and girls differed in their mean levels of REEL-3 receptive language, \( t(26) = -2.46, p = .021 \), CDI receptive language, \( t(26) = -2.35, p = .027 \), REEL-3 expressive language, \( t(24) = -3.70, p = .001 \), CDI expressive language, \( t(16) = -
3.10, \( p = .007 \), early gestures, \( t(23) = -4.03, p = .001 \), late gestures, \( t(20) = -4.90, p < 0.001 \), and total gestures, \( t(20) = -4.92, p < 0.001 \). Mental age and gender were not correlated in this group, \( r(28) = .34, p = \text{ns} \). As well, boys and girls in the 22q13 Deletion Syndrome group did not differ in mental age, \( t(26) = -1.84, p = \text{ns} \). To date, no gender differences in language ability have been reported in this population. Thus, the gender difference may be caused by sampling error due to the small sample size (\( n = 28 \)); more research needs to be conducted to explore this phenomenon.

**Relationship Between Language and Gestures**

*Language and gestures in children with autism.* In children with autism, moderate correlations were observed between REEL-3 receptive language skills and early and late gestures. As shown in Table 6, moderate to strong correlations were observed between CDI receptive language skills and late gestures. Contrary to findings using the REEL-3, no significant correlation was found between CDI receptive skills and early gestures. No significant correlations were found between expressive language skills (as measured by the REEL-3 and CDI) and early or late gestures (see Table 6).

The linearity of the significant relationships between language and gestures was examined using bivariate scatterplots. Overall, receptive language and gestures have a positive linear relationship (see Figures 1-3).

Squared partial correlation coefficients (\( r^2 \)) were calculated for significant correlations in order to measure the proportion of variance of one variable explained by the second variable while controlling for mental age. Early gestures accounted for 40.8% of the variance in receptive language skills as measured by the REEL-3. As well, late gestures accounted for 38.8% and 24.7% of the variance in receptive language skills as measured by the REEL-3 and CDI, respectively.
To examine which types of gestures (early deictic and ritualized request gestures or late recognitory and symbolic gestures) were most associated with language skills, Neill and Dunn’s $z$-test (1975) was used to compare correlations within the group (see Hittner & May, 1998; Hittner, May, & Silver, 2003). There were no significant differences in the relationship between early and late gestures and CDI receptive language skills, CDI expressive language skills, REEL-3 receptive language skills, REEL-3 expressive language skills, $z = -.40, p = \text{ns}, z = -.78, p = \text{ns}, z = .086, p = \text{ns}, z = -.67, p = \text{ns}$, respectively.

Table 6

*Correlations between Language and Gestures Controlling for Mental Age in Children with Autism*

<table>
<thead>
<tr>
<th></th>
<th>REEL-3 receptive</th>
<th>CDI receptive</th>
<th>REEL-3 expressive</th>
<th>CDI expressive</th>
<th>Early gestures</th>
<th>Late gestures</th>
</tr>
</thead>
<tbody>
<tr>
<td>REEL-3 receptive</td>
<td>1.0</td>
<td>.38</td>
<td>-.12</td>
<td>-.12</td>
<td>.64**</td>
<td>.62**</td>
</tr>
<tr>
<td>CDI receptive</td>
<td>-</td>
<td>1.0</td>
<td>.02</td>
<td>.48</td>
<td>.41</td>
<td>.50*</td>
</tr>
<tr>
<td>REEL-3 expressive</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>.47</td>
<td>.22</td>
<td>.39</td>
</tr>
<tr>
<td>CDI expressive</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>.18</td>
<td>.37</td>
</tr>
<tr>
<td>Early gestures</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>.48</td>
</tr>
<tr>
<td>Late gestures</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
</tr>
</tbody>
</table>

* $p < .05$, ** $p < .01$, *** $p < .001$
Figure 1. Scatterplot of the relationship between CDI receptive language and late gestures in children with autism

Figure 2. Scatterplot of the relationship between REEL-3 receptive language and early gestures in children with autism
Language and gestures in children with 22q13 Deletion Syndrome. Overall, children with 22q13 Deletion Syndrome showed a different pattern of association between language and gestures (see Table 7). As in children with autism, children with 22q13 Deletion Syndrome showed moderate correlations between REEL-3 receptive language skills and early and late gestures. Moderate correlations were also observed between CDI receptive language skills and late gestures. Contrary to findings using the REEL-3, no significant correlation was found between CDI receptive skills and early gestures. This same pattern emerged in children with autism. However, unlike children with autism, moderate correlations were found between early and late gestures and expressive language skills as measured by the REEL-3. No significant correlations were found between CDI expressive language skills and early or late gestures (see Table 7).
The linearity of the significant relationships between language and gestures was examined using bivariate scatterplots. Overall, language and gestures have a positive linear relationship (see Figures 4-8).

Squared partial correlation coefficients ($r^2$) were calculated for significant correlations in order to measure the proportion of variance of one variable explained by the second variable while controlling for mental age. Early gestures accounted for 31.5% and 23.1% of the variance in REEL-3 receptive skills and expressive skills, respectively. Late gestures accounted for 16.0%, 36.2%, and 39.3% of the variance in CDI receptive skills, REEL-3 receptive skills, and REEL-3 expressive skills, respectively.

To examine which types of gestures (early deictic and ritualized request gestures or late recognitory and symbolic gestures) were most associated with language skills, Neill & Dunn’s $z$-test (1975) was used to compare correlations within the group (see Hittner & May, 1998; Hittner, May, & Silver, 2003). There were no significant differences found in the relationship between early and late gestures and CDI receptive language skills, CDI expressive language skills, REEL-3 receptive language skills, REEL-3 expressive language skills, $z = -.20, p = ns$, $z = .25, p = ns$, $z = -.32, p = ns$, $z = -1.10, p = ns$, respectively.
Table 7

*Correlations between Language and Gestures Controlling for Mental Age in Children with 22q13 Deletion Syndrome*

<table>
<thead>
<tr>
<th></th>
<th>REEL-3 receptive</th>
<th>CDI receptive</th>
<th>REEL-3 expressive</th>
<th>CDI expressive</th>
<th>Early gestures</th>
<th>Late gestures</th>
</tr>
</thead>
<tbody>
<tr>
<td>REEL-3 receptive</td>
<td>1.0</td>
<td>.48*</td>
<td>.64***</td>
<td>.21</td>
<td>.56**</td>
<td>.60***</td>
</tr>
<tr>
<td>CDI receptive</td>
<td>-</td>
<td>1.0</td>
<td>.61***</td>
<td>.47*</td>
<td>.37</td>
<td>.40*</td>
</tr>
<tr>
<td>REEL-3 expressive</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>.75***</td>
<td>.48*</td>
<td>.63***</td>
</tr>
<tr>
<td>CDI expressive</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>.33</td>
<td>.29</td>
</tr>
<tr>
<td>Early gestures</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>.65***</td>
</tr>
<tr>
<td>Late gestures</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*p < .05, ** p < .01, *** p < .001
Figure 4. Scatterplot of the relationship between CDI receptive language and late gestures in children with 22q13 Deletion Syndrome

Figure 5. Scatterplot of the relationship between REEL-3 receptive language and early gestures in children with 22q13 Deletion Syndrome
Figure 6. Scatterplot of the relationship between REEL-3 receptive language and late gestures in children with 22q13 Deletion Syndrome

Figure 7. Scatterplot of the relationship between REEL-3 expressive language and early gestures in children with 22q13 Deletion Syndrome
Figure 8. Scatterplot of the relationship between REEL-3 expressive language and late gestures in children with 22q13 Deletion Syndrome

**Discussion**

In the current study, the patterns of association between gestures and language skills in children with autism were compared to children with 22q13 Deletion Syndrome. The objectives of this study were to examine whether children with autism and 22q13 Deletion Syndrome have similar patterns of association between language and gestures, and which types of gestures (early deictic and ritualized request gestures or late recognitory and symbolic gestures) were most associated with language skills in these groups.

**Relationship Between Language and Gestures in Children with Autism**

It was expected that gestures and language skills would be associated in children with autism. Results partially confirmed this hypothesis, as receptive language skills were strongly associated with both early and late gestures, whereas expressive language skills were not associated with gestures. This overall pattern of association is consistent with findings by Charman et al. (2003), who found large correlations between gestures and language.
comprehension but not between gestures and language production in preschoolers with ASD when controlling for mental age. However, this contradicts findings by Luyster et al. (2008), who found that gestures were a significant predictor of both receptive and expressive language skills in toddlers with ASD.

**Receptive language skills and gestures.** The relationship between receptive language skills and both early and late gestures is consistent with that of typically developing infants and toddlers (e.g., Butterworth & Morrisette, 1996; Harris et al., 1995; Morford & Goldin-Meadow, 1992; O'Reilly et al., 1997; Rowe et al., 2008; Tfouni & Klatzky, 1983). Fenson et al. (1994) found large correlations between gestures and language comprehension, but not between gestures and language production when controlling for mental age in typically developing infants. Fenson and colleagues concluded that gestures may serve as a bridge between language comprehension and language production, with gestures scaffolding language from comprehension to production. Charman et al. (2003) confirmed the bridge hypothesis in children with ASD and concluded that “in children with autism spectrum disorders, as in typical development, increased comprehension is a route to later increased production, and gestures are the bridge to this transition” (p. 232).

The findings from this study are consistent with Charman et al., suggesting that the same may be true for children with autism. Thus, as in young typically developing children, gestures may serve a facilitating function in children with autism.

Children with autism may continue to use gestures as they age as a means of supporting their limited communication skills. In typically developing children, gesture production declines as a function of increasing age and spoken lexical competence (Stephanini et al., 2009). However, in this study, gestures were associated with receptive language skills in school-aged children.
with autism (mean CA = 83 months), suggesting that gestures may continue to act as a compensatory or scaffolding device in children with language impairments.

Evidence in support of this hypothesis comes from research on children with atypical language development. For example, Singer Harris et al. (1997) examined profiles of language and gesture development in 12 to 76 month old children with Down Syndrome (DS). They found that children with DS had larger gestural repertoires relative to typically developing children at similar comprehension and word production levels, suggesting that children with DS “may compensate for their poverty of spoken language by the use of gestures” (p. 365). These findings were replicated by Stefanini, Caselli, and Volterra (2007), who examined gestures and lexical production in 3 to 8 year old Italian children with DS. Stefanini and colleagues found that the total number of gestures produced was higher in children with DS and younger typically developing children than in chronological age-matched controls. These findings have also been established in children with other types of disabilities. For example, Botting, Riches, Gaynor, and Morgan (2010) examined gesture production and comprehension in 4 to 7 year old children with specific language impairment (SLI). They found that older children with SLI showed stronger associations between gestures and language than age-matched typically developing children. In other words, gestures are more related to language development in children with DS and SLI than age-matched typically developing peers who have outgrown earlier reliance on gestures. In the current study, the pattern of correlation between receptive language skills and gestures is similar to typically developing infants, suggesting that children with autism may continue to use gestures as a means of supporting their limited language abilities. Longitudinal studies with larger samples and with typically developing comparison groups are needed in order to further investigate this hypothesis.
**Expressive language skills and gestures.** Many studies have found that early and late gestures facilitate and predict later expressive language skills in typically developing children (e.g., Acredolo & Goodwyn, 1988; Camaioni et al., 1991; Capirci et al., 1996; Iverson & Goldin-Meadow, 2005; Iverson et al., 2008). However, in the current study, gestures were not correlated with expressive language skills in children with autism. This may be explained in part by the variation in the timing and patterns of language acquisition among children with autism. Some researchers have suggested that children with ASD have a similar although delayed developmental relationship between language skills and gestures (Sowden, Perkins, & Clegg, 2008). Thus, it is possible that the relationship between expressive language skills and gestures in this sample is simply delayed and will emerge if examined longitudinally. Alternatively, it is also possible that the relationship between expressive language and gestures is not only delayed but rather deviant from the typically developing trajectory. Longitudinal research examining this relationship needs to be conducted to examine the development of expressive language skills and gestures in this population.

**Relationship Between Language and Gestures in Children with 22q13 Deletion Syndrome**

Given their similar deficits, children with 22q13 Deletion Syndrome and children with autism were expected to show similar patterns of association between language and gestures. However, contrary to what was expected, children with 22q13 Deletion Syndrome showed a different pattern of association between language and gestures. Similar to children with autism, receptive language skills were strongly associated with both early and late gestures in this group. However, gestures were also associated with expressive language skills as measured by the REEL-3 in this group. There were no significant correlations between gestures and expressive
language skills as measured by the CDI. A possible explanation for this inconsistency is that the two measures of language measure expressive language skills differently.

As in young typically developing children, gestures may serve a facilitating function in children with 22q13 Deletion Syndrome. In typically developing children, gesture production decreases as children age and become proficient in their language (Stephanini et al., 2009). In the current study, the pattern of correlation between receptive language skills and gestures is similar to typically developing infants, suggesting that children with 22q13 Deletion Syndrome may continue to use gestures as a means of supporting their limited language abilities. Longitudinal studies with larger samples and with typically developing comparison groups are needed in order to further investigate this hypothesis.

Given the absence or low levels of language skills in the majority of individuals with 22q13 Deletion Syndrome, gestures are not expected to predict later expressive language skills as they do in typically developing children. However, it is possible that children with 22q13 Deletion Syndrome with higher levels of gestures will develop more advanced language skills than those who gesture less. Longitudinal research is needed to understand the complex relationship between gestures and expressive language skills in this population.

Thus, the profile of gestures and language in children with 22q13 Deletion Syndrome has similarities and differences to that of children with autism. Both groups had similar mean levels of language skills and gestural abilities and had significant positive correlations between receptive language skills and gestures. However positive correlations between expressive language skills and gestures were only observed in children with 22q13 Deletion Syndrome. The findings from this study show that children with autism and 22q13 Deletion have comparable abilities in language and gestures but differ in the way that these skills associate to one another.
Early Versus Late Gestures

One of the objectives of this study was to determine whether early deictic and ritualized request gestures or late recognitory and symbolic gestures were most associated with language skills in children with autism and 22q13 Deletion Syndrome. The production of early gestures was significantly more delayed than that of late gestures in both groups, however there were no significant differences in the relationships between language skills and early versus late gestures. In both groups, early and late gestures were strongly associated with language skills.

Some researchers suggest that early deictic and conventional gestures (as opposed to late iconic/symbolic gestures) compensate for weak or absent language (e.g., Nicoladis, 2002). Botting et al. (2010) suggest that children with language impairments use gestures to scaffold communication but did not differentiate between which types of gestures children use. Nicoladis (2002) examined how different kinds of gestures and speech are related in bilingual preschool children and found that children used a higher rate of iconic gestures in their more proficient language, whereas the use of other kinds of gestures did not differ by proficiency. These results suggest that the relationship between iconic gestures and speech is closer than that of other gestures, and that iconic gestures might be used as a compensatory strategy only when a language is well known. In other words, children’s production of iconic gestures may be dependent on their ability to produce complex speech and therefore are not used in the preschool years as a compensatory strategy for weak proficiency. Findings from this research study do not support this hypothesis, as both early and late gestures were associated with language skills in both groups.

Thus, despite their reported limitations in functional and symbolic play, as well as impairments in gestures to direct attention, children with autism show significant positive
correlations between both early and late gestures and receptive language skills. Children with 22q13 Deletion Syndrome also show positive correlations between early and late gestures and language skills. Both early and late gestures may be used as a compensatory strategy by children with language impairments.

**Implications for Practice in School Psychology**

Findings from this research study have theoretical implications for the broad understanding of language and gesture development in children with autism and 22q13 Deletion Syndrome, as well as practical implications for clinical assessment, educational curriculum, and intervention programs aimed at improving communication in all children with language impairments.

Understanding the development and association between language and gestures in children with specific profiles of language delay and/or impairment can help professionals make important decisions in clinical assessment (Crais, Watson, & Baranek, 2009). For example, clinicians can use early gestures diagnostically to identify children at-risk for language difficulties in the future (Goldin-Meadow, 2009). As well, researchers have shown that gesture development can be a key distinguishing feature in differentiating children with typical development from those with disabilities (e.g., Mundy, Kasari, Sigman, & Ruskin, 1995; Zwaigenbaum et al., 2005). Examining the pattern of gesture use across communicative functions such as language can also help distinguish between children with many other types of disabilities (Crais et al., 2009). Thus, although this study specifically addresses questions about the similarities and differences in gestures and language in children with autism and 22q13 Deletion Syndrome, its findings can inform differential diagnoses and clinical assessment in that
they explore an important area of qualitative difference between typical development and
disabilities as well as between various types of disabilities.

Findings from this research study also have practical implications for interventions aimed
at improving language and can help in creating or modifying educational programs and
curriculum for children with language impairments. By improving the knowledge base
concerning the relationship between language and gestures in children with language
impairments, researchers and clinicians can design early intervention programs that target
gestures in an effort to improve language development. Research found that efforts to increase
gesture use in typically developing toddlers led to increases in receptive and expressive language
skills (e.g., Acredolo & Goodwyn, 1988; Iverson & Goldin-Meadow, 2005). Results from the
current study support the hypothesis that early and late gestures serve a facilitating function in
children with autism and 22q13 Deletion Syndrome (as they do in young typically developing
children). Therefore, the production of gestures may be a “legitimate, indirect target for
intervention and one that will impact positively on later productive language competence”
(Charman et al., 2003, p. 232).

A large part of the current educational curriculum is accessed through oral or written
language (Botting et al., 2010). As a consequence, alternative means of supporting children with
language impairments in the classroom are needed (Botting et al., 2010). Gestures can be used in
the classroom to promote language development and facilitate learning in children with language
impairments. Goldin-Meadow et al. (2007) suggest that gestures may act as a mechanism by
which children point out their thoughts to adults in their environment, who in turn calibrate their
speech to those thoughts, potentially facilitating language-learning. Thus, an increased use of
gestures may not only help the child communicate more effectively, it can also provide parents,
teachers, and clinicians with more child output on which to build language and other communicative exchanges (Crais et al., 2009). Increasing the frequency and variety of developmentally appropriate gestures may also benefit all students in the classroom, as recent research suggests that gesturing can facilitate learning in general by helping children extract information from their own hand movements (e.g., Goldin-Meadow, Cook, & Mitchell, 2009).

Thus, assessing gesture development in children can help identify those at risk for language difficulties in the future as well as inform differential diagnoses. Incorporating gestures into early intervention programs can help facilitate language development and may even help promote learning in general. Teachers and educators can increase their gesture use as well as implement strategies in the classroom to increase student gesture use, which can help all students access the educational curriculum.

**Study Limitations**

One of the primary limitations of this study is the reliance on a parent report of language and gesture competence developed for young typically developing children. A disadvantage of this method is parental over-reporting, especially of comprehension of language skills or gestures, where contextual understanding of gestures or well rehearsed routines may be mistaken for language comprehension (Tomasello & Mervis, 1994). However, the CDI has fair agreement with standard observational assessments and direct testing (e.g., Charman et al., 2003; Fenson et al., 2007), and previous research has suggested that it is a valid instrument for use with populations with developmental disabilities (Luyster et al., 2007). The CDI can be a particularly useful measure for children with ASD, as it addresses the floor effects that may be encountered when using standardized, brief observational measures of receptive and expressive language.
(Luyster et al., 2007). Nonetheless, it is possible that the floor effects of this instrument mask important differences between the autism and 22q13 Deletion Syndrome groups.

A correlational study design was used to describe the patterns of association between language and gestures, therefore causation between these variables cannot be implied. As well, the small sample size limited the number of variables that could be controlled for in the partial correlation models. Mental age was the variable most strongly associated with all measures of language and gestures and thus a decision was made to control for mental age. Receptive and expressive language skills were not correlated in children with autism; however they were correlated in children with 22q13 Deletion Syndrome. It is possible that controlling for all variables correlated with language and gestures may lead to different and/or non-significant results.

Differences in data sets (e.g., age range, types of gestures examined) as well as in methodology and terminology make it challenging to compare findings across studies (Gullberg, de Bot, & Volterra, 2008). For example, certain studies with similar results to the current study (e.g., Charman et al., 2003) used slightly different methodology in that they controlled for multiple variables when examining the association between language and gestures. Thus, comparisons of current results with results from studies using different statistical analyses must be interpreted with caution.

This was a cross-sectional study and as a consequence, the effect of development on the relationship between language and gestures could not be examined. As in typically developing children, gestures may assume different roles with respect to language depending on the development of children with autism and 22q13 Deletion Syndrome.
Research findings show that there is cultural variation in the gesture repertoires found in young children (Iverson et al., 2008), however cross cultural differences were not explicitly controlled.

Finally, the sample of children with autism is not representative of the total autistic population because it excluded cases with Communication standard scores of over 70 (2 SD below the mean.) Thus, the results may not be generalizable to the total autistic population. Nevertheless, it is informative to study children with autism with significant language deficits as this is one of the core deficits in the disorder and thus may reveal what is specific and unique to the condition (Charman et al., 1997).

**Directions for Future Research**

Studies with larger samples are needed in order to examine the relationship between gestures and language while controlling for more than one covariate. Studies extending this line of research longitudinally are also needed in order to investigate how the association between language and gestures develops over time in children with autism and 22q13 Deletion Syndrome. Investigating particular domains of language such as mean length of utterances, grammatical skills, and pragmatic abilities in children with language impairments may provide more insight into the relationship between gestures and specific aspects of expressive language. Similarly, detailed qualitative analyses on gestures can help elucidate the nature and intent of gesture use and gesture comprehension in atypical populations. Finally, future studies may want to include children from different cultures and who speak different and/or multiple languages to investigate whether the current findings extend to diverse cultural and linguistic environments.
Conclusions

Gestures are a robust feature of communicative development in young children. It is well established that gestures and language are associated in young typically developing children, however little research has examined atypical populations. Results from this study show that children with autism and 22q13 Deletion Syndrome have comparable abilities in receptive language, expressive language, and gestures. However, the relationships between these skills are not identical in these groups. Both groups had significant positive correlations between receptive language skills and gestures; however positive correlations between expressive language skills and gestures were only observed in children with 22q13 Deletion Syndrome. As in young typically developing children, both early and late gestures may serve a facilitating function in children with autism and 22q13 Deletion Syndrome.

There is a theoretical and clinical need to understand the association between gestures and language development (Botting et al., 2010). Findings from this study have important implications for the current understanding of how gestures are involved in the comprehension and production of language in atypical populations as well as for clinical assessment, educational curriculum, and intervention programs.
References


Appendix A

Consent Form (Autism)

INFORMATION AND CONSENT FORM

Institution: Faculty of Education, McGill University

Title of Project: Development of precursory language skills, nonverbal communication skills, and joint attention for children with autism disorder: A longitudinal prospective approach

Project leader: Steven Shaw, Ph.D.

Other Investigators: Shohreh M. Rezazadeh (Ph.D. candidate) and Tia Ouimet (M.A. student)

Dear parent or legal tutor,

You have kindly agreed for us to contact you so that we can give you more information about our study. We are currently conducting a research project looking at early language skills in children. We are contacting you now because we would like to provide you with information about this project and ask you to consider participating in our study. The information included below reviews the purpose of the study and what will be required of you if you do decide to participate. Please take the time to read this information and feel free to discuss it with anyone from our research team. You will be given as much time as you need in order to make a decision about whether or not you would like to participate.

What is the purpose of the study?

The focus of this research project will be on identifying the proficiencies and deficiencies in one aspect of development that is undoubtedly a crucial component of a child’s learning experience - the development of basic language skills. The ability to use language to communicate is a fundamental ability that children acquire early in development. These early language skills allow children to acquire knowledge that will form the building blocks for later school achievement.

The objective of our research is to document the development of early language and nonverbal communication skills such as joint attention when such skills are developing and maturing. Joint attention is defined as the non-verbal communication between nonverbal children and caregivers through “intentional” meaningful gestures (for example, children will point to objects and nod their head to communicate intent and or interest).

What are the educational implications of our projects?

The knowledge gained from this research will help to understand the developmental progression of the critical skills involved in language development and how joint attention skills impact them. This knowledge will further allow for the creation of specific educational programs and curriculum for children with language disorders.

Who is organizing this study?

This is a research project supervised by Dr. Steven Shaw (Assistant Professor) of the Department of Educational and Counselling Psychology at McGill University, Shohreh M. Rezazadeh (Ph.D. candidate, McGill University), and Tia Ouimet (M.A. student). Dr. Shaw’s area of expertise is the study of the cognitive, language, and communication development of children with autism spectrum disorder and Phelan-McDermid syndrome.
What will I be required to do?

Upon your written consent and once we determine your child’s eligibility:

a) You will be sent the second package of questionnaires (consisting of four questionnaires in total, provided in a self-addressed envelope) that pertain to your child’s language use at home and behavior in specific situations.

> Each questionnaire will take 10-20 minutes to complete

b) You will receive an email from our team to begin completing online survey about your child’s language use. You will be required to complete a survey every two weeks for 12 months (a total of 24 surveys). These will be simple multiple choice questions. You will be provided with written information on how to complete the online survey and a number to call in case of any questions and or problems.

> Each diary will take 5-7 minutes to complete

c) Your child will be asked to engage in a semi-structured play activity with you, and videotaped. You will be provided with a script for the semi-structured play activity. You will receive a reminder email as to when to tape these sessions (approximately 1 every three months for a total of four videotapes). You will be asked to use your own camcorder to videotape each play session. If you do not have a camcorder available to you, you may rent one and we will compensate you for the rental. You must ensure that that the videotape captures you and your child at all times during the play activity. The purpose of the videotape is to assess your child’s nonverbal communication skills and joint attention skills (e.g., coordinated joint look, showing, giving to share, and pointing).

> This task will take 15 minutes

d) At the end of the study you will be asked to complete three final questionnaires.

You and your child’s participation in this study is voluntary and your child is allowed to refuse to participate in this task.

Privacy and Confidentiality

To ensure privacy of information:

1) All data sent to and from participants will be encrypted using commercially available software. In this fashion, the interactive website encrypts information and e-mail before participants send information to McGill. Confidential e-mails and e-mails containing identifying information will also be encoded using secure forms.

2) Information submitted via website and e-mail will be moved from the website and moved to a secured (not connected to internet) computer and secure external hard drive. This computer will physically stay in the laboratory on the McGill campus and is also password protected. Information will then be erased from the website.

In addition, the following lab policies will be communicated to all lab personnel in meetings and in writing. All data will be marked as “Confidential” when communicated in hardcopy or electronic form. Only those individuals (direct project team members, employees and non-employees) designated with approved access and appropriate trained in ethical management of data (via course work, readings, and laboratory discussions of research ethics).

To ensure confidentiality, your child will be assigned a file number, and all materials collected from your child will be labeled with only the case number. A list of the participant’s names with their assigned file numbers will be kept separately from the collected materials and stored in a locked cabinet at our research unit on the McGill University campus. Only the principal investigators (Shohreh M. Rezazadeh and Tia Ouimet), the research supervisor (Dr. Steven Shaw), and designated undergraduate research assistant will have access to this information. If and when the data is included in future academic presentations and publications, no mention of your child’s identity will be made and only
group results (i.e., group means) will be reported. As this is a research study, only information regarding your child’s general performance will be made available to you, upon request.

**Dissemination of Results**

The findings stemming from this study will be disseminated to a range of professions including special education, and health professions through a Master’s and a doctoral thesis, presentation at both national and international conferences, and Article(s) in peer-reviewed, scientific journals.

**Potential Harms and Risk**

There are no known physical or psychological risks inherent in this study. The questionnaires are simple to complete and the video recordings are simple and child friendly and will likely be enjoyable for the participants. In addition, the testing takes place at the comfort of your own home.

**I want to participate, what next?**

We have attempted to answer some of the questions you may have regarding you and your child’s participation in our study. If you agree to participate in this study, please sign the consent form below and return it to the address provided at the end of this letter (also found on the self-addressed envelope provided to you).

**Declaration of the parent or legal tutor:**

In signing this consent form, I recognize that all aspects of the study have been explained to me. I also agree that I have had the opportunity to ask questions about the study, and that all my questions have been answered satisfactorily.

I, __________________, have read the above description with one of the investigators, __________________. I have been fully informed about the procedures, advantages and disadvantages of the study. I freely and voluntarily consent to participate in this study.

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If you have any more questions or concerns please feel free to contact one of the research team members by using the information indicated below.

We thank you kindly for considering this request and hope that we can have your participation in this study. If you have any questions or concerns about your rights as a volunteer in this project you may contact the McGill Research Ethics Officer at 514-398-6831.
Sincerely,

Dr. Steven Shaw  
Assistant Professor  
Faculty of Education, McGill University  
3700 Rue McTavish, Room 614  
Montreal, Quebec, H3A-1Y2  
Tel: (514) 398-5833  
e-mail: Steven.shaw@mcgill.ca

Contacts:

Shohreh M. Rezazadeh (Ph.D. candidate)  
Tel: (514) 398-5833  
e-mail: maryam.rezazadeh@mail.mcgill.ca

Tia Ouimet (Master’s student)  
Tel: (514) 398-5833  
e-mail: tia.ouimet@mail.mcgill.ca
Appendix B

Consent Form (22q13 Deletion Syndrome)

INFORMATION AND CONSENT FORM

Institution: Faculty of Education, McGill University

Title of Project: Development of precursory language skills, nonverbal communication skills, and joint attention for children with Phelan-McDermid Syndrome: A longitudinal prospective approach

Project leader: Steven Shaw, Ph.D.

Other Investigators: Shohreh M. Rezazadeh (Ph.D. candidate) and Tia Ouimet (M.A. student)

Dear parent or legal tutor,

You have kindly agreed for us to contact you so that we can give you more information about our study. We are currently conducting a research project looking at early language skills in children. We are contacting you now because we would like to provide you with information about this project and ask you to consider participating in our study. The information included below reviews the purpose of the study and what will be required of you if you do decide to participate. Please take the time to read this information and feel free to discuss it with anyone from our research team. You will be given as much time as you need in order to make a decision about whether or not you would like to participate.

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What will I be required to do?

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a) You will be sent the second package of questionnaires (consisting of four questionnaires in total, provided in a self-addressed envelope) that pertain to your child’s language use at home and behavior in specific situations.

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In addition, the following lab policies will be communicated to all lab personnel in meetings and in writing. All data will be marked as “Confidential” when communicated in hardcopy or electronic form. Only those individuals (direct project team members, employees and non-employees) designated with approved access and appropriate trained in ethical management of data (via course work, readings, and laboratory discussions of research ethics).

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I, __________________, have read the above description with one of the investigators, __________________. I
have been fully informed about the procedures, advantages and disadvantages of the study. I freely and voluntarily
consent to participate in this study.

________________________________________________________________________
Name of participant          Signature of parent/legal tutor  Date
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Date of birth of participant
________________________________________________________________________
Name of witness                Signature of witness          Date
________________________________________________________________________
Name of investigator           Signature of investigator  Date

If you have any more questions or concerns please feel free to contact one of the research team members by using
the information indicated below.

We thank you kindly for considering this request and hope that we can have your participation in this study.

If you have any questions or concerns about your rights as a volunteer in this project you may contact the McGill
Research Ethics Officer at 514-398-6831.
Sincerely,

Dr. Steven Shaw
Assistant Professor
Faculty of Education, McGill University
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Tel: (514) 398-5833 Tel: (514) 398-5833
e-mail: maryam.rezazadeh@mail.mcgill.ca email: tia.ouimet@mail.mcgill.ca