The Effects of Gestures and Pictures on Word Acquisition and Use in Children with Autism Spectrum Disorders

by

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I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

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ABSTRACT

Although gestures have been found to aid the development of verbal communication, little is known about their influence on functional communication of young children with Autism Spectrum Disorders (ASD). This study explored the influence of iconic gestures on word acquisition and use specifically by children with ASD in contrast to using pictures. An iconic gesture-based teaching method was compared to a picture-based teaching method to support word acquisition and use. The study aimed to determine whether there was a difference in the number of trials taken to learn new words using either a gesture- or picture-based method, and whether any advantages would be maintained over time. In addition, it aimed to determine whether the two methods had differential effects on children’s spontaneous, unplanned vocalisations, eye contact with communicative partner, and on-task behaviours when being taught. Results indicated that there was an overall trend for the children to take longer to master a new word when using gestures compared to pictures. This was expected as the children involved had a history of using pictures in past communication programmes. However, it was unexpected that, after mastering gestures and pictures, when given a free choice all five participants chose to use gestures as their preferred mode of communication. Participants also produced significantly more spontaneous vocalisations, eye contacts and on-task behaviours during the gesture-based teaching and testing conditions compared to the picture-based conditions indicating engagement in more extensive,
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generalized communicative behaviour. Overall gains in communication skills due to word acquisition through the gesture-based and picture-based teaching programme were shown in improved scores on the Preschool Language Scale (5th Edition) and the communication subscale of the Gilliam Autism Rating Scale (2nd Edition). Overall, the results obtained encourage future research on the effects of including iconic gestures in teaching common words across mand and tact functions at early stages of intervention for young ASD children with minimal verbal skills.
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1. Introduction

Over the past two decades, there has been a global increase in the diagnosis of Autism Spectrum Disorder (ASD) (Fombonne, 2009; Parner et al., 2011) with close to a 20-fold increase reported in Western Australia reflecting more than 200 children newly diagnosed with ASD on a yearly basis (Glasson et al., 2008). ASD is a term widely used to define a group of disorders that display similar deficits in social communication and interaction as well as restricted patterns of behaviour or interest (American Psychiatric Association; APA, 2013). ASD is recognised as one of the most common neurodevelopmental disorders with an estimated 6 in 1000 children (Glasson et al., 2008) and close to 39.2 per 10,000 people meeting diagnostic criteria (Elsabbagh et al., 2012). With the rise in ASD diagnoses, research has intensified to increase understanding of the developmental trajectory of these children and, more importantly, add to the empirically supported base for behavioural interventions at an early stage to reduce the negative impact of poor social interaction, communication and restricted repertoires on this challenging population.

Studies with ASD populations have found that they display non-verbal communicative deficits from as young as 12 months old (Goodhart & Baron-Cohen, 1993; Warreyn, Roeyers, & de Groote, 2005) which lead to early pragmatic language problems and increasing difficulties in social interactions in later years (Thurm, Lord, Lee, & Newschaffer, 2007). In addition, evidence of delays in motor functioning resulting in lower production and integration of gestures and speech have also limited their ability to express emotions, make requests, engage in joint attention, and initiate and respond appropriately to others (Buffington, Krantz, McClannahan, & Poulson, 1998; Cihak, Smith, Cornett, & Coleman, 2012). Not only do these children have difficulty in social/interpersonal interactions, many of them display negative and challenging behaviour, such as tantrums, avoidance, and self-harming acts, due to their
difficulty with functional communications that lead to frequent misunderstanding and poor attachment with people around them (Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002; Durand & Carr, 1991; Falcomata, White, Muething, & Fragale, 2012; Landa, 2007).

The aim of this thesis is to provide an overview of ASD and the difficulties these children have, primarily exploring the relationship between gesture and later language development and acquisition. As this difficulty has been shown to impact many different areas of life, the introduction of iconic gesture as a possible teaching strategy to aid children in communication will be explored. In particular, the study will compare the use of iconic gestures to a picture-based teaching method for teaching children with ASD to use new words as mands (i.e., request) and tacts (i.e., labels) for functional and effective communication. As early intervention can lead to faster language development and increase positive behaviour (Itzchak & Zachor, 2011; Kaiser & Roberts, 2011), re-examining the role of iconic gestures, in particular in early word acquisitions, is very timely and essential (McGregor, Rohlfing, Bean, & Marschner, 2009; Rowe & Goldin-Meadow, 2009).

1.1. Autism Spectrum Disorders

In the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR; APA, 2000) there are five diagnoses within the spectrum of ASD, namely, Rett’s disorder, Childhood Disintegrative Disorder, Autism, Asperger’s Syndrome and Pervasive Developmental Disorders-Not Otherwise Specified (PDD-NOS). ASD is more commonly found in males, with females making up 18% of reported cases in Australia with a similar finding in USA (17% - 20%) (Australian Bureau of Statistics; ABS, 2011). More recently, the introduction of the DSM-5 (APA, 2013) has subsumed all individual categories into one broad term, collectively
recognised as ASD. The difficulties displayed in the triad of domains (i.e., social interaction, restricted behaviour and communication) have been further revised into two separate categories: restricted, repetitive behaviours or interest as well as the combination of social and communication deficits into one domain (Grzadzinski, Huerta, & Lord, 2013; McPartland, Reichow, & Volkmar, 2012). Although categorised differently, it is clear that individuals with ASD display problems with delayed motor functioning as well as poor social communicative ability, with research suggesting a closer link between both domains (Akechi, Kikuchi, Tojo, Osanai, & Hasegawa, 2013; Bhat, Landa, & Galloway, 2011; Grzadzinski et al., 2013; Luyster & Lord, 2009; Tager-Flusberg, Paul, & Lord, 2005).

1.1.1 Restrictive / Repetitive Behaviour and Motor Delay

It is well accepted that ASD populations generally display impairment in social interaction and communication and particularly restrictive or undeveloped communication. This is due to behavioural inflexibility and is often the first recognised symptom for a positive diagnosis (APA, 2000; DeGiacomo & Fombonne, 1998; Williams, Botting, & Boucher, 2008). These deficits range from mild to severe and at least one of these key symptoms must appear before 3 years of age (Llaneza et al., 2010; Tager-Flusberg et al., 2009) for a diagnosis to be given. A study conducted by Provost, Lopez and Heimerl (2007) compared children aged between 21 – 41 months with a diagnosis of ASD to children without ASD matched on gender, and chronological and mental age. They assessed motor skills using the Bailey Scales of Infant Development (BSID) II Motor Scale and the Peabody Developmental Motor Scales, 2nd Edition (PDMS-2) and found that children with ASD showed atypical motor development with delays present in both gross (e.g., jumping, balancing on one foot) and fine motor skills (e.g., grasping, eye-hand coordination) compared to the control
Colgan, Lanter, McComish, Watson, Crais and Baranek (2006) analysed social interaction gestures between typically developing (TD) and ASD children based on retrospective video analysis. They found that emergent gestures used by children at 9 – 12 months of age were lower in type and quantity for the ASD group compared to typically developing (TD) children. Furthermore, children who displayed a restricted variety of gestures were associated with a later diagnosis of ASD. It was suggested that it was not the quantity of gestures produced that was important but, rather, the variety and diversity of gestures produced at a young age that contributed to a diagnosis of ASD later in life (Colgan et al., 2006). This finding supports DSM-5 criteria indicating difficulties in use and production of non-verbal communication such as gestures are defining features of ASD (APA, 2013).

Ham, Bartolo, Corley, Rajendran, Szabo, & Swanson (2011) studied the ability of children with ASD to imitate and recognise different gestures including transitive (i.e., actual object use), intransitive (i.e., social gestures such as waving) and pantomimes (i.e., gestures that describe object use) and concluded that individuals with ASD had greater difficulty imitating actions of others compared to a control group. Furthermore, when comparing children with developmental delay and typically developing children to children with ASD, the ASD children displayed increased frequencies and severity of repetitive sensorimotor (RSM) behaviours (e.g., repetitive use of objects, insistence on sameness and rituals with resistance to change in the environment). The presence of these behaviours however was not necessarily predictive of later ASD diagnosis (Richler, Bishop, Kleinke, & Lord, 2007). Restricted and repetitive behaviours have also been examined across age groups with results suggesting that, although less severe and frequent in older individuals, these behaviours can be present throughout the life of an individual with ASD (Esbensen, Seltzer, Lam, & Bodfish, 2009).
1.1.2 Communication and Social Interaction

In relation to communication deficits, children with ASD tend to display difficulty in comprehension and verbal expression; developmental delays and deficits have been observed in a range of areas, such as prosody (McCann & Peppe, 2003; McCann, Peppe, Gibbon, O’Hare, & Rutherford, 2007), semantics (Eigsti & Bennetto, 2009), syntax (Gluer & Pagin, 2003) and pragmatics (Eigsti, de Marchena, Schuh, & Kelley, 2011; Gerenser, 2009). Furthermore, key developmental markers such as delays in verbal imitation (Ham et al., 2011; Ingersoll & Lalonde, 2010; Shih, Shen, Öttl, Keehn, Gaffrey, & Müller, 2010) and joint attention (Paparella, Goods, Freeman, & Kasari, 2011; Naber et al., 2008) have also been found to be prevalent in children with ASD. Although deficits in pragmatic language are a defining feature in ASD, recent literature has suggested that other aspects of language such as articulation, vocabulary and morphology are not core due to high variability among individuals with ASD (Grzadzinski et al., 2013; Tager-Flusberg et al., 2005).

Nevertheless, numerous studies have provided evidence in this population for language delay and later use that is often repetitive, non-reciprocal and with poor pragmatic skills (Armstrong & Jokel, 2012; Boucher, 2003; Chan, Cheung, Leung, Cheung, & Cheung, 2005; Chiang & Lin, 2008; Mundy, Sigman, Ungerer, & Sherman, 1986). Children with ASD typically produce words at 3 - 4 years of age compared to 8 - 14 months in typically developing children (Eigsti et al., 2011) and have a different trajectory of development compared to children without ASD. Some studies have suggested almost 35% - 50% of children with ASD remain ‘nonverbal’ (Bailey, Phillips, & Rutter, 1996; Gerenser, 2009) and others have found that only 40% - 45% acquire fluent and functional language (Luyster & Lord, 2009). However, a study of 1000 ASD children found that although they had a marked delay in language acquisition, only 9% remained nonverbal in later childhood (Hus, Pickles, Cook, Risi,
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& Lord, 2007). Building upon verbalisation, Chan and colleagues (2005) examined the language profile of children with ASD and found that children aged 5 - 6 years showed differing levels of expression and comprehension abilities indicating substantial language heterogeneity. This is in line with Rapin, Dunn, Allen, Stevens and Fein’s (2009) finding of four different clusters of language problems, refuting the theory of a single language disorder for children with ASD and indicating a wide range of deficits in expression and comprehension. Although there is a clear presence of more frequent language difficulties, a more positive outlook of eventual verbal behaviour for children with ASD can be expected with appropriate treatment.

1.2 Language Embedded in Motor Movements

Although ASD appears to be characterised by two different domains, the close link between movements such as gestures and eye contact and later language development has been well researched. Watson, Crais, Baranek, Dykstra and Wilson (2013) used retrospective video studies to compare gesture use between children with Autism, Developmental Disability (DD) and Typically Developing (TD) children. They found that infants with autism used fewer joint attention (e.g., pointing to bring attention to an aeroplane in the sky), behaviour regulation (e.g., pointing to request an object) and social interaction (e.g., waving to bring attention to self) gestures compared to the other two groups. Colonnese, Stams, Koster and Noom (2010) conducted a meta-analysis investigating both concurrent and longitudinal relations between pointing and language development. It was argued that the pointing gesture was one of the first forms of non-linguistic communication and when produced with differing motives (e.g., declarative or imperative intentions) could lead to increased socio-communicative interactions, which was positively associated with language development. Paparella and colleagues (2011) also found that joint attention through pointing was impaired for
children with ASD with a longitudinal results indicating that development of pointing preceded development of expressive language. Watson and Baranek (2003) supported this finding through highlighting that children with ASD tend to display less babbling and limited preverbal communicative movements such as eye gaze and pointing. It was argued that this puts children with ASD at higher risk for poor communication and reduced reinforcement from social interaction with others, leading to fewer opportunities for encouraging development of language.

Problems with non-verbal communication such as eye gaze and gestures have been proposed to contribute to poor pragmatic functioning and communication ability seen in ASD children (Bhat et al., 2011; Luyster & Lord, 2009; Tager-Flusberg et al., 2005). Due to the close interaction found between gestures and language communication, it would be worthwhile to explore the effects of teaching natural hand movements (i.e., iconic gestures) on learning and applying new words in communications with others.

1.2.1 Gestural Origin of Communication

The discussion of the evolution of language and its origins often include debates between researchers that support a gestural origin of language compared to a system based on vocalisation (Corballis, 2009). More recently, authors have suggested a theory of embodiment, indicating the importance of gesture and language as two aspects of a single, well integrated system (Glenberg, 2010; Glenberg & Gallese, 2012; Kendon, 1997).

The evolutionary perspective proposes that language evolved from manual gestures rather than word-like vocalisations as manual actions provide more immediately understood and clearer linkages to objects and actions in cross cultural contexts (Gentilucci & Corballis, 2006). Drawing on animal research, it has been
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suggested that the origins of language first began in the gestural domain with gestural communication found in apes. Hewes (1992) highlighted that apes possess the capacity to read “signals” or “gestures” to assess or predict intentions. These largely include head and neck positions, flicking of ears and body stance, which are used more often as a method of communication within their groups. Pollick and de Waal’s (2007) study of natural communication in apes also supports the greater use of manual gestures across different contexts over and above facial expressions and vocalisation. These studies indicate that nonhuman primate gestures (i.e., primate iconic gestures) play an integral role in communication between communicators and communicative partners (Tanner & Byrne, 1996) and have been suggested to be similar to very basic human linguistic communication.

Reinforcing the importance of gesture in speech and language development is the theory of embodiment, whereby many cognitive processes such as language, memory and social development are believed to be based on motor simulations and bodily actions (Glenberg, 2010; Glenberg & Gallese, 2011; Hostetter & Alibali, 2008). Embodiment suggests that gestures and symbols present in the environment are only meaningful if they are grounded in our bodily interactions. In other words, these symbols are better understood if the body interacts through our sensory, motor and emotional systems, highlighting the important role our body and subsequent manual movements play (Glenberg, 2010). The theory of embodiment has been widely applied to many areas such as memory (Brunel, Labeye, Lesourd, & Versace, 2009), emotions (Havas, Glenberg, & Rinck, 2007), social and cognitive development (Sommerville, Woodward, & Needham, 2005) and language (Chwilla, Virgillito, & Vissers, 2011; Glenberg, 2010).

Glenberg and Gallese (2011) approached the concept of language with the introduction of an Action-Based Language model (ABL) which proposed that language
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acquisition, comprehension and production are derived from embodied bodily
movements. Evidence supporting the notion of linguistic meaning stemming from
manual action systems comes from functional magnetic resonance imaging (fMRI) data
showing that presentation of verbs such as “kick”, “pick” and “lick” in a passive reading
task resulted in more activation in the leg, fingers and face respectively (Hauk,
Johnsrude, & Pulvermüller, 2004). Additionally, Tettamanti et al. (2005) conducted an
fMRI study that involved people listening to either mouth, hand or leg action-related
sentences. Results showed that across all body part conditions, Broca’s area, which is
known to be actively involved in language, was activated. Moreover, mouth related
sentences resulted in more motor activation in mouth specific ventral motor regions,
hand sentences activated medio-dorsal hand regions and leg sentences resulted in
activation in the dorsal leg regions; these results indicate a tight integration of motor
movement and language (Tettamanti et al., 2005). Providing behavioural support for the
relationship between motor activation and language, a study on 1st - 3rd grade typically
developing (TD) children found that actual and imagined movement of toys to reflect
the movements of objects described in a corresponding sentence led to improved
memory and comprehension (Glenberg, Gutierrez, Levin, Japuntich, & Kashcak, 2004).
Zwaan and Taylor (2006) also showed that comprehension of sentences describing an
action involving a manual rotation of an object (e.g., he turned the volume down) was
easier when participants rotated a dial in the same direction (i.e., turning a dial
clockwise) compared to the opposite direction (i.e., turning a dial clockwise)
indicating that comprehension of language was embodied within our body perceptions.
The studies highlight the close relationship between motor activity and linguistic input,
providing evidence for the essential role manual movements such as gestures play in
subsequent language production, comprehension and expression.
Using the theory of an action-based embodied language, it would make sense that a delay in motor development and early gesture production (i.e., pointing), as discussed earlier, would co-exist with language delays and communication difficulties (Arnold, Semple, Beale, & Fletcher-Flinn, 2000; Carpenter, Pennington, & Rogers, 2002; Stone, Ousley, Yoder, Hogan, & Hepburn, 1997; Stone & Yoder, 2001; Watson, Baranek, & DiLavore, 2003). Given the spontaneous use of iconic gestures in typically developing populations from a young age, it would be interesting to explore the ease of learning and use of naturally occurring iconic gestures for children with ASD in learning to communicate effectively and functionally with others.

1.3 A Gesture-Based Communication System

The relationship between gestures and language as a tightly embedded system has been well researched and documented through the use of animal studies as well as infant research. Humans from all backgrounds and cultures move their hands, arms, head and body when they speak (Feyereisen & deLannoy, 1991; Gentilucci & Corballis, 2006; McNeill, 1992; Yap, So, Yap, Tan, & Teoh, 2011). Kendon (1997) defined these body movements as actions that are used and treated by others as a part of what the speaker means to convey while interacting. They are commonly referred to as iconic gestures. Gestures convey similar meaning in the contexts of particular communities and are well integrated with speech as evidenced by high rates of gestures (90%) produced while talking in typically developing populations (McNeill, 1992). The relationship between gesture and language has been widely discussed, with some researchers suggesting gesture to be the first form of language (Armstrong, 2008; Corballis, 2009; Gentilucci & Corballis, 2006). Gestures have been proposed to play major roles in early years in enhancing and predicting later language comprehension (Kirk, Pine, & Ryder, 2011; McNeil, Alibali,
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& Evans, 2000) and expression and functional communication in children (Colonnese et al., 2010; Goodrich & Kam, 2009; Hostetter, 2011). Furthermore, as gestures are semantically related to content of speech (Goldin-Meadow, 2003) and have similar communicative functions (Tomasello, Carpenter, Call, Behne, & Moll, 2005) they have been found to develop closely with word learning in both typical and ASD children (Eigsti et al., 2011; Ham & Bartolo, 2012).

1.3.1 Gestures and Language Development

In understanding the important role gestures play in language onset and development, Tomasello (2007) stated that the comprehension and production of linguistics symbols comes soon after infants start pointing and using manual gestures. Infants as early as 7 – 15 months have been found to produce more defined movements, such as deictic or pointing gestures (Colonnese et al., 2010; Ejiri & Masataka, 2001; Iverson, Hall, Nickel, & Wozniak, 2007; Iverson & Goldin-Meadow, 2005; Rowe, Özçalışkan, & Goldin-Meadow, 2008) to communicate or share attention with others around them. These early gestures, such as reaching with open-close hand movement to request, provide an initial pathway for initial non-verbal communication (Capone & McGregor, 2004) and later language acquisition (Colonnese et al., 2010). Studies have shown that infants use nonverbal gestures before words to represent objects and needs when communicating with those around them (Acredolo & Goodwyn, 1988; Dick, Goldin-Meadow, Solodkin, & Small, 2012). Acredolo and Goodwyn (1988) followed sixteen infants from 11 to 24 months with data showing that production of these early gestures as object labels led to an increase in subsequent verbal labelling and naming behaviour. A later study by the same researchers suggested that gestures were used or produced before words due to gestures being more visual, with increased opportunities for caretakers to physically guide infants in performing or imitating gestures and their
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iconic properties (i.e., being representative of objects or actions) (Goodwyn & Acredolo, 1993). In their study, a comparison between gestural and verbal modalities in the use of symbols revealed a small but significant gestural advantage, with gestural symbols employed correctly before vocal symbols. Iverson and Fagan (2004) provided supporting evidence for vocal-rhythmic coordination in 6 to 9 month olds with less vocal-motor coordination found in pre-babblers compared to babblers. This is in line with the theory that manual behaviours influence onset of speech production (Iverson & Thelen, 1999).

Though the gestural origin theory of language suggests the importance of gestures before speech, it seems more relevant to focus on how the emergence of manual movement occurs in a tight synchrony with speech production (McNeill, Bertenthal, Cole, & Gallagher, 2005). Iverson and colleagues (2007) conducted a study examining right-handed rhythmic activity and laterality bias in infants prior to, at and following reduplicated babble onset (i.e., vocalisations with syllable repetition). In their study, although they found that infants frequently produce organised repeated movements prior to the onset of babbling and, more importantly, rhythmic arm activity increased together with babble onset across ages suggesting that the tight connection between gesture and speech could come from links between motor movements and vocal systems in infants. Iverson and Goldin-Meadow (2005) also examined gesture production in the early stages of communication between child and primary caregiver in ten typically developing (TD) children aged between 10 to 24 months. Gesture alone, Speech alone and Gesture and Speech were coded as communicative behaviour. The results of this study indicated that children relied more heavily on gestures to refer to objects around them. Moreover, all ten children produced single gestures with single words in a supplementary (e.g., point at bird while saying “nap”) and complementary (e.g., point at bird while saying “bird”) manner before the onset of two-word utterance
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production. Predictive relationships between gesture-word and two-word utterances were specific to supplementary gestures. This is important as it suggests that gestures could be essential for onset of more complex speech (Iverson & Goldin-Meadow, 2005) rather than being a precursor for speech, supporting the theory of a tight integration between language and motor movements such as gestures.

In evaluating the theory for children with ASD, Landa (2007) reviewed early communication in 2 – 3 year old children with ASD and found that communication development was characterised by a reduction in complexity and frequency of gesture-word combinations, gestures and word usage. Thurm and colleagues (2007) also found that poor non-verbal communication (e.g., joint attention, play, gestures) and socialisation at 2 years of age predicted poor receptive language at 5 years of age providing evidence for non-verbal communication to be a strong predictor of later language acquisition (i.e., both expressive and receptive language) in an ASD population. In support, Sowden, Perkins and Clegg (2008) found similar patterns of language development for children with ASD. In their observational study of two children in intensive therapy, they noted that for both children their early gestural repertoire consisted of deictic gestures, including proximal and distal pointing, but that these decreased as gesture-speech combinations increased. Even though the study was based on two children, it provides promising signs that children with ASD might be able to develop language and gesture with the same developmental trajectory as typically developing children, albeit slower. It also suggest that early gesturing might be a developmentally important precursor for first word production later in childhood.

In looking at early gesture production for children with ASD, Buffington et al. (1998) showed that gestures produced by ASD children were more often isolated, less integrated with speech and seldom used to engage socially. Stone and colleagues (1997) also found that the same pattern of requesting more than directing others attention was
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evident in young children with ASD. This is in line with the understanding that
gesturing might be a developmentally important for language onset and development,
which might be a reason for children with ASD to generally present with very limited
verbal ability and impaired ability to express emotions, make requests or initiate and
respond appropriately to others (Cihak et al., 2012). Although there are clear difficulties
that children with ASD face in relation to impaired motor movements and spontaneous
use of gesture, these children are able to use iconic gestures to enhance communication
(Capone & McGregor, 2004). For example, introducing gesture imitation to a language
intervention programme led to more language use over and above object imitation in
four ASD children (Ingersoll & Lalonde, 2010). Using a naturalistic behavioural
intervention programme, children with ASD were found to increase imitation and
spontaneous use of descriptive gestures both in trained and novel situations. Moreover,
children were rated as having appropriate gestures and language use during and post-
treatment compared to baseline, providing evidence for the acquisition of gesture-
speech associations in ASD populations (Ingersoll, Lewis, & Kroman, 2007).
Furthermore, studies have found that imitation of gestures improved when action was
goal-directed, meaningful and object-oriented (Nielsen & Hudry, 2010; Smith &
Bryson, 2007; Zachor, Ilanit, & Itzchak, 2010). Nielsen and Hudry (2010) found that
ASD children could copy a model’s actions as well as a child with Down Syndrome,
suggesting object-oriented imitation can be taught. Smith and Bryson (2007) found that
children with ASD could understand and comprehend gestures with a greater tendency
to move objects according to its conventional functions (e.g., telephone put to ear) more
so than their unconventional functions (e.g., writing with a hammer). Zachor et al.
(2010) found that ASD children aged between 32 – 51 months displayed poor motor
abilities overall but performed better on meaningful actions (e.g., pretend drinking from
a cup) compared to non-meaningful actions (e.g., rolling a cup), and actions on objects
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(e.g., drinking from cup) compared to pure body movements (e.g., drinking action without cup). Akechi et al. (2013) recently reported that adding gesture (i.e., pointing) to a speaker’s gaze improved referential word learning for children with ASD although this was only true for high functioning ASD children.

These studies lead to an overall understanding that imitation and use of iconic gestures, though impaired, was possible by children with ASD. Furthermore, the use of iconic gestures have also been found to be easier for adult second-language learners to remember, suggesting that it is the iconicity and concreteness of the gesture-word pairing that could make learning easier for children with ASD (Beukelman & Mirenda, 2006; Johnston & Schembri, 2007). Given that gesture and speech seem to integrate seamlessly, allowing humans to use words and bodily actions to produce meaning, incorporating iconic gestures into word-learning programs could lead to gains in functional communication for these children with ASD.

1.4 Communication Systems for Children with ASD

1.4.1 Manual Sign Systems

Despite some earlier promising results in the 70s and 80s indicating strong links between manual motor movement and language, there have been few attempts to incorporate manual movements such as iconic gestures in early intervention programs by psycholinguists and applied behavioural analysis (ABA) researchers alike. Layton (1988) studied high-verbal and low-verbal imitators (i.e., based on performance on verbal imitation task) to determine if comprehension, production and spontaneous expression of language by children with ASD improved after treatment. Four treatment conditions were presented: sign-alone, speech-alone, speech and sign simultaneously or speech and sign alternately. Results showed that using signs helped all children to
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produce, comprehend and use language better, with high-verbal imitators performing equally well across all conditions while low-verbal imitators performing better only in the treatment conditions involving signing. Carr, Binkoff, Kologinsky and Eddy (1978) tested four children aged between 10 - 15 years old and taught signs for five common foods (i.e., apple, banana, milk, cookie and candy) based on American Sign Language for the deaf. The simultaneous communication method was employed with a combination of sign and verbal word presented during each training trial. Results indicated that a combination of prompting, fading and stimulus rotation helped children with ASD learn expressive sign labels although it was unknown if this could lead to the development of more complex communicative abilities across different settings.

Konstantareas, Oxman and Webster (1977) studied five children with autism and other severely dysfunctional problems and found that introducing simultaneous manual sign and speech training over 5 weeks helped four out of five children increase their use of a number of receptive and spontaneous signs of concrete nouns, action verbs and adjectives.

Although promising results were obtained 30 - 40 years ago, only recently has there been a new surge of interest on manual sign systems. However, this research has produced mixed results with research suggesting that sign language is not as effective as, for example, picture-based systems (Barlow, Tiger, Slocum, & Miller, 2013; Chambers & Rehfeldt, 2003; Schlosser & Sigafoos, 2006; Tincani, 2004; van der Meer et al., 2012) which can be more quickly acquired and understood by listeners. Carbone, Sweeney-Kerwin, Attanasio and Kasper (2010) found that the use of prompt delays together with manual sign language produced an increase in vocalisation in children with developmental disability. In contrast, van der Meer, Didden, Sutherland, O'Reilly, Lancioni and Sigafoos (2012) compared acquisition, maintenance and preference for three different communicative systems such as speech generating devices (SGD),
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picture-exchange (PE) and manual sign systems from the Dutch sign language system (MS). In their study of four children with ASD, all four children learnt to mand using SGD and PE but only two used MS successfully to criterion. Barlow and colleagues (2013) found that when comparing training of picture exchanges with manual signs for three participants with language deficits, all three participants reached criterion for picture exchange systems while none mastered the use of sign language. Tincani (2004) compared the effects of teaching mands through PECS and sign language on two children with Autism. Results indicated a PECS preference for one child and a sign language preference for the other, suggesting that acquisition of communicative systems could depend on individual skills or characteristics (e.g., motor imitation skills).

The studies highlighted above suggest that the use of sign language as a teaching method has not been as successful as shown by earlier research. This is hardly surprising given the many limitations to this structured form of non-verbal language that could present problems for communication with typically developing children. Sign language is not universal and can be culturally specific with different sign languages such as American Sign Language (ASL) and Australian Sign Language (AUSLAN) each having their own sign for a similar word (Beukelman & Mirenda, 2006; Johnston & Schembri, 2007). In addition, many signs such as those seen in the Makaton vocabulary (Ryan, Cowley, & Keesing, 2001) are not iconic in nature, resulting in difficulty for others who have not learnt the language to communicate effectively with children who use them. Having a unique sign language that is unfamiliar to untrained peers will pose some difficulty for children with ASD to communicate effectively as they are already likely to be impaired in both language and social ability and might be less reinforced to do so (Duffy & Healy, 2011; Sundberg, 1993). Furthermore, research has also suggested that successful acquiring of sign language depends on an individual's fine motor skill ability (Seal & Bonvillian, 1997). This appears to be a limitation for
children with ASD and other developmental disabilities as their poor fine motor flexibility and inability for rapid motor coordination might lead to difficulties in using sign language for functional communication with others (Mirenda, 2003; Seal & Bonvillian, 1997).

1.4.2 Picture-Based Systems

An approach using pictures as a means of communication is the Picture Exchange Communication System (PECS; Bondy & Frost, 2001). This communication system was initially developed to counter the disadvantages posed by sign language systems. PECS can be used with any population with delayed speech and has been widely used to teach communication skills to children with ASD (Landa, 2007; Llaneza et al., 2010; Magiati & Howlin, 2003; Travis & Geiger, 2010). PECS involves the use of pictures to represent target words and phrases that the child requires to either mand an item of interest by presenting a picture of the desired item to the intended ‘communicative partner’ or audience or tact an item they want to label or talk about with others. The pictures are stuck on strips backed with Velcro to be used eventually unprompted across settings and people when needed by the child from his or her communication book. Children using picture exchange procedures have shown reductions in challenging, negative behaviours as well as spoken language development even though these behaviours have not been targeted specifically (Buckley & Newchok, 2005; Charlop-Christy et al., 2002; Frea, Arnold, & Vittimberga, 2001; Llaneza et al., 2010).

Charlop-Christy et al. (2002) studied three boys with Autism using a single-case design and found that all three children demonstrated an increase in speech, social communicative behaviour and a reduction in problem behaviour. Yoder and Stone (2006) compared PECS to a child-initiated, play-based incidental teaching method (i.e.,
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Responsive Education and Prelinguistic Milieu Training) and found that PECS was more successful in increasing nonimitative spoken communication acts. Schreibman and Stahmer (2014) also found that PECS was as effective as Pivotal Response Training (PRT) in increasing spoken language skills for thirty-nine young children (2 – 4 years old) with Autism, indicating that PECS could help increase communicative repertoire for children with ASD.

Schwartz, Garfinkle and Bauer (1998) found that children with severe disabilities could employ PECS for communication and, based on a one-year follow up, found that gains were generalised to untrained settings. A more recent study by Greenberg, Tomaino and Charlop (2009) also found that across all four participants with Autism, PECS usage was generalised across settings and people and during follow up. Tincani (2004) however, compared PECS with sign language training and found that only for one participant, PECS was more effective in promoting communication when generalised to a new communicative partner. This is in line with the review done by Maglione and colleagues (2012), who found that though PECS generally had positive outcomes in the short term, long term results did not appear to be as consistent. Taken together, evidence from individual studies suggest that though promising, PECS still requires clearer scientific literature to become an evidence-based treatment.

On a broader scale, Ganz et al. (2012) conducted a meta-analysis of PECS and found that the highly visual nature of PECS was suited for children with ASD, with many studies supporting PECS as an effective means of increasing communication in children with ASD. Sulzer-Azaroff, Hoffman, Horton, Bondy and Frost (2009) too studied thirty-four reports on PECS and the data reviewed demonstrated that PECS was a low-technology teaching alternative for children who lacked functional speech. In their review, when comparing communicative treatment methods, participants taught to mand using PECS performed as well as or better than those receiving other alternative
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methods (i.e., manual signs, voice output communication aids; VOCA). In support, Preston and Carter (2009) studied twenty-seven studies and found that PECS was easily learnt and implemented for individuals with low or no functional speech, providing evidence that picture-based systems such as PECS can lead to functional communication gains.

Although promising, Flippin, Reszka and Watson (2010) conducted a systematic review on the PECS literature between 1994 – 2009 and found that in most PECS studies, small to moderate gains were made following training with small to negligible gains made in speech production. Supporting this, Tincani and Devis (2011) described a meta-analysis of sixteen studies and found that PECS was moderately effective in establishing mands though results were less consistent with speech acquisition and generalisation across settings and people. This suggest that though promising, PECS is not yet a fully established and evidence based method for increasing communicative skills and speech development for children with ASD.

Although PECS has been found to be an efficacious intervention method, picture systems do have some disadvantages in that they require cards, sentence strips and banks of pictures which need to be stored and carried when outside the therapy or class room. Moreover, PECS is a comprehensive communication system requiring up to 2 years for training a full communicative repertoire (Sulzer-Azaroff et al., 2009). Sundberg (1993) highlighted the effort required when using picture-based systems requiring fine-motor responses for initiating a communicative exchange, which is quite cumbersome and “unnatural” when in the company of typically developing peers or in regular social environments. Although PECS caters for the pragmatic and meaning elements required in successful communication, the use of cards and communication books is quite restricted and difficult.
1.4.3 Gestures as a Teaching Method

With the negative impact of language impairments and communication restrictions on the growth and development of children with ASD, it is essential that developments in early intervention methods are explored and evaluated to enhance outcomes for this particular population and indeed for others who progress slowly in language and communication skills. In reviewing the current literature on communicative intervention methods, the use of aided (e.g., pictures) and unaided (e.g., manual signs) augmentative and alternative communication methods has been found to be effective for increasing speech production across a wide range of children, including those with ASD (Miller, Light, & Schlosser, 2006; van der Meer et al., 2012). Although advantageous in promoting speech development, functional, shared communication with other typically developing individuals might still pose problems for this unique population if extra effort and materials are needed especially before speech is developed enough to predominate. Hence, it is important to examine alternatives and supplements in teaching programmes that do not necessarily replace existing effective procedures but add to them.

Iconic gestures differ from sign language in that they do not require skilled trainers for teaching and are readily understood by communicative partners without previous knowledge of them, as is the case for formal sign language systems. Iconic gestures are produced by individuals of all ages spontaneously and naturally during speech and conversations (McNeill, 1992) and are relatively easy to form thereby providing greater opportunities for more immediate reinforcement of initial learning and later initiations of generalized use. Moreover, iconic gestures have been observed to occur more frequently in face-to-face interactions when the receiver has difficulty comprehending or when interaction is difficult and has been used by both typically developing children (Cook & Goldin-Meadow, 2006; Goldin-Meadow, 2000) as well as
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children with ASD to communicate (Buffington et al., 1998; Nielsen & Hudry, 2010; Smith & Bryson, 2007; Zachor et al., 2010). This provides evidence for the potential usefulness of teaching iconic gestures to children who have significant social/communication problems such as those with ASD (Beukelman & Mirenda, 2006).

Given that children tend to use the quickest, easiest, and most effective ways to communicate their needs and comments to others (Cress & Marvin, 2003), it is to be expected that teaching iconic gestures that occur “naturally” will increase speed of acquisition and use of words learnt in functional ways. In addition, by directly comparing an iconic gesture-based method to a known to be successful picture-based teaching method, the additional influence that gesture might have on language acquisition by children with ASD can be explored. This thus forms the basis for the present experimental study to be conducted in this thesis.

2. Objectives and Rationale of Study

The primary aim of the study is to examine the extent to which, for non-verbal children with ASD, the communication of words learnt with accompanying iconic gestures is preferred and maintained longer than words learnt with accompanying pictures. A secondary aim was to assess the extent to which words learnt with accompanying iconic gestures prompt spontaneous use of vocalisations and eye contact with the communicative partner to a greater extent than words learnt with accompanying pictures. Based on these aims, the research questions were:

1. Will there be a difference in the number of trials to learn new words required to mand or tact for items using a gesture- or a picture-based teaching protocol?
2. Will there be a difference between a gesture-based and a picture-based teaching protocol when communication of the new words learnt is tested at long-term follow-up and across untaught mand and tact functions?

3. After learning new words by the gesture-based or picture-based teaching protocols, will non-verbal children with ASD show a stronger preference for using gestures or pictures when given a free choice in how new words may be communicated?

4. During the learning of new words by a gesture-based and a picture-based protocol, and at subsequent follow-up tests of acquisition and maintenance, do children with ASD spontaneously vocalise and engage in eye contact with a communicative partner more frequently in one condition than the other?

2.1 Rationale for Design of Study

A single case, repeated measures design counterbalanced across mand and tact conditions was employed. Single case research designs have had a long history with the use of small samples to study behavioural interventions across diverse populations (Matson, Turygin, Beighley, & Matson, 2012) with the bulk of recent research employing single case designs focused on individuals with ASD (Davis, Kahng, & Coryat, 2012; Mayer, Sulzer-Azaroff, & Wallace, 2012; Morgan & Morgan, 2001) and their acquisition of key skills such as imitation (Ingersoll et al., 2007), social skills (Cappadocia & Weiss, 2011), interpersonal behaviour and communication problems (Carmo, Rumiati, Siugzdaite, & Brambilla, 2013; Chan et al., 2005).

Single case designs allow an independent variable to be introduced in a systematic manner to screen out other possible factors that might contribute to changes in the dependent variable of interest. The design focuses on variation within an individual over a time period as a function of other variables that change over time or as
a function of factors that change across subjects. The aim is to establish a functional relation between independent and dependent variables by observing a change in dependent variables only when the independent variable is implemented (Mayer et al., 2012). In essence, it is a type of design suitable for intra-subject research where generalizability of findings is addressed through repetition and replication of individual cases (Hilliard, 1993). In addition, repeated measures of dependent variables over different conditions or phases enables confidence that the measures are representative of that participant and allow stronger causal inferences to be made as the number of repetitions increases. Based on single-case experimental designs, participant’s behaviour will be interpreted relative to their own baseline, in context, and across planned conditions of treatment or intervention (Hayes, 1981; Morgan & Morgan, 2001; Parker & Hagan-Burke, 2007). Single case experimental research designs allow visual analysis due to real time graphing of behaviour (e.g., number of accurate mands / tacts) to determine when and to what extent a change in dependent variables occurs.

In this study, an alternating treatment approach was used. In this case, phase A was a time period where establishment of trend and stability in knowledge of a list of words was obtained before the implementation of a teaching procedure. Phase B included the implementation of the word teaching program (i.e., treatment condition). An alternating design was based on the alternation of two teaching procedures; in this case the gesture-based and the picture-based teaching strategies. This design allows for simultaneous comparisons of learning outcomes as they occur and is of value especially when the aim is to distinguish between teaching strategies to determine which strategy might have greater effect or efficiency.

The use of an across subjects single-case experimental approach has been widely employed in the field of clinical practice and research assessing interventions for children with ASD (Ingersoll & Lalonde, 2010; Ingersoll et al., 2007; Ross & Greer,
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Studies in the literature examining the effects of behavioural strategies for children with ASD average five participants (Buffington et al., 1998; Ingersoll & Lalonde, 2010; Ingersoll et al., 2007; Iverson & Braddock, 2011; Plavnick & Ferreri, 2011) hence the number of participants \((N = 5)\) for this study based on the current literature is appropriate.

3. Method

3.1 Participants

Seven preschool aged children with a diagnosis of mild – moderate Autism Spectrum Disorder (ASD) were interviewed before participation into the study. Two children were excluded as one did not meet PLS-5 criteria and the other left the programme due to prior therapy commitments. Thus, the final sample consisted of five preschool aged children \((M = 60 \text{ months}; \text{ range of } 50 - 72 \text{ months})\) all diagnosed with ASD by a paediatric medical practioner, a speech pathologist and a clinical psychologist prior to participation in the study. Participants were recruited from local Education Support Centres, Child Wellbeing Clinics and Specialist Language Centres in the metropolitan area of Perth, WA, through the distribution of recruitment fliers (Refer to Appendix A).

3.1.1 Inclusion criteria

The following measures were used to ensure participants met inclusion criteria before admission in the study.

**Autism ratings.** The Gilliam Autism Rating Scale, 2\(^{nd}\) Edition (GARS-2; Gilliam, 2006) is a practical and useful instrument for clinicians and researchers who work with children with ASD. GARS-2 is a screening tool for individuals aged 3 – 22
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years old whom has severe developmental problems indicative of Autism. The tool takes approximately 5 – 10 mins to administer and provides information from parents about child’s development during the first 3 years of life. Behavioural frequency ratings are used with a final Autism Index providing a composite indication of Autism severity (Gilliam, 2006; Montgomery, Newton, & Smith, 2008). GARS-2 permits accurate assessment by parents and teachers and presents as a tool with strong psychometric properties, making it suitable for research in the field. As GARS-2 is easy to administer, it has been used as a measure of students’ developmental progress and as a supplementary tool for ASD diagnosis and research (Klose, Plotts, Kozeneski, & Skinner-Foster, 2012). GARS-2 was administered for confirmation of current ASD status as it has been shown to be suitable as a supplementary diagnostic tool for research purposes (Klose et al., 2012; Montgomery et al., 2008).

Language ability. Steiner, Goldsmith, Snow and Chawarska (2012) reviewed the usefulness of the Preschool Language Scales 5th Edition (PLS-5; Zimmerman, Steiner, & Pond, 2011) as a language assessment instrument for children with ASD. The tool is a combination of structured assessment, observations and a parent questionnaire. It is primarily a measure of receptive and expressive language with a supplementary screening test for articulation and home communication (Steiner et al., 2012) and also provides a comprehensive overview of children’s communication skills. The tool has reported .93 -.98 reliability coefficients for children with language disorder and language delay as found in ASD (Volden et al., 2011; Zimmerman et al., 2011). In addition, as gestures in young children have been found to be indicative of later language development (Buffington et al., 1998; Butcher & Goldin-Meadow, 2000; Eigsti et al., 2011; Gerenser, 2009; Goldin-Meadow, 2003; Goodrich & Kam, 2009; Mundy et al., 1986; Tager-Flusberg et al., 2009) both in typically developing and ASD
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populations the PLS-5 incorporates new items to better understand gesture, play and emergent literacy which is relevant to this study.

For inclusion in the study, participants had to meet the following criteria: (a) aged between 48 – 72 months (4 – 6yo); (b) agreed previous diagnosis of ASD as obtained from specialist reports; (c) autism index severity scores above 85 on GARS-2; (d) total language standard scores below 70 on PLS-5; (e) communication subscale raw scores above 8 on the GARS-2; (f) English as their first language; (g) no previously diagnosed visual or auditory impairments.

3.1.2 Participant Demographics

Participants were recruited on a rolling basis and Table 1 shows the ages, sex and diagnostic characteristics of the participants as well as their inclusion criteria scores on the GARS-2 and PLS-5 standardised assessments.

Table 1

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age (Mths)</th>
<th>Gender</th>
<th>Measure of Inclusion</th>
<th>Imitative ability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>GARS –2</td>
<td>PLS –5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Autism Index</td>
<td>Total Language</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Communication Raw Score</td>
<td>Score</td>
</tr>
<tr>
<td>Tom</td>
<td>64</td>
<td>M</td>
<td>89</td>
<td>9</td>
</tr>
<tr>
<td>Harry</td>
<td>53</td>
<td>M</td>
<td>136</td>
<td>36</td>
</tr>
<tr>
<td>Jamie</td>
<td>63</td>
<td>F</td>
<td>94</td>
<td>22</td>
</tr>
<tr>
<td>John</td>
<td>72</td>
<td>M</td>
<td>111</td>
<td>27</td>
</tr>
<tr>
<td>Alex</td>
<td>50</td>
<td>M</td>
<td>85</td>
<td>16</td>
</tr>
</tbody>
</table>

Note. \(^a\) Although John presented with a total language score >70, he was not able to respond to mand/tact instructions and met criteria across all other domains hence his inclusion into the study.
Tom. Tom was a boy aged 64 months with ASD. His score on the GARS-2 Autism Index was 89 indicating a mild severity. He was generally compliant to adult requests and was learning the PECS system during participation in this study as part of a centre based program including 10 hours a week based on an Applied Behavioural Analysis (ABA) framework. He showed an interest in toys that made sounds (e.g., bells / guitar), was observed to be able to imitate simple gross motor actions, and made the occasional vocalisation of part-words (though extremely poorly articulated) when instructed to do so. During instructional situations, Tom was observed to comply when his attention was reinforced by tokens that were later exchanged for toy play. Tom was able to communicate using verbal (i.e., part word sounds) and non-verbal means (i.e., pointing) when asked questions and displayed some eye contact and facial expressions. Parental reports indicate that he was familiar with 10 out of the 33 target items and these were excluded from his intervention sessions.

Harry. Harry was a 53-month-old boy with ASD. His scores on the GARS-2 Autism Index was 136, classifying him in the moderate/severe category for severity of ASD. His speech was limited largely to echolalia and initial parental reports suggested difficulty in understanding and responding accurately to instructions provided. Harry often displayed aggressive and tantrum behaviour when he did not get what he wanted and these could last through an entire session. When asked to engage in single imitative actions, Harry was observed to be able to follow through with instructions and could vocalise some part-words. During participation in the study, Harry was observed to require prompting to stay on-task and employed the use of token reinforcement to help encourage compliance to the word-learning program. During the time of participation, Harry was not undergoing any home training, had limited exposure to pictures and no exposure to direct teaching of gestures as aspects of communication training. Harry was
observed and reported to be familiar with 8 out of the 33 items and these were promptly excluded from the study.

**Jamie.** Jamie was a verbal 63-month-old girl with a diagnosis of ASD with a GARS-2 Autism Index score of 94 classifying her in the mild/moderate range. Jamie was initially observed to enjoy playing on her own and did not initiate activities with adults when shown toys in the room. She was observed to be interested in items that made sounds and could move (e.g., bell / car / train). Parental reports suggest that Jamie had difficulty in responding to instructions or questions and more often remained silent. Jamie displayed a majority of compliant behaviours when given instructions and was observed to use some non-verbal gestures such as pointing rather than vocalisation of words when questions were posed. In the initial part of the study, Jamie was observed to engage primarily through non-verbal responses (i.e., pointing) though this seemed to decrease as vocalisation improved as the study progressed. Prior to participation, Jamie had received speech therapy for 3 – 4 months though this was largely based around comprehension and response to instructions provided. In particular, she had not been taught to communicate via pictures and Mum reported that this was to be introduced after participation in this study. Mum reported that she was familiar with 10 items out of the 33 target items with one used as reinforcement for appropriate behaviour during session.

**John.** John was a verbal 72-month-old boy with a GARS-2 Autism Index of 111 indicating moderate severity of ASD. His verbal ability was observed to be restricted; being able to respond when asked questions (e.g., You choose, PEN or TOKEN) but was unable to respond accurately to mand or tact questions (i.e., Had difficulty saying “I want [COMB]” in response to the question “What do you want?”). He would engage in
vocal stimming occasionally and displayed some echolalia though poorly articulated. John was compliant through instructional settings and had no limitations in his motor imitation skills (e.g., being able to imitate gestures shown very quickly without frequent errors). He displayed some difficulty staying on-task as sessions progressed (e.g. constantly moving on the seat) and required prompting to keep to task. Also, John employed verbal and non-verbal modes of communication such as facial expressions and eye contact. Parental reports indicated previous exposure to picture communication strategies although these had been completed more than a year ago and his parents reported that he had not used pictures since training had completed and during the time of his participation in this study. John was observed to have the largest amount of vocabulary, understanding 15 out of the 33 target items. However, though he knew the names of these items, he was unable to use them appropriately nor respond to “I want..” or “I see...” questions.

**Alex.** When Alex was recruited he scored 85 on the GARS-2 Autism Index indicating a diagnosis of mild ASD. He was non-verbal and during the baseline phase, did not display spontaneous language and was largely restricted to non-word sounds (e.g., “ahh” “ohh” “fff”), echolalia and poor articulation of part words (i.e., “P” sound for [PLANE]). Alex displayed many stereotyped behaviours such as continuous hand movements across his face and preoccupation with small parts of toys such as spinning the wheels of the toy train / plane. In addition, he displayed aggressive behaviour such as scratching and hitting towards others especially when people interfered in what he was currently engaged in (e.g., requesting for toy to be returned to researcher / change of task from free play to word learning intervention phase). Alex displayed tantrum behaviour (e.g., screaming and lying on the floor) when he did not get what he wanted (e.g., no video of cars movie) and presented with poor eye contact and on-task
behaviour (e.g., screaming and crying with a refusal to sit at the table for more than 25 minutes) in initial sessions. Parents reported that he was currently in the process of learning PECS (Bondy & Frost, 2001) as a communicative system in a centre based teaching program run for 10 hours a week and was just completing modules for manding at time of participation. Alex was reported to be familiar with 2 of the items and these were removed from the list of target items available for him to choose from.

3.2 Setting

All sessions were conducted on-site in a Murdoch University Clinic room equipped with video equipment and a laptop computer. The room contained a child-sized table with two chairs for the researcher and participant to use during the administration of the teaching programs. In addition, two other chairs were available for parents to sit and observe and these were put about 1 metre behind the child to minimise contact and distraction of child during the training sessions. Age-appropriate toys were made available for children to play with during short breaks between trials. Out of the pool of toys, target items that the children picked and their least preferred items were made available during the administration of the word-learning teaching program. All parents of participants were given $10 per session attended for reimbursement of their transport and parking costs. In addition, an item was provided after each training session to thank the child for participation (e.g., coloured stickers in a book).
3.3 Stimulus Materials

3.3.1 Toys

Thirty-three age appropriate items were selected for use in the study based on teachers’ suggestions. They included toy musical instruments, stationery/paper, vehicles, balls, food, animals and personal items (e.g., toothbrush / comb). Appendix B shows pictures of the toys used. Chosen toys for individual training sessions varied according to each child’s preference assessment to ensure an item of choice was likely to be reinforcing when presented contingent on correct child responses.

3.3.2 Words

All words were taught in either gesture or picture conditions for both mands and tacts. Words were measured on the English Lexicon Project’s scale to ensure words were of high frequency and similar across participants (Balota et al., 2007). Appendix C lists all the words taught and their respective familiarity ratings. All were high frequency words and expected to be familiar by the general population (i.e., Familiarity ratings > 6.5). Familiarity ratings as cited in Goh and Lu (2012) that were > 6 usually suggest that these words are common in the general population and would be easily recognised and used in every day settings and conversations.

3.3.3 Gestures

In order to select the iconic gestures that were to be used in the study, a group of 63 typically developing children aged between 4 – 6 years of age attending a kindergarten in Singapore were presented individually with 33-videotaped gestures corresponding to earlier selected target toys/word items. Each video showed a female adult modelling a series of separate hand/arm actions without accompanying speech.
each lasting approximately 4 seconds. After one viewing of a gesture, a child was given 10 seconds to write or say a single word that described the meaning of the gesture. This procedure was based on a study conducted by Yap et al. (2011) and it had a more stringent criterion of 80% agreement set across age groups to determine if the gestures shown had a common interpretation. The findings showed that 22 of the gestures had a consistency rating of at least 80% or above. Out of the 33 demonstrated gestures, six were then revised to ensure gestures were more iconic and representative of a word and an additional four gestures were added. These were then re-rated by the children and the final sample of 33 gestures were videotaped and used for training during the gesture-based teaching condition in the word-learning program.

To further provide evidence for the use of gestures over the Australian Sign Language (AUSLAN) system, a selection of words from the final sample were presented to a group of 52 typically developing children aged between 4 – 6 years of age from the same kindergarten in Singapore. Using the same procedure as above, children were presented with videos showing a female adult using the sign language actions without accompanying speech. Actions were obtained from the AUSLAN sign language site (i.e., Sign Planet) for teachers and trainers and each video lasted approximately 4 seconds. All videos were played once and children were provided the same amount of time to decide what the hand action meant to them. A total of 32 out of the original 33 word/gestures were then shown for testing due to there being no AUSLAN sign for the word “guitar”. Out of the 32 words presented, 13 words were categorised as iconic gestures (i.e., similar to iconic gestures used in the study) while 19 were categorised as non-iconic, with actions bearing little to no resemblance to actual use or depiction of object. For the iconic sign language gestures, the kindergarten children displayed a percentage accuracy of 90.4 % (Range, 87.0% - 96.2%) whereas they displayed 8.4% (Range, 3.8% - 11.8%) accuracy for non-iconic AUSLAN sign
GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD

language. This showed that the iconic gestures chosen were far more easily understood and thus used in this study (Refer to Appendix E for results of pilot study).

3.3.4 Gesture Condition Materials

In this study, video modelling was chosen as a medium to present the gesture condition to the participants so as to control for variables such as time taken for gesture to be done as well as inconsistency in the way gestures might be reproduced. Furthermore, research has also suggested that use of video modelling together with reinforcement and prompts as proposed in this study (refer to Procedure section p. 49 – 51) has helped children with ASD acquire complex social skills as well as other functional communicative behaviours (Kleeberger & Mirenda, 2010; Nikopoulos, Canavan, Nikopoulou-Smyrni, 2009; Shukla-Mehta, Miller, & Callahan, 2010), which are key areas of interest in this study.

A camera was placed on a tripod and used to record the training videos showing a female adult modelling “I want” and “I see” gestures concurrently with speech. For example, for the target item [e.g., COMB], the video depicted the adult modelling an “I want” gesture which involved stretching out her right hand and moving it towards the body and placing her palm on her chest, followed by a “comb” gesture which involved shaping her hand into a fist and bringing it up to the top of her head before engaging in a swift motion downwards to her shoulder level. This was done while simultaneously saying the phrase “I want -- comb”. All video clips were streamed into an .MOV format using a MacBook laptop computer. They were played on the computer in the clinic room for participants to view and imitate the gestures seen. During the teaching program in the gesture condition, participants viewed video clips of an “I want…” or an “I see…” gesture (i.e., raising of right hand and flattening it such that a straight open palm is facing downwards and placed on the forehead above eyes) during a mand or tact
condition respectively with each video approximately 8 seconds in length (see Figure 1).

![Figure 1](image1.png)

**Figure 1.** Sample stimuli for the target word “comb” in the Gesture condition. The three frames on the left show an “I want… comb” gesture for a mand and the three on the right show an “I see… comb” gesture for a tact. This sequence was repeated until the participant gained mastery of the target word as defined to be 8 out of 10 accurate gesture imitations in the mand/tact training condition and three out of five accurate gesture imitations in the discrimination task across both mand and tact conditions.
3.3.5 Picture Condition Materials

For the picture training condition, a communication board was made using a two-ring communication binder, (approximately 20cm by 15cm) which had a Velcro strip placed across the centre for participant to place picture cards onto the strip when communicating. The binders consisted of pages inserted with strips of Velcro on both sides for storing of picture cards. Pictures of each of the 33 items were made into laminated colour-picture cards (4.5cm by 4.5cm), including an “I want” and an “I see” card for mand and tact conditions. Target item picture cards were placed inside the binder in front of the child for easy access during the training phase. All picture cards could be attached to the hard board to create “I want…” and “I see…” sentences. These are shown in Appendix D.

3.4 Measures

3.4.1 Reinforcement Preference

A multiple stimulus without replacement preference assessment (MSWO) was conducted to determine reinforcing items for testing. Based on a similar procedure introduced by DeLeon and Iwata (1996) and employed in the study conducted by Tsiouri and Greer (2003), a selection of six items based on a pre-set pool of 33 items was presented in front of each participant. Each participant was given 30 seconds to select a preferred item by pointing or touching. When a selection was made, all items were first removed before presenting the remaining five items in front of the participant for another selection to be made. If more than one item was selected, the object that was first touched was recorded as the selected item. This procedure was repeated until two items remained. The first item chosen was used to teach mands and the last two items in the selection (i.e., the least preferred) were used as distracter items. The first two items
chosen underwent another preference assessment to ensure that the item to be taught first was an item that was likely to be highly reinforcing for the participant. In the event that the child did not respond in 30 seconds, new items were provided for the child to make a selection once more.

### 3.4.2 Data Coding

Data coding was conducted for all baseline, training and follow up sessions for each participant (i.e., 18 sessions per participant). The researcher together with a rater who was not directly related to the project rated all videos using a 5 second interval schedule. For each participant, a video session was picked at random and both raters coded target behaviours observed over 5 second intervals for a total of 10 minutes (i.e., 20% of session). In both instances, coding of target behaviours was recorded “yes/no” for a full 5 seconds even if the gesture or picture task was completed before the 5 second interval was up. In the gesture condition, the 5 second coded intervals began immediately after the question “What do you want? / What do you see” was asked and coding ended once the participant produced the gesture accurately. In the picture condition, the 5 second coded interval began after the same questions were asked and coding ended once the participant placed both the “I want” / “I see” cards and target item card onto the Velcro strip on the communication folder in the right order. The communication folder was placed on the table between researcher and participant.

Upon completion of the 10 minute coding time, inter-observer agreement (IOA) was calculated through taking the total number of agreements divided by the total number of agreements and disagreements before multiplying by 100 to get a percentage agreement (Mayer et al., 2012). For the videos that were rated less than 80%, a repeat 10-minute coding time was implemented and both raters continued rating the video until a minimum of 80% agreement was achieved.
For all sessions, a rating of 1 was provided if target behaviours were observed and 0 if no target behaviour was observed within each 5-second interval. All target behaviours were coded as long as they were present; even if not in direct response to the mand/tact questions posed. The target behaviours of interest were as follows:

- **Vocalisation.** This was defined as any word or part word made by the participant that sounded like the target vocalization. For example, “Ca..” for “comb”, “See..” for “I see”, and “Wha..” for “I want”.

- **Eye contact.** This was defined as participant looking in the direction of the researcher’s eyes after the question “What do you want?” or “What do you see?” was asked.

- **On-task behaviour.** This was defined as participant sitting at the table and looking at objects, TV monitor or researcher when requested/required, or doing actions and movements when requested/required.

50% of each participant’s sessions (i.e., 9 sessions) were cross-rated to ensure an inter-rater agreement of at least 80%. The nine sessions were chosen on a random basis from the beginning (Three sessions from session 1 – 5), middle (Three sessions from session 6 – 10) and end (Three sessions from session 11 – 16) of training sessions. If raters did not display an 80% agreement rate, the full session was re-rated by both raters once more. Across all five participants, IOA across videos was approximately 81.6% (Range, 76% - 90%), which was in line with Mayer et al. (2012) suggestion that an IOA of at least 80% would indicate high reliability of results.
3.5 Design of Study

A single case, repeated measures alternating treatment design counterbalanced across manding and tacting conditions was used. This involved:

1. **Baseline (Condition A)**. 1 week / one session. Measures of pre-treatment child verbal and non-verbal behaviour (parental report / coded 5 second observations of vocalisation, eye contact and on-task behaviour from video of 1 session)

2. **Intervention (Condition B)**. 8 weeks / 16 sessions. Implementation of a word teaching procedure using a Discrete Trial Training (DTT) method adapted from the training procedure outlined by Tsiouri and Greer (2003). Measures of vocalisation, eye contact and on-task behaviour were obtained for each session.

3. **Non-intervention follow-up (Condition A)**. One follow up session. Measure of child verbal and non-verbal behaviour (parental report, GARS-2, PLS-5 and coded 5 second observations from single follow up session). Participants will be tested through 3 different conditions:
   a. Re-test of original items (i.e., blue car)
   b. Test of alternate items (i.e., red car)
   c. Test across conditions (i.e., learnt blue car in a mand condition but now asked in a tact condition)

The independent variables were two teaching conditions (i.e., Gesture + Speech condition and Picture + Speech condition). The dependent variables were child responses using gestures or pictures, and spontaneous (i.e., non-prompted) vocalizations to mand (i.e., request) and tact (i.e., label) object. Dependent variables were assessed on a weekly basis through the study. Follow-up measures on standardised measures (i.e., PLS-5 and GARS-2) were obtained 2 months after completion of the intervention (Week 18 of study). Figure 2 shows an outline of the study.
Figure 2. Outline of study with measures done from Week 1 – Week 18.

Week 1: Baseline Phase
Parents:
- To complete the GARS-2 questionnaire to determine eligibility of participation
- PLS-5 Home questionnaire

Child:
- Administration of PLS-5 to test for language ability
- Reinforcement Preference Assessment to determine target item for testing

Week 2 – 9: Intervention Phase (Alternating teaching condition)
Child will be tasked to go through a word learning training program with the following conditions:
1. Gesture condition
2. Picture exchange condition
3. Discrimination Task
4. Testing condition

Week 18: Baseline Phase (Non-intervention follow-up)
Parent:
- Administration of GARS-2 questionnaire to determine Autism Rating and Communication scores
- PLS-5 Home questionnaire

Child:
- Administration of PLS-5
- Follow up test with different test items and across same items
3.6 Procedure

3.6.1 Baseline phase

Parent / primary caregiver of a child participant attended an initial interview at the Psychology Clinic at Murdoch University. A parent interview (1 hour) was conducted to determine whether the participant met inclusion criteria. The GARS-2 (Gilliam, 2006) was administered to confirm diagnostic criteria for inclusion into study. Child participants attended an individual session (1 hour) for administration of the PLS-5 (Zimmerman et al., 2011) and the reinforcement preference assessment (Deleon & Iwata, 1996).

To ensure that the participants had no prior knowledge of target objects, a list of questions including a mand (i.e., “What do you want?”), a tact (i.e., “What do you see?”), and questions such as, “What does this do?” “Tell me more about it” were asked to determine whether participants already had target mand or tact responses in their verbal repertoire. The amount of vocalisations, eye contact as well as on-task behaviour done when asked mand and tact questions for all initial chosen target items were calculated and scored as a baseline measure. In addition, parental reports were obtained to confirm the child’s knowledge of target items. Children who could name or provide information on more than half of the target items (i.e., more than 16) were excluded from the study.

3.6.2 Intervention phase

Once inclusion criteria were met, participants went through a word-learning program conducted over 8 weeks with participants attending two, one-hour sessions biweekly (i.e., 16 training sessions). Each session was divided into two 20-minute blocks with each participant being exposed to two different teaching methods to learn
words in each session. The first method involved the child being taught to use gestures, and the second to use pictures to mand and tact objects.

**Gesture condition – mand.** The training phase began with the question “What do you want?” and this was followed by the video showing a female adult modelling an iconic gesture for a word or phrase (e.g., mand: “I SEE COMB”) and co-occurring speech (e.g., “COMB” is vocalised). The child was given 5 seconds to respond to the question asked. A light prompt (i.e., touch hand/arm of child and physically guide to complete the whole gesture) was used to teach the child to imitate the gesture shown if no response was made. This procedure was repeated a total of 10 trials for the mand condition before gesture training for manding was completed for that session. After each complete imitation, the child was allowed to access and play with the item for 5 – 10 seconds as reinforcement before the next trial began.

**Gesture condition – tact.** A similar procedure was conducted for the tact condition where participants watched videos of an adult modelling iconic gestures (e.g., tact: “I SEE COMB”) and co-occurring speech (e.g., “COMB” is vocalised). A video of a gesture co-occurring with speech was shown and the question “What do you see?” was asked. The child was given 5 seconds to respond to the question asked before a light prompt was provided as the method above. This procedure was repeated a total of 10 trials but after each trial, the participant was not allowed to play or have the item. Instead, the participant received an unrelated item that was reinforcing and predetermined by parents (e.g., chocolate / bubbles / tokens). This information was obtained during the baseline phase through parental reports.
Picture condition – mand. In this training condition, the participant was provided with an “I want..” card and a picture of a desirable object (e.g., “COMB”) and a communication folder with a strip of Velcro® stuck down its middle. The training phase began with a question “What do you want?” If the participant did not respond in 5 seconds, he/she was prompted (i.e., touch hand/arm of child and physically move it) to place the picture on the sentence strip and give it to the communicative partner as modelled on PECS training. As this is a mand condition, the communicative partner (i.e., researcher) responded with, “Well done! You want [COMB]” and gave the requested item to the participant to play with (Bondy & Frost, 2001). This procedure was repeated for 10 trials before the tact training ended.

Picture condition – tact. Similar to the mand condition, a picture of the “I see...” card and the picture of the object was taught to the child in a similar manner as described above. As this is a tact condition, the child was not given the object, but rather was told, “Well done! You see [COMB]” and was then reinforced by an unrelated preferred object (e.g., chocolate/bubbles/tokens) as determined by the reinforcer assessment during baseline session. Again this was repeated for 10 trials before the training period ended.

Discrimination task. Once 10 trials of mands or tacts had been completed, the participant went through a discrimination task whereby the target item (e.g., COMB) was presented with two distractor items (i.e., least preferred items) as determined by the reinforcement preference assessment conducted during baseline. In this task, the three items were placed in front of the child and the question, “What do you want?” or “What do you see?” was asked following either a mand or tact condition. The three items (e.g., COMB, DOG and CUP) were rearranged in a systematic manner after each trial was
presented and the participant was given 5 seconds to respond. The figure below represents the actual procedure for a target word “COMB”.

![Diagram of target item during the discrimination task](image)

*Figure 3. Arrangement of target item [COMB] during the discrimination task.*

If participants responded either using a gesture or a picture within their respective training conditions praise, such as “Well done!” was given and participants’ response was reinforced with the item [COMB] in a mand condition or an unrelated preferred item in a tact condition. If no response was provided, or if the participant moved away within 5 seconds of presentation, gentle prompting was provided (i.e., touch hand/arm of child and physically move it). Five trials of this task were administered after each mand picture/gesture condition as well as after each tact picture/gesture condition. This activity was included to help participants learn to discriminate target items from other distractor objects to help reduce novelty of task during the testing phase.

To ensure equity of trials administered in both picture and gesture conditions, all participants were first administered the mand gesture condition in session one and the
mand picture condition in session two (Refer to Figure 4 for a detailed procedure of each training session). To determine mastery of a word, eight consecutive accurate responses during the mand and tact conditions respectively, three consecutive accurate responses during the discrimination task, and two consecutive accurate responses during the testing phase were required before participants progressed to the next target item.

**Figure 4.** Detailed procedure for training sessions in the mand condition.

Every target word picked (e.g., COMB) will first be taught using the gesture condition before the picture condition. Each condition will be repeated an equal number of trials. The conditions were counterbalanced in order to avoid any order effects. The
tact condition will be trained using the same procedure. All words learnt were matched on familiarity and frequency based on the ELP (Balota et al., 2007) criteria.

Testing phase. After 30 trials of mands or tacts (i.e., 15 trials of gesture and 15 trials of picture), a testing phase was conducted to determine whether participants had learnt the word. The method of communication, either through use of a gesture or a picture to communicate was also determined. During this phase, the participant was exposed to the target items learnt and these were placed on the table in front of the child. All relevant laminated picture cards were placed on the communication folder, which was placed next to the computer showing a still screenshot to represent the gesture condition. Figure 5 shows the set up for the testing condition:

*Figure 5*. Set up for testing phase with target item placed on the table. Gesture and picture conditions were represented through use of the computer showing a still image of the video of the female adult used in the gesture training condition and a laminated picture card of the object respectively. These were placed on a table equidistant away from the child. Parent could observe the session but could not participate in proceedings.
During the mand condition, the participant was asked the question, “What do you want?” and during the tact condition asked, “What do you see?” no prompts were provided. If participant did not respond, training was repeated. If two consecutive accurate responses were made, participants were considered to have mastered the word and the next teaching condition (i.e., either a mand or tact condition) for a new word commenced.

**Non-intervention follow-up phase.** Upon completion of the word-learning program, follow-up data was obtained 2 months later (i.e., Week 18 of study) to assess the long-term maintenance of acquired word knowledge and communication skills. During follow-up sessions, both parent/primary caregiver and child attended a single session at the Murdoch Psychology Clinic. The parent/primary caregiver again completed the GARS-2 and the participant was administered the PLS-5 to assess changes in language ability.

In addition, participants were administered the same test procedure as described previously for all words previously learnt. Testing occurred under three conditions:

1. Testing using the same objects as used in teaching programme by the same (original) researcher.

2. Testing using different items from those used in the teaching programme (e.g., Red comb, blue comb, white comb) by the original researcher.

3. Testing using the same objects as used in the teaching programme across mand and tact conditions (i.e., words originally learnt under mand condition were now tested in a tact condition).

Throughout the study, no attempt was made to prompt the children to engage eye contact with the researcher, nor to make vocalisations, nor to maintain on-task
behaviour once a trial had begun nor were these behaviours targeted for contingent reinforcement.

3.7 Treatment Integrity

Fidelity of the intervention was ensured through the researcher and a rater with no direct relation to the project independently coding a randomly selected 30% sample of word learning training videos. Researcher would be scored “1” if she

• Correctly asked the target questions for mand / tact conditions respectively without providing additional prompts.

• Prompted the child only after 5 seconds of non-response in both the mand / tact conditions and across modes of communication (i.e., picture / gesture).

• Provision of target item for child to play in the mand condition and provision of other reinforcing item in the tact condition.

The researcher would be scored “0” if she:

• Provided additional prompts after the target question was asked which influenced vocalisation, eye contact or on-task behaviour

• Or omitted steps in the procedure (i.e., less than 8 trials before changing target item)

According to Mayer and colleagues (2012), treatment integrity could be assessed through dividing the number of correct instances by the total number of correct and incorrect instances and multiplying this by 100. In this study, percentage of treatment integrity was assessed to be 95% per session, which reflects a high treatment integrity leading to greater reliability of results obtained. Although a further exploration of the
data by participant and behaviour would be interesting, this would involve a
considerable quantity of additional information and is beyond the scope of the project.

3.8 Inter-Observer Agreement

Inter-observer agreements (IOA) were calculated based on the number of
accurate mands and tacts per participant (Tsiouri & Greer, 2003). This was calculated
by taking the total number of agreements per 5-second interval divided by the total
number of agreements and disagreements before multiplying by 100 to get a percentage
agreement (Mayer et al., 2012). IOA was calculated for 20% of sessions for each
participant (i.e., three sessions). The mean IOA for mands and tacts for each participant
is presented in the Table 2 as follows:

<table>
<thead>
<tr>
<th>Participants</th>
<th>Mand</th>
<th>Range</th>
<th>Tact</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tom</td>
<td>95.3%</td>
<td>92% - 98%</td>
<td>95%</td>
<td>92% - 96%</td>
</tr>
<tr>
<td>Harry</td>
<td>90.3%</td>
<td>87% - 94%</td>
<td>89.3%</td>
<td>85% - 93%</td>
</tr>
<tr>
<td>Jamie</td>
<td>94%</td>
<td>92% - 96%</td>
<td>92.7%</td>
<td>87% - 98%</td>
</tr>
<tr>
<td>John</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>98% - 100%</td>
</tr>
<tr>
<td>Alex</td>
<td>90.3%</td>
<td>88% - 93%</td>
<td>89%</td>
<td>84% - 93%</td>
</tr>
</tbody>
</table>

The average IOA agreements reported for this study were above 85%. Following Mayer
et al.’s. (2012) argument, having an IOA of 80% and above would increase the
reliability of the results and be more likely to represent the performance of the
participants through the word-learning intervention.
4. Results

Figure 6 shows the number of trials required to learn each new word (dotted lines indicate new word) for each participant across picture and gesture teaching methods for the mand and tact condition.

**Mand Condition**

- **TOM**
- **JAMIE**
- **ALEX**

- **JOHN**
- **HARRY**
Figure 6. Number of trials required learning new words (eight out of 10 trials correct) across picture and gesture methods in the mand and tact conditions.
4.1 Picture and Gesture Methods during Intervention Phase

In comparing the average number of trials required to master using a new word functionally as a mand or tact, the results suggest that eliciting it as a mand function required fewer trials than as a tact function. A paired samples t-test confirmed that there was a significant difference in the number of trials taken for using a new word correctly as a mand ($M = 19.94, SD = 7.74$) compared to using the new word as a tact ($M = 24.26, SD = 8.74$), $t(4) = -2.97, p = .04$. Table 3 shows the average number of trials taken for each participant per condition.

Table 3

<table>
<thead>
<tr>
<th>Participant</th>
<th>Mand M</th>
<th>Mand SD</th>
<th>Tact M</th>
<th>Tact SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tom</td>
<td>25</td>
<td>10.5</td>
<td>28</td>
<td>4.5</td>
</tr>
<tr>
<td>Harry</td>
<td>16.7</td>
<td>5.2</td>
<td>17.5</td>
<td>9.6</td>
</tr>
<tr>
<td>Jamie</td>
<td>18</td>
<td>13.0</td>
<td>27.5</td>
<td>9.6</td>
</tr>
<tr>
<td>John</td>
<td>10</td>
<td>0</td>
<td>13.3</td>
<td>5.2</td>
</tr>
<tr>
<td>Alex</td>
<td>30</td>
<td>14.1</td>
<td>35</td>
<td>21.2</td>
</tr>
<tr>
<td>Overall Mean</td>
<td>19.9</td>
<td>7.7</td>
<td>24.3</td>
<td>8.7</td>
</tr>
</tbody>
</table>

Based on the graphical data displayed in Figure 6, an overall finding was that four out of the five participants required fewer or equal number of trials to learn a new word to 80%+ accuracy using pictures as compared to gestures. The data obtained on the discrimination task suggest a similar finding with fewer trials required on the picture task for both mand and tact conditions. Figure 7 shows the number of trials required for participants to learn new words to accuracy (i.e., provide an accurate response at least three out of five trials) on the discrimination task for both a mand and tact condition.
The only participant to show a preference for the gesture method during intervention and discrimination task activities was Harry.
GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD

Mand Condition

- TOM
- JAMIE
- ALEX
- JOHN
- HARRY

- ■ Picture
- △ Gesture
Figure 7. Number of trials required to apply words learned accurately (three out of five trials) across picture and gesture conditions in the mand and tact condition for the discrimination task.
4.2 Preferred Mode of Communication

Results indicated that initially fewer trials were required for picture-based communications over gesture-based methods when learning new words. However, when participants were given a free choice in how the new words learned were communicated, all of them used gesturing as the mode of communication (see Figure 8). Tom was observed to use both picture and gesture as a mode of communication in the initial sessions although gesture was employed more consistently as a more reinforcing method for communicating both mands and tacts. For the other four participants, all of them used gesturing early on in sessions. Missing data points were largely due to absences caused by illness.

Non-intervention follow-up phase. Results obtained 2 months post intervention show similar results to those obtained during the study. All five participants chose to either vocalise “I want [target item]” / “I see [target item]” or vocalised with simultaneous production of gesture when asked to mand or tact over three different tests. Over the three different tests (see Methods section, p. 54) when given free choice, none of them chose to exchange pictures and spontaneously used gestures learned during the intervention (see Figure 8). Table 4 details the average percentage use across sessions of communicative methods used by each participant.
Table 4

Mean percentages and SDs for the modes of communication used by each participant across all testing sessions when given a “free choice”.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gesture (%)</th>
<th>Picture (%)</th>
<th>Gesture and Picture (%)</th>
<th>Vocalisation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>TOM</td>
<td>71.6 29.4</td>
<td>0.02 0.08</td>
<td>21.1 30.9</td>
<td>94.1 16.6</td>
</tr>
<tr>
<td>HARRY</td>
<td>81.1 33.2</td>
<td>0 0</td>
<td>0.01 0.03</td>
<td>69.6 38.7</td>
</tr>
<tr>
<td>JAMIE</td>
<td>85.2 19.0</td>
<td>7.5 17.3</td>
<td>0 0</td>
<td>75.5 34.9</td>
</tr>
<tr>
<td>JOHN</td>
<td>100.0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>100 0</td>
</tr>
<tr>
<td>ALEX</td>
<td>70.3 42.1</td>
<td>6.7 25.8</td>
<td>1.7 6.45</td>
<td>77.2 39.9</td>
</tr>
<tr>
<td>Overall</td>
<td>81.6 12.0</td>
<td>2.8 3.9</td>
<td>4.8 9.9</td>
<td>83.3 13.1</td>
</tr>
</tbody>
</table>

The results show that gestures and vocalisations were used more than 80% of the time when participants were given a free choice of mode of communication and these results were generalised and maintained at the follow up post intervention test conducted 2 months later.
Figure 8. Mode of communication used when given free choice to use the new words learned in an autoclitic frame such as “I want” and “I see”.

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When analysing the results for any differences obtained in the mand and tact conditions in the follow up phase, results indicated that mands were more easily learned and generalised across items and untaught conditions compared to tacts. Figure 9 shows the results for participants’ performances in mand and tact conditions. Across all five participants, more accurate responses were made for the mand condition ($M = 97.54$, $SD = 3.39$) compared to the tact condition ($M = 66.78$, $SD = 20.06$). This difference was significant; $t(4) = 3.44$, $p = .026$.

**Non-Intervention Follow Up**

![Bar chart showing percentage of accurate use of new words](chart.png)

*Figure 9*. Percentage of accurate use of new words when elicited in mand and tact conditions in autoclitic frames of “I want” and “I see” during the non-intervention follow up phase.
4.3 Vocalisation, Eye Contact and On-Task Behaviour

**Vocalisation.** Results from recordings of spontaneous vocalisations, eye contact with the communicative partner, and on-task behaviour (i.e., engaging in activity, sitting on chair and looking at materials) using 5 second interval schedules through baseline, intervention and follow-up phase are shown in Figure 10. Four out of five participants produced significantly greater spontaneous vocalisation in the gesture-based condition compared to the picture-based condition. There were increasing vocalisations over the 8-week program and these were maintained in the post intervention follow-up session. Tom’s results showed greater vocalisation in the picture-based method over the gesture-based method although both methods resulted in increasing spontaneous vocalisations as intervention progressed (see Figure 10).

**Eye Contact.** When comparing the gesture-based method to the picture-based one, all five participants were found to engage in greater eye contact with a communicative partner in the gesture-based teaching condition across all intervention sessions (see Table 5). In addition, all five participants showed an increase in eye contact as sessions progressed and the trend was maintained in post intervention follow-up sessions (see Figure 10).

**On-Task Behaviour.** Both Tom and John were observed to have generally high levels of on-task behaviour across all sessions including the follow up session, whereas Harry, Jamie and Alex had sessions with low on-task behaviour particularly in the first half of the intervention phase. However, their on-task behaviour was found to increase in gesture- and picture-based conditions as sessions progressed and their gains in on-task behaviour were maintained during the follow-up session 2 months later (see Figure 10 and Table 5).
Table 5

*Significance of mean difference between percentage of vocalisations, eye contact and on-task behaviour observed between gesture- and picture-based conditions*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Vocal Contact</th>
<th>Eye Contact</th>
<th>On-Task Vocal</th>
<th>Eye Contact</th>
<th>On-Task Vocal</th>
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<td>Gesture - Picture</td>
<td>-13.10*</td>
<td>34.53**</td>
<td>1.29</td>
<td>30.7**</td>
<td>42.2**</td>
<td>24.7**</td>
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<td>45.1**</td>
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<td>36.1**</td>
<td>6.00*</td>
<td>14.85*</td>
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</tbody>
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*p < .05. **p < .01.*
GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD

Vocalisation

- **TOM**
- **JAMIE**
- **ALEX**
- **JOHN**
- **HARRY**

- **Baseline**
- **Picture**
- **Gesture**
- **Follow Up**
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Eye Contact

- TOM
- JAMIE
- ALEX

- JOHN
- HARRY

Legend:
- ▲ Baseline
- ■ Picture
- △ Gesture
- ▲ Follow Up
Figure 10. Percentage of spontaneous vocalisation, eye contact and on-task behaviour observed through baseline, intervention and non-intervention follow-up phases.
4.4 Overall Language Ability

**GARS-2 rating.** Parents rated their child’s behaviour during baseline and at post-intervention follow up on the GARS-2 (Gilliam, 2006) rating scale. Four out of five participants showed a decrease in raw scores obtained on the communication subscale and a lower overall Autism Index score. Tom’s score on the communication subscale increased and his Autism Index score remained the same between baseline and post-intervention follow up. Figure 11 shows the scores obtained by each participant on the GARS-2 (Gilliam, 2006) rating scale.

![GARS-2 scores](image)

*Figure 11.* Raw scores on the communication subscale and overall Autism Index on the GARS-2 rating scale at baseline and post-intervention follow-up.
PLS-5 rating. Parents rated their child’s language ability using the PLS-5 (Zimmerman et al., 2011) and results from baseline and the follow up session are shown in Figure 12. All participants scored higher on the auditory comprehension, expressive communication and total language score domains during the post-intervention follow up session compared to the pre-intervention baseline.

Figure 12. Raw scores obtained on the PLS-5 at baseline and non-intervention follow-up.
5. Discussion

In reviewing the literature on communication, gestures have been more commonly researched in the field of speech production and later language development, with accounts documenting gesture and speech to be a single, integrated system. Employing an evolutionary theory of language development, it is believed that gestures preceded more complex speech production and value added communication through the semantic information that iconic gestures in particular brought while conversing (Capone & McGregor, 2004; Goldin-Meadow, 2000; Iverson & Thelen, 1999; McGregor et al., 2009; McNeil et al., 2000; Sowden et al., 2008). This has led to increasing interest in the use of iconic gestures as non-verbal communication supports.

Though research on sign language as an AAC was popular in the 1970s and 80s, these waned with the introduction of picture communication systems like PECS which provided clear advantages over manual signing as earlier discussed. However, more recently, there has been very little interest in evaluating present formal sign systems such as AUSLAN (Johnston & Schembri, 2007) and Key Word Sign (formerly known as Makaton; Grove & Walker, 1990) and even less on iconic gestures in early interventions for children with ASD. This study focused on the least researched area, setting out to explore the effects iconic gestures have on early language, in particular learning new words within an autoclitic frame, on early communicative behaviour including spontaneous vocalisations and eye contact, and compliance and attention to tasks.

To date, most studies in the literature on manual communication (i.e., usage of hands in communication) have largely focused on motor imitation (Ross & Greer, 2003; Tsiouri & Greer, 2003; Tsiouri, Simmons, & Paul, 2012), sign language (Carr et al., 1978; Chambers & Rehfeldt, 2003; Luftig, 1972; Watters, Wheeler, & Watters, 1981) with few studies employing gestures (Ingersoll & Lalonde, 2010; Ingersoll et al., 2007).
or in particular, iconic gestures (Kurt, 2011; Stefanini, Bello, Caselli, Iverson, & Volterra, 2009) as a method for comparison with other motor or object imitation conditions. More importantly, there have been no studies in the literature that have attempted to compare iconic gestures to a picture-based system for word learning and functional communication. The argument made for iconic gestures being a preferred method for communication and learning will be further explored through the discussion.

5.1 Gesture-based and Picture-based Teaching Methods

The study compared the efficacy of an iconic gesture-based teaching method and a picture-based teaching method. Both methods were found to help children with ASD acquire words within an autodictic frame (i.e., “I want…” “I see…” ) as all participants achieved at least 80% accuracy during the 16 sessions (16 hours) intervention phase. The findings are in line with research suggesting that picture-based systems (Barlow et al., 2013; Cihak et al., 2012; Charlop-Christy et al., 2002; Tincani, 2004) as well as sign systems (Carbone et al., 2010; Konstantareas et al., 1977; Watters et al., 1981; Wraikat, Sundberg, & Michael, 1991) can be used as teaching methods for children with ASD when learning new words or phrases.

When given equal opportunities to learn new words in both the gesture-based and picture-based condition, the results indicated that fewer trials were required to reach mastery in the picture-based method across mand and tact conditions. On first look, this finding seems to support the conclusion that the picture-based system led to more rapid learning as has been found with other selection based (SB) systems compared to topographic (TB) systems (Barlow et al., 2013; Chambers & Rehfeldt, 2003; van der Meer et al., 2012; Ziomek & Rehfeldt, 2008). However, three (Alex, John and Tom) out of the four participants who initially learnt more quickly with the picture system either
had been taught some stages of PECS prior to the study or were engaged in a home /
centre-based intervention programme involving the use of PECS.

Jamie and Harry, however, had not received any PECS or other picture
communication training. The results showed that Jamie required a similar number of
trials to learn new words/phrases in both gesture and picture conditions, while Harry
required fewer trials and had more accurate responses in the gesture-based method
compared to the picture-based method. The presence of at least some PECS training
prior to participation in this study could have influenced Alex, John and Tom’s initial
speed of learning new words/phrases with pictures given the familiarity of the teaching
method. Harry and Jamie’s results, however, indicate that if given an equal experiential
starting point, a gesture-based system might be as easily learnt and used as a picture-
based method. More importantly, during the testing and follow up phases when
participants were free to choose gestures or pictures when asked to respond to the
communicative partner in the mand or tact condition, although three of the participants
had acquired accurate manding and tacting responses quicker when using a picture-
based system, all five of the participants used iconic gestures exclusively in both
conditions.

Possible reasons for gesture preference could be that the gestures taught were
simple motor movements that required relatively little effort to acquire. Certainly the
fine-motor responses required for the picture-based method were as demanding and
actually required longer to initiate when responding to the communicative partner’s
requests. Unlike picture-based systems, iconic gestures do not require resources and
environmental supports, such as communication books and cards, making them portable
and similar to speech (Sundberg, 1993). In this study, children who used gesturing
could mand the preferred toy immediately rather than having to get up from their seat,
select and pick up the target card before placing it on the sentence strip in their
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communication book to indicate “I see..” and “I want..”. This meant less effort was used to mand or tact items, which in turn led to more efficient use for communicative purposes and more immediate contact with reinforcement. Richman, Wacker and Winborn (2001) studied the effect of effort on response allocation and found that children with developmental delays were more likely to respond (e.g., show aggression, use picture exchange or sign “please”) in forms that required the least effort for reinforcement. Buckley and Newchok (2005) also found that low effort mands were preferred (e.g., taking TV card and passing to primary instructor who was seated next to child) compared to high effort mands (e.g., walking to a board placed a distance away, taking the TV card and coming back to the seat to pass it to the primary instructor), with more aggression displayed during high effort mand conditions.

Sundberg (1993) argues that many signed response forms are representational, which could make sign acquisition easier compared to a pictorial or vocal response acquisition and Thompson (2011) explains that iconicity of sign language could lead to even quicker acquisition. A retrospective study was conducted to specifically compare iconic gestures with AUSLAN signs for the same words and found that there was a clear difference in comprehension by children aged 4 to 6 years between words formally signed in AUSLAN compared to those gestured in an iconic form (see Methods section, p. 40 / Appendix E for study details and analyses of results). Evidence for differences in young children’s immediate understanding of words when spoken with iconic gestures showed support for the ‘iconicity hypothesis’ (Angermeier, Schlosser, Luiselli, Harrington, & Carter, 2008; Schlosser & Sigafoos, 2006; Sundberg, 1993). Although still debatable, these findings have also been supported by results in other domains involving new learning, comprehension and memory recall (Driskell & Radtke, 2003; Cook & Goldin-Meadow, 2006; Goldin-Meadow, 2004; Goodrich & Kam, 2009; Hostetter, 2011; Kelly, Özyürek, & Maris, 2010; Kendon, 1997).
5.2 Communicative Behaviour

The study compared picture-based and gesture-based methods of teaching words within an autoclitic frame to not only determine if there was a difference in speed of acquisition, but to also determine whether other, untaught communicative and compliant behaviours were influenced by the teaching methods. Communicative behaviour was defined as sounds, part word and word vocalisations and was measured using a 5 second observation schedule (See Methods section, p. 45) and eye contact, and attending behaviour (compliance) was defined as on-task behaviour (e.g., participant sitting at the table and looking at objects, TV monitor or researcher when requested/required, or doing actions and movements when requested/required).

Participants displayed an increase in vocalisations across both methods of teaching. Notably, however, except for Tom and Jamie, the other participants showed a higher percentage of vocalisations per 5 second observation in the gesture (77%) compared to the picture condition (58%). An increase in vocalisations and words has been found through using PECS (Charlop-Christy et al., 2002; Preston & Carter, 2009; Yokoyama, Naoi, & Yamamoto, 2006) as well as using manual sign systems (Ingersoll & Lalonde, 2010; Tsiouri & Greer, 2003; Tsiouri et al., 2012). A case study reported by Cole, Gallagher and McNeill (2002) suggested that gestures, especially iconic gestures, share additional semantic and communicative aspects (Iverson & Thelen, 1999; McGregor, 2008), which could be a reason for spontaneous vocalisations made by participants in this study. To date, it has been difficult to find research comparing gesture-based to picture-based communications, which makes these findings more important as a contribution to current literature.

In comparing data obtained on frequency of spontaneous eye contact, all participants were found to display more eye contact with a communicative partner during gesture-based teaching sessions compared to picture-based teaching sessions.
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This is encouraging given the atypical processing of information from faces seen in children with ASD, with less attention on the eyes and more attention on the lower part of the face (Kaartinen et al., 2012). There has been very little measurement of spontaneous eye contacts as an outcome of communication interventions with most evaluations focusing on vocal output and reduction of aggressive behaviour. Spontaneous increases in eye contact are important, as they are a missing or weak component that frequently underlies poor social skills and language acquisition observed in children with developmental disabilities and especially children with ASD (Arnold et al., 2000; Stone et al., 1997; Watson et al., 2003). Support for increases in eye contact following gesture use can be obtained from sign language research where both native and beginning signers fixated primarily on the signer’s face when conversing (Emmorey, Thompson, & Colvin, 2009). This could provide a basis for increased eye contact when using iconic gestures when communicating mands and tacts compared to the picture condition which might reduce eye contact opportunities or even need for eye contact when children are looking down attending to pictures and sentence strips prior to and when providing answers to requests.

In the present study, three participants (Harry, Alex and Jamie) initially displayed high incidences of off-task behaviour before becoming more compliant as sessions progressed. On-task behaviour as defined above (See Methods section, p. 45) was found to be higher in the gesture-based condition as compared to the picture-based condition (approximately session 6 – 9, see Results section p. 57) for these three participants when measured at intervention completion. Tom and John displayed equally high levels of on-task behaviour in both conditions. PECS has been found to aid in the reduction of problem behaviour (Buckley & Newchok, 2005; Charlop-Christy et al., 2002; Frea et al., 2001) but few researchers have explored the effects of gestures in reducing aberrant behaviour. Buckley and Newchock (2005) showed that in high effort
conditions, aggression occurred rather than picture-exchanges for manding. This could be a reason for off-task behaviour being higher in initial sessions due to the greater effort required in using new gestures over familiar pictures. Research on problem behaviour in children with ASD indicates that with communication training, problem behaviours usually decrease due to more efficient and effective communication (Charlop-Christy et al., 2002; Lancioni et al., 2007). It is possible that the gradual increases in vocalisations and eye contact observed as sessions progressed indicated the development of more effective and efficient communication through gesture-based learning.

5.3 Manding and Tacting

In this study, we aimed to find out if there would be a difference in the number of trials taken for manding and tacting and whether the teaching method used to teach new words (i.e., accompanied by pictures or gestures) would influence the number of trials required for acquiring functional communication. As utilised by Barlow et al. (2013), an alternating treatments design was used to ensure that participants had equal opportunity to mand or tact items in either a picture- or gesture- based condition when embedded in the autoclitic frames “I want..” and “I see..” . The new words/items chosen were based on a reinforcement preference procedure (DeLeon & Iwata, 1996) and were rated as highly familiar (see Appendix C for details) (Yap et al., 2011).

The results showed that participants took fewer trials on average to use the new words in mand functions (i.e., where the highly reinforcing item requested was given to them contingent upon their accurate request made) compared to using them in tact functions (i.e., where a general, unrelated social reinforcer was delivered contingent on an accurate label). This finding was consistent with previous results obtained on mand and tact research (Barlow et al., 2013; Carroll & Hesse, 1987; Ross & Greer, 2003;
Sigafoos, Reichle, Doss, Hall, & Pettitt, 1990). Importantly, results at post-intervention
follow-up two months later show that the increased accuracy of using the newly learned
words in a manding function over tacting was maintained and generalised across the
three testing protocols involving the original words and corresponding items, alternate
items, as well as across untaught items (i.e., tact items tested in a mand condition and
vice versa). In the tact condition, participants were found to make more errors, with a
few participants responding within the autoclitic frame of “I see” by taking the item
instead of pointing at it. Participants generally showed less accuracy in untaught tact
conditions than in untaught mand conditions.

Additionally, the results showed evidence for tact to mand transference, showing
that emergence of mands could occur without direct training (Kooistra, Buchmeier, &
Klatt, 2012; Sigafoos et al., 1990; Wallace, Iwata, & Hanley, 2006). Kooistra and
colleagues (2012) found that there was an emergence of signed mands after tact training
though only for high preference items. Sigafoos et al. (1990) tested two learners and
found that two out of three mands emerged without direct training, though they noted
that having appropriate symbol discriminations was necessary. Wallace et al. (2006)
also found that manding high preference items maintained much better when compared
to manding low preference items. However, unlike the findings reported by Egan and
Barnes-Holmes (2009) and Finn, Miguel and Ahearn (2012), mand training did not lead
to consistent production of untaught tacts under testing conditions. This is similar to
Kelley, Shillingsburg, Castro, Addison and LaRue’s (2007) finding of successful tact to
mand generalisations compared to mand to tact generalizations.

In addition to the above findings on improved communicative behaviour and
manding ability, improvements in all participants’ communication skills were
confirmed by increases in the GARS-2 (Gilliam, 2006) Communication subscale as well
as the Comprehension, Expression and Total Language scores on the PLS-5
GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD (Zimmerman et al., 2011). Despite the short intervention period of 8-weeks gains made were maintained after the teaching sessions terminated. In this study, teaching iconic gestures did not lead to difficulties in generalisation across settings and people, which has been reported to be a common disadvantage for use of topography-based systems like sign language (Rotholz, Berkowitz, & Burberry, 1989). Also, across all participants except Tom, whose ratings remained the same, all parents generally rated their child as displaying less autistic behaviour leading to an overall reduction in Autism Index scores as rated on the GARS-2 (Gilliam, 2006) at follow-up.

5.4 Implications

The results of the study suggest that iconic gestures can play an important role in teaching children with ASD, especially in the early days of communication and language development. Iconic gestures may positively affect verbal and non-verbal communication skills when taught to children with ASD as well or even more so than a well-established picture-based methods, reflecting the embedded nature of speech and gestures in the domains of communication and language (Goldin-Meadow & Alibali, 2013; Goodrich & Kam, 2009; Iverson & Thelen, 1999; Lacerda & Sundberg, 2006; So, Kita, & Goldin-Meadow, 2009; Sowden et al., 2007; Valentino, Shillingsburg, & Call, 2012; Yap et al., 2011). As there has been little research in the area of iconic gestures for teaching children with ASD, the results have implications in the areas of clinical and educational practice and future research.

5.4.1 Clinical Practice

Taking a clinical perspective, the study provides several implications in the area of teaching, proposing that iconic gestures could be used to teach children with ASD words and more importantly, functional communication (Cook & Goldin-Meadow,
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2006; Luyster & Lord, 2009; McGregor, 2008; Roth, 2000). This is important, as it has been well researched that children with ASD display poor motor functioning, speech deficits and difficulties with social skills (Carmo et al., 2013; Chan et al., 2005; Ham & Bartolo, 2011; Llaneza et al., 2010; Rapin et al., 2009). This leads to great difficulty in effective communication, which tends to result in behavioural difficulties and poor social interactions amongst peers (Charlop-Christy et al., 2002). As an alternative or an addition to a picture-based method, the use of iconic gestures could address the need for portability and less dependence on intrusive, effortful materials (Sundberg, 1993). Incorporating video modeling of iconic gestures together with in-vivo prompting and reinforcement could also be an effective strategy to aid children in acquiring appropriate communicative behaviour (Carr et al., 1978; Konstantaras et al., 1977; Layton, 1988). This in turn could promote socially appropriate means of communicating that increase natural and spontaneous social interaction amongst peers (Goldin-Meadow, 2000). Furthermore, iconic gestures are widely accepted to be more universally understood compared to sign language, suggesting that other teachers or peers do not need special training to understand the child’s needs (Mirenda, 2003; Thompson, 2011). Use of gestures while conversing has also been found to improve comprehension of the listener with semantic information gained from complementary hand movements while speaking (Goldin-Meadow, 2000; Iverson & Goldin-Meadow, 2005; Roth, 2000). There are limits to the range of vocabulary that can be included in iconic gestures. However, as a supplement to establish child initiations and entry to communities of social and interpersonal reinforcement, training children with ASD to produce natural gestures while learning to speak could enhance early communication beyond just vocalisation of words.

In looking beyond this profile of children, children with other issues such as specific language impairment (Loucas et al., 2008; Williams et al., 2008), speech delays
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as well as other developmental delays (Iverson et al., 2003) could also benefit from training in use of iconic gestures to aid in their communication with others. Given that children with ASD are believed to be at a high risk of having poorer outcomes of overall language development and nonverbal communication (Geurts & Embrechts, 2008; Williams et al., 2008), it would be logical to be optimistic about the possible benefits such training could provide to other children who are not as delayed. Indeed, with the introduction of iconic gestures in early childhood programmes, there is a possibility that this method could aid typically developing as well as delayed children’s production of speech or vocalisations and might have a positive influence on later social and language development.

5.4.2 Research: Positives and Limitations

Despite a thorough review of literature it has been difficult to find comparisons of gestural and pictorial methods for teaching new words that function as mands and tacts. Single-case alternating designs as used here can offer benefits for scientist-practitioners working with small numbers of children in clinical or home-based teaching programmes, including increased sensitivity to measurement of changes over time within an individual and the establishment of functional relations between targeted dependent variables and possibly innovative independent variables. Alternating treatment designs, however, can lead to multiple interferences and spill-over effects from one condition to another. It is possible that one instructional procedure could promote performance under the other condition (e.g., picture exchange training could lead to production of iconic gestures and vice versa) (Barlow et al., 2013).

Another issue is that some of the participants had prior experience with at least some stages of PECS training. Although two of the participants had no prior exposure to PECS, the other three were either having ongoing PECS training or had completed
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PECS prior to the study which might indicate a possible bias in favour of picture-based learning. In accordance with this, the results indicated greater ease of learning using pictures in the early training sessions for three of the participants. When given free choice, however, gestures were used as the preferred mode of communication across all five participants. Although there did not seem to be a bias in this study, future research could look at recruiting children with no exposure to PECS so as to better determine the effects of one method over the other on new word learning.

One other possible limitation was the use of GARS-2 as a measure of participant’s actual communicative repertoire. In this study, the Gilliam Autism Rating Scale 2nd Edition (GARS-2; Gilliam, 2006) was administered to assess for ASD (Klose, Plotts, Kozeneski, & Skinner-Foster, 2012) as well as provide a measure of their communicative abilities before and after intervention. Klose and colleagues (2012) found that the GARS-2 minimally addressed some target items such as non-verbal behaviour, ability to sustain conversations as well as stereotyped use of language; which are specific criteria pertaining to communication. Pandolfi, Magyar and Dill (2010) also found that some GARS-2 subscales measured multiple constructs with several items not Autism specific in nature (e.g., responds inappropriately to simple commands). As this study used GARS-2 as a supplementary tool to the PLS-5 (Zimmerman et al., 2011) to determine overall communicative ability, these limitations did not seem to have a profound impact on analysis of results. However, future research could look into the use of more stringent tools or scales that assess specific areas of communication so as to better understand the direct impact gesture training has on these children with ASD.

A final limitation could be the general difficulty in identifying iconic representations for a wider vocabulary and more complex phrases and sentences. This is similar to the stated disadvantages of sign language when generalising and using signs beyond context-bound requesting and commenting (Rotholz et al., 1989). There is a
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possibility that iconic gestures are most suitable for and best used during early word and phrase recognition.

Understanding the advantages that iconic gestures can bring when compared to picture-based methods provides a preliminary start for further research to bridge the gap between gesture and behavioural communication research. To further the understanding of the role gestures can play in the language development of children with ASD, longitudinal studies incorporating the use of iconic gestures during early intervention programmes could be carried out and evaluated with children of different ages and pre-requisite skills. This is essential as the outcomes of this study are relevant to the individual participant’s profiles and generalizability to other children (e.g., children without an imitation repertoire or ability to use functional words) is limited. Future research could employ longitudinal study designs to aid in validating alternative teaching methods and provide practitioners with greater flexibility when matching methods to individuals in their intervention programmes.

6. Conclusion

In conclusion, gestures have been well researched as an important component of children’s word learning, comprehension, memory and recall. More importantly, gestures have been considered to be embedded with, and even to precede, speech production in typically developing populations as well as populations with developmental disabilities. As deficits in speech and communicative ability have been found to be core characteristics of children with ASD, it is interesting that research has not yet fully evaluated the use of iconic gestures as a teaching method for these children. The results obtained show support for iconic gestures being more easily used and generalised across items and across manding and tacting conditions. This indicates that iconic gestures could be an alternative or supplementary teaching method to the
more established communication systems for children with ASD. It is important to note that it is not our intention to suggest that iconic gestures replace PECS or sign language systems as a method for teaching children words within an autoclitic frame. This paper focuses simply on comparing between picture- and gesture-based systems for functional communication teaching.

This study set out to bridge the gap in the literature and provided empirical support for the use of iconic gestures in word learning for some children with ASD. It also extends the literature on gesturing and communication by showing that gestures can not only lead to the generalized use of new words within autoclitic frames but can positively affect other spontaneous socio-communicative behaviours, such as vocalisations, eye contact and increased compliance to requests which are considered common problems displayed by children with ASD. Future researchers could look at replication studies through early intervention programmes to identify possible profiles of children who might particularly benefit from gesture-based methods, designed to enhance speech, communication and language skills; to enhance functional communication for this unique population.
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http://www.signplanet.net/Default.asp?Vocab=ALN
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Tomasello, M. (2007). If there are so good at grammar, then why don't they talk? Hints from apes' and humans' use of gestures. *Language Learning and Development, 3*(2), 133-156.


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Participant recruitment flyer sent to local Education Support Centres, Child Wellbeing Clinics and Specialist Language Centres in the metropolitan area of Perth, WA.
Appendix B

Pictures of actual (1\textsuperscript{st} column) and follow-up items (2\textsuperscript{nd} column) used in the study.

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GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD

Appendix C

Word characteristics of target words used during the study.

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Note. Freq_KF, Frequency norms based on Kucera & Francis (1967), NSyll, Number of syllables, FAM ratings, Familiarity ratings of words
Appendix D
All 33 picture cards used for the picture-based condition for word learning training.

- SPOON
- SPADE
- TRAIN
- FISH
- APPLE
- DOG
- HAT
- BALL
- BOOK
- CUP
- COMB
- KEY
- PHONE
- PENCIL
- I SEE
GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD

WATCH

TOOTHBRUSH

CAR

BABY

SCISSORS
GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD

Appendix E

To assess their relative ease of understanding, iconic gestures were compared with gestures of words in the Australian Sign Language (AUSLAN) system, a selection of words from the final sample were presented to a group of 52 typically developing children aged between 4 – 6 years of age from the same kindergarten in Singapore who had never seen any of the signs or gestures nor asked their meaning. Out of the 32 words shown, 13 were categorised as iconic gestures and 19 were categorised as non-iconic gestures. Table A1 shows the words as categorised by the researcher. Words were categorised as iconic in nature if the sign language action was similar to the iconic gestures used in the present study.

Table A1

| Words categorized as iconic or non-iconic within the Auslan sign language protocol. |
|------------------------------------------|-----------------
| Iconic                  | Non-Iconic     |
| Train                   | Spoon          |
| Bell                    | Fish           |
| Comb                    | Apple          |
| Rabbit                  | Hat            |
| Knife                   | Ball           |
| Car                     | Cup            |
| Baby                    | Pencil         |
| Scissors                | Key            |
| Toothbrush              | Glasses        |
| Book                    | Chicken        |
| Phone                   | Boat           |
| Camera                  | Snake          |
| Spade                   | Drums          |
|                         | Plane          |
|                         | Watch          |
|                         | Bat            |
|                         | Bubbles        |
|                         | Hammer         |
|                         | Dog            |

Figure A1 shows the results when children were asked to name the objects or actions of the different signs shown. When comparing iconic and non-iconic signs within
AUSLAN, it was clear that all three age groups (i.e., 4yo, 5yo and 6yo) were more accurate in identifying the word when the sign was iconic in nature.

**Figure A1.** Percent correct for identification of words when shown iconic and non–iconic AUSLAN gestures across three age groups.

The difference in accuracy of word identification when a sign used was iconic or non-iconic was highly significant for all three age groups, $X^2 (1, N = 1664) = 1156.69, p < .001.$
GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD

Appendix F

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GESTURES AND PICTURES ON WORD ACQUISITION FOR ASD

WATCH