Predicting Expressive Language Change in Children With Autism Spectrum Disorder

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Abstract

Children with autism spectrum disorder (ASD) show differences in their communication development when compared to children who are typically developing and other clinical populations. In addition, children with ASD show divergence and delays in their expressive language when compared to each other, and a reported 30% do not develop spoken language even with access to early intervention. In order to support children with ASD in their communication development, there is a critical need for (a) detailed accounts of the emergence of expressive language for children receiving early intervention, (b) investigation of factors that might explain differences in expressive language abilities, and (c) investigation of sensitive predictors of expressive language change for children receiving early intervention.

Children with ASD are often recommended augmentative and alternative communication (AAC) as part of early intervention to augment existing communication abilities, thus providing a complementary communication system while supporting early language development. Augmentative and alternative communication can be introduced as a focused intervention to target communication specifically, or it can be introduced as part of a comprehensive intervention program targeting multiple domains of learning. When used as part of a comprehensive intervention program, AAC is believed to support communication development broadly, including children’s use of spoken language.

Despite emerging evidence for its effectiveness as a focused intervention and potential to support spoken language development within the context of comprehensive interventions, little research exists examining the mechanisms underpinning outcomes of AAC interventions. The current project aimed to address this gap by investigating both the emergence of expressive language in children with ASD, and factors underpinning concurrent
and longitudinal expressive language abilities for children receiving an AAC-infused comprehensive intervention program.

This research was conducted as a series of three studies: Study 1 investigated the communication profiles of 246 children with ASD upon entry and exit to a comprehensive early intervention program; Study 2 investigated mechanisms underpinning concurrent expressive language abilities, and Study 3 investigated predictors of longitudinal expressive language abilities, in 48 children with ASD receiving an AAC-infused comprehensive intervention program. The findings from Study 1 documented that 58.7% of children who started early intervention as minimally verbal remained minimally verbal after approximately 12 months of intervention, while 41.3% went on to develop phrase speech (using two-word phrases), highlighting an as yet unmet clinical need, as well as research need to understand these differences. The findings from Study 2 challenged previously held beliefs regarding word learning abilities in children with ASD, and extended on previous research by investigating the relationship between symbolic word learning and expressive language level. By focusing on processes that might be relevant to children’s development within interventions incorporating AAC, the findings from Study 3 provided preliminary data on the characteristics of children who might experience the largest gains in spoken language within AAC-infused comprehensive interventions.

This research demonstrated a novel approach to investigating variability in expressive language development in children with ASD. The findings from this research demonstrate potential to explain some of the variability through analysis of social-cognitive learning processes that might help predict change within intervention. Finally, the findings of this research have potential to inform how researchers and clinicians approach individual differences in all children who present with complex developmental profiles.
Statement of Originality

This work has not previously been submitted for a degree or diploma in any university.

To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

(Signed) ________________ 15/02/2018

Veronica Rose

Date:
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Acknowledgments and Dedication

Conducting this research has had an incredible impact on me, not only in the academic sense, but on a personal level as well. I have learnt so much over the past three years, about the field and about myself, and I would like to reflect on those who have provided their support throughout this period, and helped me on this journey.

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I would like to extend an enormous thank you to the children and families who participated in this research. Without your support we would not be able to carry out this incredibly important research which is helping us to understand the emergence of language in children with ASD, which we hope will help us improve practice and lead to better outcomes.
for all children. I am incredibly inspired by your willingness to share your journey with others and contribute to the field. Thank you also to the amazing staff at the AEIOU Foundation for working so hard to support the families enrolled at AEIOU. It was truly an honour to observe you in action. Your passion to support all children and families who attend the centre is incredibly inspiring, and I thank you for supporting my research and welcoming me into your work place. I would also like to extend my thanks to Dr Madonna Tucker from the AEIOU Foundation for her support of this research.

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Publications and Grants Arising From This Thesis

Journal Articles


Peer Reviewed Abstracts and Presentations


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Acknowledgement of Papers Included in This Thesis

Section 9.1 of the Griffith University Code for the Responsible Conduct of Research (“Criteria for Authorship”), in accordance with Section 5 of the Australian Code for the Responsible Conduct of Research, states:

To be named as an author, a researcher must have made a substantial scholarly contribution to the creative or scholarly work that constitutes the research output, and be able to take public responsibility for at least that part of the work they contributed. Attribution of authorship depends to some extent on the discipline and publisher policies, but in all cases, authorship must be based on substantial contributions in a combination of one or more of:

- conception and design of the research project
- analysis and interpretation of research data
- drafting or making significant parts of the creative or scholarly work or critically revising it so as to contribute significantly to the final output.

Section 9.3 of the Griffith University Code (“Responsibilities of Researchers”), in accordance with Section 5 of the Australian Code, states:

Researchers are expected to:

- Offer authorship to all people, including research trainees, who meet the criteria for authorship listed above, but only those people.
- accept or decline offers of authorship promptly in writing.
- Include in the list of authors only those who have accepted authorship
- Appoint one author to be the executive author to record authorship and manage correspondence about the work with the publisher and other interested parties.
- Acknowledge all those who have contributed to the research, facilities or materials but who do not qualify as authors, such as research assistants,
technical staff, and advisors on cultural or community knowledge. Obtain written consent to name individuals.

Included in this thesis are papers in Chapters 4, 5 and 6 which are co-authored with other researchers. My contribution to each co-authored paper is outlined at the front of the relevant chapter. The bibliographic details for these papers including all authors are:


Appropriate acknowledgements of those who contributed to the research but did not qualify as authors are included in each paper.

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Preface

Overview of Thesis

This thesis consists of seven chapters. Four chapters are presented in a traditional thesis format, while the remaining three chapters are presented as journal articles that have been prepared in a manner suitable for publication (published or submitted for publication).

Chapter 1 includes an introduction to autism spectrum disorder (ASD) and provides both the clinical and research context in which this research is positioned. The purpose of this chapter is to present a brief overview of the literature and to establish the need for research investigating individual differences in change within early intervention programs for children with ASD.

Chapter 2 presents a comprehensive review of the relevant research literature. Identification and pathways to diagnosis for children with ASD are discussed, and a description of early communication development in this population is provided. This is followed by a critical appraisal of the research literature, with a focus on mechanisms underpinning expressive language development within early intervention. This chapter concludes with a summary and statement of the aim of this research.

Chapter 3 presents the theoretical and methodological perspectives which influenced this research. A description and rationale for the choice of methods is also presented.

Chapter 4 is the first of three chapters in which the results of the three studies comprising this thesis are presented. This chapter takes the form of a journal article, published in the Journal of Intellectual Disability Research (JIDR). The aim of this study was to document the emergence of expressive language in children with ASD receiving early intervention. The clinical implications of the findings are discussed with reference to existing research, and recommendations for measuring communication development in children with ASD are presented.
Chapter 5 is the second of the three chapters in which study findings are presented. This chapter takes the form of a journal article, currently under peer review. The aim of this study was to investigate mechanisms underpinning concurrent expressive language abilities in children with ASD. A discussion of how the findings may contribute to understanding of individual differences in expressive language development in children with ASD is presented.

Chapter 6 is the third of three chapters in which study findings are presented. This chapter takes the form of a journal article, currently under peer review. The aim of this study was to investigate theoretically driven predictors of expressive language change for children with ASD receiving a community-based early intervention program.

Chapter 7 presents a general discussion of the main findings across studies, with specific reference to the clinical implications and future research directions.

A Note on Repetition

It is important to acknowledge that in presenting a thesis consisting of individual manuscripts some repetition is unavoidable. Effort has been made to reduce repetition through clearly delineating and defining the purpose of each chapter.

A Note on Autism Terminology

The focus of this research was on children with ASD receiving a comprehensive early intervention program in which augmentative and alternative communication (AAC) was identified as a component of the program. For the purposes of this project, person-first language was adopted to describe the population (i.e., ‘children with ASD’ or ‘on the autism spectrum’). This terminology was selected for two reasons. First, given that this research focused on children, it was important to take into account parent preferences regarding terminology. A community consultation study conducted in the United Kingdom indicated that while consensus could not be found regarding preferred terminology, as a group, parents showed a preference towards ‘person with autism’ and ‘on the autism spectrum’ (Kenny et
It is acknowledged that among some of the adult population, *identify-first* (i.e., ‘autistic’) language is the preferred terminology (Kenny et al., 2015). Second, this research sits within the broader research context regarding early childhood development for children with ASD. Given the recent changes in diagnostic classifications which refer to ASD as a single disorder (American Psychiatric Association, 2013), it was important to ensure that terminology aligned with this description so that results can be compared across studies with children diagnosed using similar classifications (i.e., children with ASD as classified using the DSM-5).

Finally, given that the focus was on children with ASD who accessed early intervention, the sample consisted of children with a broad range of abilities but who presented with functional impairments requiring support. Thus the sample included children with complex developmental and communication profiles, including children with minimal to no spoken language. For the purposes of this research, children with minimal spoken language were referred to as ‘minimally verbal’ to align with existing research documenting expressive language abilities for this subgroup of children (Norrelgen et al., 2014). The term ‘minimally verbal’ was selected over ‘preverbal’ (i.e., without spoken language, but within the age range in which language might be expected to develop) to indicate that children who used minimal spoken language were at an age at which spoken words are documented to emerge for children who are typically developing (Ukoumunne et al., 2012). It is acknowledged that multiple terms exist to describe spoken language abilities (e.g., ‘nonverbal’ ‘low verbal’), and that assigning a single classification does not provide sufficient detail regarding the various modes (i.e., speech, AAC) or functions of communication used by an individual (Tager-Flusberg & Kasari, 2013). This discussion is raised in the first study (Chapter 4) in which the proportion of minimally verbal children with
ASD receiving a comprehensive community-based early intervention program are documented.
Chapter 1: Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterised by challenges in social communication and interaction, and restricted and repetitive behaviour patterns (American Psychiatric Association [APA], 2013). While not central to diagnosis (DSM-5; APA, 2013), expressive language abilities of children with ASD vary substantially along a continuum (Kjelgaard & Tager-Flusberg, 2001). At one end there are children who do not develop spontaneous spoken language by school age (Anderson et al., 2007; Norrelgen et al., 2014) although they may be proficient in other forms including augmentative and alternative communication (Ganz & Simpson, 2004). At the other end are individuals with primary difficulties in social use and understanding of language only (Tager-Flusberg, Paul, & Lord, 2005). Developing an understanding of the factors contributing to differences in communication development in children with ASD is crucial to optimising outcomes for all children (Kasari, 2002; Stahmer, Schreibman, & Cunningham, 2011; Stahmer, Suhrheinrich, & Mandell, 2016). The development of an effective communication system is fundamental to children’s learning (Landa, 2007; Toth, Munson, Meltzoff, & Dawson, 2006), and provides the means for social interactions and forming relationships (Casenisher, Shanker, & Stieben, 2013). Further, the development of spontaneous use of spoken language by school age is documented predictor of later adaptive functioning abilities in children with ASD (Howlin, Goode, Hutton, & Rutter, 2004).

Clinical Context

Recent estimates within Australia indicate that approximately 0.74% of children aged 7 years and under are diagnosed with ASD based on families registered to receive funding between 2010 and 2012 (Bent, Dissanayake, & Barbaro, 2015). Internationally, estimates for similarly aged children range from 1.46% in the United States in children aged 8 years (Centers for Disease Control and Prevention, 2014), to 1.57% in the United Kingdom in
children aged 5 - 9 years (Baron-Cohen et al., 2009). Taken together, these figures suggest that best overall estimate for prevalence of children diagnosed with ASD within the population is between 1% and 2% (Christensen et al., 2015). In Australia, the geographical context in which this research was completed, the average age of diagnosis is 49 months (Bent et al., 2015), and while a diagnosis of ASD is not required for accessing services, early intervention has been identified as a health and educational priority (National Disability Insurance Agency [NDIA], 2016).

The National Disability Insurance Scheme (NDIS) is an insurance scheme designed to support Australians living with disability and their families, and has two core principles: (1) Choice and control for people with disability, and (2) Providing access to reasonable and necessary supports (NDIA, 2016). Individuals with ASD comprise approximately 30% of participants accessing NDIS plans (NDIA, 2017), highlighting their need for evidence informed supports and services. The NDIS has a dedicated Early Childhood Early Intervention (ECEI) scheme for children aged 0 - 6 years with developmental delay or disability (NDIA, 2016). Policy guiding decision-making for what supports are provided as part of the ECEI scheme is based on the level of support a child requires, as indicated by parents and educators involved in the child’s support network (NDIA, 2016). Legislation governing the NDIS (NDIA, 2016) stipulates that funding should only be allocated to evidence-based interventions demonstrated to improve functional abilities for children with ASD. Currently, recommendations regarding what supports are funded within the ECEI scheme are based on research focused on group outcomes (i.e., what works for the majority) and common factors at a group level, despite recognition of the need for individualised support (Roberts, Williams, Smith, & Campbell, 2016). Access to early intervention is only valuable if the services provided can be tailored to suit the needs of individuals (Stahmer et al., 2011; Stahmer et al., 2016; Trembath & Vivanti, 2014). Basing decisions on what works
for the majority means that it is likely that some children are enrolled in intervention that is not suited to their needs and/or accessing multiple interventions that may have little additional benefit, placing significant cost and time demands on children and families, as well as demand for services (Horlin, Falkmer, Parsons, Albrecht, & Falkmer, 2014; Knapp, Romeo, & Beecham, 2009). Therefore, there is an urgent need for research investigating factors contributing to variability in outcomes for children with ASD to inform policy for how to accommodate differences, and meet the needs of all children (Vivanti, Prior, Williams, & Dissanayake, 2014).

**Research Context**

Attempts to understand ASD and the neurodevelopmental impact of the disorder have focused on underlying biology and genetic causes (Taylor, Maybery, & Whitehouse, 2014). It has been documented that ASD occurs more frequently in individuals who have certain medical conditions such as fragile X syndrome and tuberous sclerosis (Curatolo, Porfirio, Manzi, & Seri, 2004; Koukoui & Chaudhuri, 2007), and in these instances rare genetic mutations associated with the condition have been identified as the cause of ASD (Yoo, 2015). For the majority of individuals with ASD where a single cause is unknown, there is agreement that ASD results from genetic and environmental factors (Yoo, 2015). A focus on underlying genetics is important and lays the foundation for future biological discovery research, particularly for subgroups of children who share phenotypic similarities (Yoo, 2015); however, there is increasing awareness of the need to investigate real-world challenges and opportunities for people living with ASD and their families (Pellicano et al., 2018).

Investigating ways to improve services for individuals with ASD has been identified as a research priority (Pellicano et al., 2018). As a result, there have been research efforts investigating methods to enhance early identification (Barbaro & Dissanayake, 2012;
Zwaigenbaum et al., 2015) in order to provide access to early intervention, and complementary research aimed at investigating early intervention outcomes (Eapen, Črnčec, & Walter, 2016). Research focused on outcomes following early intervention for children with ASD has documented gains in communication and adaptive behaviour for many, but not all children who access early intervention (Camarata, 2014; Eapen et al., 2016; Fava & Strauss, 2014). In their review of early intervention research, Stahmer et al. (2011) reported that it is not uncommon for up to 50% of children to show substantial gains following intervention, while the remaining 50% show limited to modest gains in skill development. In light of these figures, a pressing need now is not so much on the development of new interventions, but on understanding how children change within existing approaches (Stahmer et al., 2011; Vivanti, Prior, et al., 2014).

There have been calls to investigate individual differences in outcomes within early intervention for children with ASD (Schreibman, Stahmer, Barlett, & Dufek, 2009; Stahmer et al., 2011; Stahmer et al., 2016; Trembath & Vivanti, 2014), with two main research avenues emerging. First, there is a need to move beyond broad predictors of outcome such as chronological age, cognitive functioning, and ASD symptomatology (Perry et al., 2011), to a more fine-grained approach to analysis (Sherer & Schreibman, 2005; Vivanti, Prior, et al., 2014), given that even among children who present with similar pre-intervention developmental profiles, there is significant variability in outcomes (Bal, Katz, Bishop, & Krasileva, 2016). Second, there is a need to link predictors to hypothesised active ingredients (Gulsrud, Hellemann, Shire, & Kasari, 2015; Pellecchia et al., 2015) of interventions in order to investigate whether these factors are consistent across, or specific to, particular programs (Stahmer et al., 2016; Vivanti, Dissanayake, Zierhut, & Rogers, 2013). This project aimed to contribute to research advances in understanding variability within early intervention for children with ASD by (a) documenting the emergence of expressive language in children
with ASD receiving early intervention, (b) investigating mechanisms underpinning concurrent expressive language abilities, and (c) investigating the relationship between children’s responsiveness to a key component of a comprehensive intervention program and change in expressive language abilities. This research aimed to advance both theoretical understanding of the nature of expressive language development in children with ASD, while building on science informing practice for tailoring intervention to suit individual needs based on a child’s propensity to engage with certain program elements.
Chapter 2: Literature Review

Autism Spectrum Disorder

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterised by difficulties in social communication, and restricted and repetitive behaviour patterns (American Psychological Association [APA], 2013). Typically diagnosed during early childhood, ASD is a lifelong disorder and impacts on the way individuals interact, respond to, and learn from other people and their environment (Dawson, 2008). While core difficulties in social communication and behaviour are identifiable for diagnostic purposes, no two individuals with ASD present with the same profile of strengths and difficulties (Fava & Strauss, 2014; Reichow, Barton, Boyd, & Hume, 2012). Some individuals will require substantial levels of support at different stages of development (Howlin et al., 2004), while others will require less support, if any, and will lead relatively independent lives (Howlin, 2003). Given the differences in presentation, it is now proposed that rather than a single cause, there are multiple pathways for multiple conditions (‘autisms’) which share phenotypic similarities consistent with a diagnosis of ASD, but reflect the heterogeneity of the disorder (Happé, Ronald, & Plomin, 2006).

**Diagnosis.** In the absence of a single biological marker, ASD is diagnosed at a behavioural level through formal and informal (parent and/or self-report) interview and observation (Lord et al., 2012; Rutter, LeCouteur, & Lord, 2003, 2008). A diagnosis of ASD can be given at any age, but a requirement of the diagnosis is that the onset occurs during early childhood (APA, 2013). In Australia, the average age of diagnosis, based on reported access to services between 2010 and 2012, was 49 months (4 years 1 month) (Bent et al., 2015). Individuals who are diagnosed later are typically referred (or self-referred) for diagnostic assessment when environmental demands exceed functional abilities and the presence of ASD behaviours become apparent (APA, 2013). An example of this is when
children transition between education settings and are expected to adapt to changes in their environment.

In Australia, two classification systems are commonly used to diagnose ASD; the Diagnostic and Statistical Manual of Mental Disorders 5\textsuperscript{th} edition (DSM-5; APA, 2013) and the International Classification of Diseases – 10\textsuperscript{th} edition (ICD-10; World Health Organisation [WHO], 1992). The DSM-5 uses \textit{autism spectrum disorder} to refer to a single disorder with difficulties in both ‘social communication and social interaction’ and ‘restricted, repetitive patterns of behaviour, interests, or activities’ (APA, 2013). The ICD-10 uses \textit{pervasive developmental disorders} to refer to a group of disorders characterised by ‘qualitative abnormalities in reciprocal social interactions and in patterns of communication’ and ‘restricted, stereotyped, repetitive repertoire of interests and activities’ (WHO, 1992). The ICD-10 is currently under revision, with the ICD-11 due for release in 2018 (WHO, 2017). A draft of the ICD-11 (ICD-11 Beta Draft) is available for review and is more consistent with the existing DSM-5 criteria of a single \textit{autism spectrum disorder} with a dyad of difficulties (WHO, 2017).

Various guidelines have been proposed to inform assessment and diagnosis of ASD (e.g., Filipek et al., 1999; Scottish Intercollegiate Guidelines Network, 2016; Whitehouse, Evans, Eapen, Prior, & Wray, 2017). Filipek et al. (1999), for example, conducted a review of relevant literature on screening and diagnosis of ASD and recommended (a) routine developmental screening with professionals working in early childhood settings assessing children’s development at different stages for early signs of ASD (Wetherby, Prizant, & Hutchinson, 1998; Wetherby et al., 2004), and (b) diagnostic assessment professionals with experience in ASD use specific diagnostic instruments and classification systems to inform a diagnosis (i.e., DSM or ICD). Similarly, in their review of the research evidence, the Scottish Intercollegiate Guidelines Network (2016) recommended (a) developmental surveillance for
early behaviours associated with ASD, and (b) a multidisciplinary approach to diagnostic assessment by professionals with experience in ASD and using recent classifications to inform diagnosis (e.g., DSM & ICD). In addition, the Scottish Intercollegiate Guidelines Network (2016) recommended that diagnostic assessment should focus not only on behaviours relevant to informing a diagnosis, but should obtain information on an individual’s strengths and difficulties, which can be used to inform future service provision. In Australia, a multidisciplinary approach to diagnosis is considered best practice (Speech Pathology Australia, 2015). It is recommended that assessment includes input from a paediatrican for assessments involving children, a speech-language pathologist, and a clinical psychologist (Speech Pathology Australia, 2015). This process is currently under review with a National Guideline being proposed to cover pathways to diagnosis for individuals with ASD across the lifespan, with the aim of ensuring consistency in service provision across the country (Whitehouse et al., 2017).

**Diagnostic assessment.** A number of standardised instruments can be used to inform a diagnosis of ASD (e.g., the Autism Diagnostic Interview-Revised [ADI-R]; Rutter et al., 2003, 2008), and the Autism Diagnostic Observation Schedule–Second Edition [ADOS-2]; Lord et al., 2012). These assessments have been designed to elicit and assess behaviours characteristic of ASD, for example, difficulty initiating and responding to social interactions, atypical or absent nonverbal communication, or presence of stereotyped and/or repetitive speech or behaviour (Lord et al., 2012; Rutter et al., 2003, 2008). While these measures have demonstrated predictive validity for detecting ASD from other clinical diagnoses (Kim, Thurm, Shumway, & Lord, 2013), there are concerns regarding sole reliance on these measures for informing a diagnosis, particularly for preschool age children and children with lower cognitive abilities (de Bildt et al., 2015; Oosterling et al., 2010). Therefore, professional judgement and clinical experience play a substantial role in the accurate
identification of behavioural criteria associated with ASD and forming of a clinical diagnosis (Ozonoff et al., 2015; Prior, 2003). Researchers have documented that early indicators of ASD can be reliably identified in children as young as 12 months (Barbaro & Dissanayake, 2012; Zwaigenbaum et al., 2015); however, for some children, differences in social communication can be subtle, and are not always reflected across all areas (Ozonoff et al., 2015). For these children, the delay or absence of expressive language is a common reason for referral and if present alongside other behaviours, can trigger the process towards assessment and diagnosis of ASD (Mandell, Novak, & Zubritsky, 2005).

**Expressive Language Development in Children With ASD**

Differences in communication development in children with ASD are apparent from an early age, when compared to both children who are typically developing (Hudry et al., 2010; Mitchell et al., 2006) and other clinical populations (Bishop, 2003; Leyfer, Tager-Flusberg, Dowd, Tomblin, & Folstein, 2008; McDuffie, Kover, Hagerman, & Abbeduto, 2013; Shriberg, Paul, Black, & van Santen, 2011). During the first 12 months of infancy, children learn important foundation skills that underpin later language development, for example, early symbolic development, gesture use, and imitation abilities (Bates, Dale, & Thal, 2017; Bates & Hammel, 2014). Communication during this time typically includes intentional, but not yet symbolic, forms of communication, for example, eye gaze and vocalisation (Rescorla & Mirak, 1997). These early communicative behaviours, and the manner in which communication partners respond to them, are important for the development of language (Paul & Gilbert, 2010). Children interact with communication partners through the establishment of joint attention (Rescorla & Mirak, 1997), that is, the act of directing a person’s attention to an object or event in order to initiate shared attention (Carpenter, Nagell, & Tomasello, 1998). To illustrate, prior to developing spoken language a child might direct the attention of her communication partner toward an object by looking at the object, using
gaze shift to direct the attention of the person, pointing to, or holding up the object. In response, the communication partner typically labels the object and/or models its use, thus providing both the label (symbol) for the object and a model of its intended function. This process of modeling connections between symbols and referents is referred to as linguistic mapping (Diesendruck, 2008; Heibeck & Markman, 1987). It proposed that this method of reinforcement of social communication attempts, and modeling of associations between symbols and referents, supports language development (Poulin-Dubois & Graham, 2008).

Through the use of retrospective investigation (parent report and videos), observable differences in these important foundations are reported in children who go on to receive a diagnosis of ASD (Barbaro & Dissanayake, 2012; Ozonoff, Heung, Byrd, Hansen, & Hertz-Picciotto, 2009; Ozonoff, Williams, & Landa, 2005; Ozonoff et al., 2015; Wetherby, Watt, Morgan, & Shumway, 2007). It is suggested that these early differences impact on the emergence of expressive language for these children (Colombi et al., 2009). For example, in the absence of physical markers, the delay or absence of eye contact by 12 months is a documented predictor of a child developing ASD (Jones, Gliga, Bedford, Charman, & Johnson, 2014; Wetherby et al., 2004). It is hypothesised that delayed or absent eye gaze among children with ASD represents early differences in social-emotional reciprocity, which may in turn impact on the way children interact with their social environment, and their ability to learn from others (Dawson, 2008). Differences in early gesture use also seem to reflect an apparent bias towards non-social (e.g., objects) versus social (e.g., people) stimuli in children with ASD (Ellawadi & Ellis Weismer, 2014; Özçalışkan, Adamson, & Dimitrova, 2016), and the absence of gesture is considered both an early indicator of a child having ASD if present alongside other behaviours (Wetherby et al., 2004), and predictive of later language abilities (Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; Özçalışkan et al., 2016).
Joint attention abilities in children with ASD are also impacted, with children reported to show fewer instances of initiation of shared attention for the sole purpose of sharing interest (Mundy, Sigman, & Kasari, 1990). Joint attention difficulties can lead to both missed opportunities for responding to social advances from others (Presmanes, Walden, Stone, & Yoder, 2007), as well as reduced opportunities for language modeling if the child is not efficiently capturing the attention of others, or if communication partners are not attuned to a child’s subtle bids for attention (Mundy & Sigman, 1989). To this end, children with ASD who have better joint attention abilities at 15 months are documented to develop language more rapidly than their peers who display lower instances of joint attention (Toth et al., 2006). Finally, imitation abilities, particularly imitation of social actions (i.e., copying another person’s actions), are reportedly impacted in children with ASD and believed to reflect early differences in social-cognitive functioning (Vivanti, Hamilton, et al., 2014; Vivanti, Trembath, & Dissanayake, 2014). Imitation is fundamental to how children learn from others, by seeing, observing, and doing (Nelson, 1973). Imitation is particularly interrelated with symbolic development, given that children acquire an understanding of the relationship between symbols and referents through observation and interaction with their environment (Fenson et al., 1994; Hoff, 2006).

Differences in early symbolic development in children with ASD emerge around 12 months of age, after differences in social communication are apparent, and are observable in the delay or absence of object play and onset of first words (Ozonoff et al., 2009). Object play represents multiple components of cognitive functioning including, interest, abstract thinking, and symbolic understanding (Oakes, 2010; Oakes & Madole, 2000; Oakes, Madole, & Cohen, 1991; Turk-Browne, Scholl, & Chun, 2008), and is used to describe the way children approach and interact with objects, including, understanding their functional use (e.g., stacking blocks), through to the development of pretend and imaginative play (e.g.,
playing with toy food) (Whitebread, Coltman, Jameson, & Lander, 2009). Representational abilities (i.e., that a symbol can be used to represent another object or event) are important for the development of both object play and language (Orr & Geva, 2015). It is suggested that this process of understanding the relationship between symbols and referents encouraged through object play underpins vocabulary development (McDuffie, Lieberman, & Yoder, 2012). Propensity for object play is documented to be associated with both concurrent (Thiemann-Bourque, Brady, & Fleming, 2012) and longitudinal expressive language abilities in children with ASD (Poon, Watson, Baranek, & Poe, 2012), providing evidence to support the relationship between representational abilities and language development (Orr & Geva, 2015).

Children with ASD show varied and complex communication abilities that can be identified prior to the onset of spoken language and impact on later communication development (D'Souza, D'Souza, & Karmiloff-Smith, 2017; Kover, Edmunds, & Ellis Weismer, 2016; Tager-Flusberg et al., 2005). An effective communication system is fundamental to children’s development (Kaiser & Roberts, 2011), providing the means by which children engage in social interactions, and learning opportunities (DiStefano, Shih, Kaiser, Landa, & Kasari, 2016). Furthermore, the absence of an effective communication system, and persistent unmet communication needs, can lead to significantly poorer adaptive functioning, social, and health outcomes (Howlin et al., 2004). For children with ASD who show heterogeneity in their communication abilities, there is a need for research investigating contributing factors to these differences, in order to identify ways to foster early language development for all children (DiStefano & Kasari, 2016).

While there are many ways in which children can communicate, spoken language is recognised as one of the most efficient, accessible, and internationally understood forms of communication (Lloyd, Fuller, & Arvidson, 1997). There is research to suggest that spoken
language level at age two might be predictive of language development at age five (Mayo, Chlebowski, Fein, & Eigsti, 2013), and the development of spoken language by age five is a documented prognostic indicator of later adaptive behaviour outcomes for children with ASD (Howlin et al., 2004), thus highlighting the importance of intervention aimed at fostering early language abilities. To this end, spoken language is often identified as an observable and socially valid target of intervention, and is used in both research and practice to measure progress within early intervention for children with ASD (McConachie et al., 2015; Tager-Flusberg et al., 2009).

Children with ASD have been documented to develop spoken language at accelerated, delayed, and/or atypical rates (Anderson et al., 2007; Eigsti, de Marchena, Schuh, & Kelley, 2011; Wodka, Mathy, & Kalb, 2013). Children may have, no spoken language at all (Tager-Flusberg & Kasari, 2013), stereotyped and/or repetitive words/phrases (e.g., echolalia) (Neely, Gerow, Rispoli, Lang, & Pullen, 2015), and/or highly formal language (Paul, Chawarska, Cicchetti, & Volkmar, 2008), highlighting the substantial heterogeneity in spoken language development in this population. Additionally, children with ASD may show spoken language abilities that on standardised testing appear to be discordant with other skills shown to be interrelated in children who are typically developing (Hudry et al., 2010; Woynaroski, Yoder, & Watson, 2015). To illustrate, children who are typically developing commonly show comprehension abilities that are equal to, or higher than, expressive language abilities (Fenson et al., 1994). In contrast, subgroups of children with ASD have been reported to show higher expressive language abilities relative to comprehension (Hudry et al., 2010); though it should be noted that there is a recognised need for development of novel methods for assessing receptive language in children ASD whose scores on standardised testing might not accurately reflect true abilities (Brady, Anderson, Hahn, Obermeier, & Kapa, 2014; Muller & Brady, 2016; Plesa Skwerer, Jordan, Brukilacchio, &
Tager-Flusberg, 2015). Furthermore, children with ASD who have minimal spoken language have been reported to have commensurate cognitive abilities (Wing, 1981); however, more recent evidence suggests that these children show a range of cognitive functioning, with some children showing higher nonverbal cognitive abilities relative to spoken language level (Bal et al., 2016), thus reinforcing the need for more sensitive tools for assessing language and cognitive abilities in this population (Brady et al., 2014; Kasari, Brady, Lord, & Tager-Flusberg, 2013). There have been a number of reports indicating that children with ASD can develop spoken language after age five (Pickett, Pullara, O'Grady, & Gordon, 2009; Wodka et al., 2013) though this is certainly not all children (Anderson et al., 2007) and it is not yet possible to predict which children will develop spoken language, and to what extent (Pickett et al., 2009). Therefore, there is a need for research investigating both the emergence of language in children with ASD, and mechanisms underpinning language differences (Hudry & Dimov, 2017).

Two key barriers to documenting and understanding communication outcomes of children with ASD have been identified (Norrelgen et al., 2014; Tager-Flusberg et al., 2009). First, there has been no consistent approach to assessing and characterising expressive language in children with ASD who present with a broad range of abilities (Broome, McCabe, Docking, & Doble, 2017; McConachie et al., 2015; Trembath, Westerveld, & Shellshear, 2016). Differences in measurement tools used to characterise expressive language, as well as differences in how spoken language abilities are defined, mean that comparison across studies reporting on group outcomes is difficult (Tager-Flusberg et al., 2009). Tager-Flusberg et al. (2009) proposed a set of benchmarks for characterising spoken language level in children with ASD in order to provide a consistent developmental framework for comparison across studies. Tager-Flusberg et al. (2009) recommended that ideally information should be gathered from multiple sources, including natural language
sampling, parent report, and direct standardised assessment in order to gather a comprehensive profile of a child’s language abilities. The spoken language benchmarks proposed by Tager-Flusberg et al. (2009) provide a developmental approach to characterising language abilities and comprise of five phases: Preverbal Communication (Phase 1), First Words (Phase 2), Word Combinations (Phase 3), Sentences (Phase 4), and Complex Language (Phase 5). Tager-Flusberg et al. (2009) provided criteria for assessing language at the different development stages, and proposed that in addition to providing researchers a consistent approach to assessment and reporting, the benchmarks might be useful in practice for measuring change within intervention (Ellawadi & Ellis Weismer, 2015). The authors acknowledged that researchers will have different study objectives and access to resources, and thus recommended that the measurement approaches described be applied as a minimum standard for language assessment, but with some flexibility to suit the aims of individual studies. To illustrate, Tager-Flusberg et al. (2009) recommended natural language sampling as a comprehensive measure of children’s expressive language abilities, but acknowledged the limitations associated with data collection and analysis, including the amount of time taken to analyse collected language samples. The spoken language benchmarks proposed by Tager-Flusberg et al. (2009) highlighted the need for a more detailed approach to language assessment in children with ASD. In particular, the authors stressed the importance of moving beyond broad descriptors of language level (e.g., ‘functional language’) for reporting outcomes following intervention, in order to allow for comparison across studies documenting communication development in children with ASD (Tager-Flusberg et al., 2009).

Standardised assessments are often used in research and practice settings and offer an immediate and accessible method for assessing communication (Luyster et al., 2008). In both research and practice, standardised scores obtained during testing are often used to indicate
change within, or response to, intervention (McConachie et al., 2015; Trembath et al., 2016). However, in most cases standardised assessments have been designed to assess language abilities of children who are typically developing, and there are limitations with regards to their use and interpretation for children with ASD who present with varied profiles of expressive language abilities (Kasari et al., 2013). In particular, there are limitations in selecting assessments with developmentally appropriate start (basal) and end (ceiling) points, and without excessive verbal and attentional demands due to standard administration techniques (Kasari et al., 2013). Further there can be challenges with selecting measures of an appropriate developmental level with normative information for a child’s chronological age when significant delays are present. For this reason, various tools have been developed for assessing communication behaviours in individuals at early stages of communication development and/or who present with idiosyncratic communication behaviours (e.g., Rowland & Fried-Oken, 2010; Sigafos et al., 1998). While such measures are useful in practice for developing a comprehensive profile of a child’s communication abilities and for informing intervention planning, they are typically designed for use with individuals with significant communication needs and are therefore not suitable to the broader spectrum of children with ASD who range in language abilities. Thus, standardised assessments offer a controlled setting for eliciting language behaviours, and are commonly used in practice, and so there is a need for research investigating the potential for these assessments to provide detailed descriptions of language, in particular for children with ASD who show such varied language abilities (Tager-Flusberg et al., 2009).

All children are equally deserving of access to individually tailored intervention to optimise developmental outcomes (Finke, McNaughton, & Drager, 2009). However, until recently, research has focused on communication development in children with ASD who are verbal, despite the apparent needs of children with ASD who have minimal spoken language
In their review, Kasari et al. (2013) addressed the challenges associated with assessing expressive language abilities in children with ASD who have minimal spoken language. Kasari et al. (2013) reported that children with ASD who have minimal spoken language have often been excluded from research because (a) they are difficult to assess and/or there are few available measures for assessing skills in this population, and (b) studies are typically designed in such a way that requires participants to have some level of spoken language (Tager-Flusberg & Kasari, 2013). In addition, children with ASD who have minimal spoken language are often reported to present with co-morbid cognitive delays and/or behaviour challenges which can make conduct of a valid assessment difficult; however, even among this population there is variability in cognitive functioning (Bal et al., 2016). Thus excluding children from research on the basis of spoken language level alone means that variables that might predict which children will go on to develop spoken language are rarely investigated.

A second barrier to understanding the emergence of language in children with ASD is the lack of detailed reports on communication outcomes for children receiving early intervention in real-world settings (Anderson et al., 2007; Magiati, Moss, Charman, & Howlin, 2011; Norrelgen et al., 2014; Pickles, Andrews, & Lord, 2014; Wodka et al., 2013). While many studies have reported on communication outcomes for children with ASD, these are typically limited to measuring response to particular interventions in controlled research settings and/or with small sample sizes (Trembath et al., 2016). In addition, communication outcomes are commonly based on change in standardised scores which provide little indication of specific language abilities (Bacon et al., 2014). The lack of longitudinal data retrieved from community-based samples means that there are few and inconsistent reports of the emergence of expressive language for this population. While there are some studies documenting communication outcomes in children with ASD, these studies included children
who were identified early (~2 years old) and were all accessing intervention, and thus might not be indicative of the wider spectrum of children with ASD who are diagnosed later and/or not referred for intervention (Anderson et al., 2007; Magiati et al., 2011; Norrelgen et al., 2014). In addition, there are few detailed reports on communication outcomes for children with ASD following recent changes to diagnostic criteria (DSM-5) and thus estimates might not be reflective of the current population of children who are diagnosed with ASD (Volkmar & Reichow, 2013).

Norrelgen et al. (2014) documented the proportion of children who were nonverbal (using fewer than three functional words, and expressive age equivalent < 15 months), minimally verbal (using three words but not yet using two word phrases, and expressive age equivalent < 24 months), and using phrase speech (using two word phrases and expressive age equivalent > 24 months) based on parent report in 165 children with ASD aged 4 to 6 years receiving intervention at specialised autism centres. In their study, Norrelgen et al. (2014) reported that following approximately 2 years of intervention, 15% of children were classified as nonverbal, 10% were classified as minimally verbal, and 75% were classified as using phrase speech. Strengths of the study included a relatively large sample size in relation to other studies in autism research (Magiati et al., 2011), and the use of clear descriptions of expressive language abilities rather than sole reliance on standardised scores. In addition, the authors investigated factors that might be associated with expressive language outcomes, and found that cognitive functioning was the most significant factor linked to verbal ability, with all children described as non- or minimally verbal reported to have IQ scores < 70 (Norrelgen et al., 2014). However, even among children who developed phrase speech, 25.5% also had IQ scores < 70, thus indicating that cognitive functioning alone cannot explain all of the variability in language level (Norrelgen et al., 2014). The authors only reported on verbal ability following intervention, meaning that change in communication abilities within
intervention was not reported. Documenting expressive language abilities upon entry and exit of early intervention is crucial to understanding how language emerges in this population, as well as the impact of early intervention on language development (McDuffie, Yoder, & Stone, 2006). If the goal to provide individually tailored intervention to all children with ASD is to be met, then there is a critical need to investigate methods that can be used to characterise expressive language development within intervention for children who present with a broad range of language abilities (Tager-Flusberg et al., 2009).

**Early Intervention**

Early intervention for children with ASD is recommended to support early development, including communication, and aims to address core difficulties associated with the disorder, with the goal to increasing a child’s opportunity for independence (Dawson, 2008, 2013; Dawson et al., 2012). For children with ASD who present with complex communication profiles, communication abilities may be targeted in isolation (i.e., focused), for example, targeting spoken language only (Odom, Collet-Klingenberg, Rogers, & Hatton, 2010). Alternatively, communication abilities may be targeted as one of many domains in comprehensive programs that bring together a range of strategies (Odom, Boyd, Hall, & Hume, 2010; Rogers & Vismara, 2008). Given the multifaceted nature of ASD, Good Practice Guidelines recommend that comprehensive programs that have been individually tailored to target multiple domains of learning should be available to all children who need them (Roberts et al., 2016; Prior, Roberts, Rogers, Williams, & Sutherland, 2011).

Comprehensive programs can be delivered 1:1 in clinics (i.e., one therapist/one child) or in groups in the community, and include programs that have been manualised and named (e.g., the TEACCH Autism Program; Mesibov, Shea, & Schopler, 2004), as well as programs that have been tailored to individual children using clinical expertise and evidence-informed principles and strategies (i.e., evidence based practice) (Roberts et al., 2016). While most
programs involve the clinician working directly with the child, some approaches focus on supporting parents in their interactions with their children in order to enhance children’s social and communication development (Carter et al., 2011; Pickles et al., 2016). Most comprehensive programs encourage a combination of both clinician led and parent implemented components (National Research Council, 2001). Intervention programs are designed and delivered depending on the theoretical basis for learning on which they were developed, and most typically fall within one of three approaches: behavioural, developmental, or combined (Schreibman et al., 2015). Behavioural interventions are those that teach new skills using specialised techniques that are guided by methodologies of applied behaviour analysis (ABA), behavioural psychology, and positive behaviour support (Kasari, 2015). Developmental interventions are those that target key developmental stages and focus on engaging in natural opportunities for learning (Prizant, Wetherby, Rubin, & Laurent, 2003). Combined interventions incorporate teaching strategies and targets from both behavioural and developmental practices (Schreibman et al., 2015). In their article, Schreibman et al. (2015) summarised the advantages of comprehensive intervention programs for children with ASD, for example, with regards to teaching strategies (e.g., specialised techniques used to prompt or elicit behaviours based on behavioural psychology), and goal selection (age appropriate goals based on knowledge of child development). With a range of intervention options available for children with ASD, key questions remain regarding the relative effectiveness of each for optimising outcomes for individual children (Stahmer et al., 2011; Stahmer et al., 2016; Vivanti et al., 2017). Given the varying underlying philosophies guiding different interventions, it has been posited that the mechanisms by which these interventions affect change in individuals with ASD may vary depending on how children interact with the different approaches (Kaale, Smith, & Sponheim, 2012). For this to be investigated it is necessary to identify key components of
intervention, including philosophies underpinning development and delivery, and measuring children’s responses to these components and relationship with outcomes (Vivanti et al., 2013; Vivanti, Prior, et al., 2014).

**Augmentative and Alternative Communication**

Children with ASD are often recommended augmentative and alternative communication (AAC), either in isolation as a focused intervention (Ganz & Simpson, 2004) or as part of a comprehensive intervention program (Mesibov et al., 2004; Prizant et al., 2003), to support early communication development (Reichle, Ganz, Drager, & Parker-McGowan, 2016; Schlosser & Blischak, 2001; Sennott, Light, & McNaughton, 2016).

Augmentative and alternative communication is defined as “…an area of clinical practice that addresses the needs of individuals with significant and complex communication disorders characterized by impairments in speech-language production and/or comprehension, including spoken and written modes of communication” (American Speech-Language-Hearing Association [ASHA], 2018, p. 1). In practice, AAC refers to systems and approaches that are designed to enhance the expressive communication abilities of individuals who are unable to meet their communication needs using natural speech, for example, by encouraging natural gesture, manual sign, or symbol based supports to augment existing communication abilities (Beukelman & Mirenda, 2013).

During early intervention, AAC is used to augment existing communication abilities, both in terms of output (i.e., to supplement natural speech), and input (i.e., to support language comprehension), and supports overall language acquisition while children are in the early stages of language development (Beukelman & Mirenda, 2013; Reichle et al., 2016).

Augmentative and alternative communication systems are typically described as being unaided, including, nonverbal natural communication (e.g., gesture, manual sign), or aided, referring to the use of external equipment such as pictures, objects, and/or writing.
(Beukelman & Mirenda, 2013). In addition, aided AAC systems can be further categorised as low-tech, for example, pictures, objects, and photographs, or high-tech, employs electronic forms including speech generating devices (SGD) (ASHA, 2018).

Augmentative and alternative communication systems use symbols to refer to objects and events, for example, spoken words or gesture and pictures or objects (Beukelman & Mirenda, 2013). Iconicity is used to refer to the extent to which symbols represent their referents and range from arguably transparent, that is, easily identifiable (e.g., a colour photograph of an apple to refer to apple), to opaque where the connection between symbol and referent may be arbitrary unless specifically taught (Fuller & Lloyd, 1991). Symbols for use within AAC systems are selected based on the needs of individuals, including, ability to access (i.e., visual or motor), recognise, and understand the meaning of the symbol and association with referent (ASHA, 2018). Vocabulary (i.e., symbols) selected for AAC systems should be appropriate to the needs of the individual for whom the system is designed (Beukelman & Mirenda, 2013), and is generally grouped into two categories: core (e.g., ‘I’, ‘you’, ‘want’) and fringe (context specific and relevant to individuals) (Trembath, Balandin, & Togher, 2007). For children who are at the early stages of language development, AAC systems need to be both individualised and flexible in order to provide the opportunity to develop functional communication skills, while supporting language and literacy acquisition (Romski & Sevcik, 1996; Romski, Sevcik, Barton-Hulsey, & Whitmore, 2015; Sevcik, Romski, & Wilkinson, 1991).

There is a growing body of evidence supporting the use of AAC for children with ASD when used as part of a focused intervention (Alzrayer, Banda, & Koul, 2017; Ganz, 2015; McLay et al., 2014). A number of studies have reported increases in expressive communication, including, increases in the use of AAC systems for making requests (Alzrayer et al., 2017; Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002) and
initiating and responding to social greetings and questions (van der Meer et al., 2013). In addition, there is evidence to suggest that AAC supports language and literacy development for children with ASD (Barker, Akaba, Brady, & Thiemann-Bourque, 2013) and a number of studies have documented increases in spoken language following the introduction of AAC systems, though changes are reportedly modest (Schlosser et al., 2007; Schlosser & Wendt, 2008), ranging from single words (Charlop-Christy et al., 2002) to short phrases (Ganz & Simpson, 2004).

Schreibman and Stahmer (2014) compared the effectiveness of Pivotal Response Training (PRT), a naturalistic behavioural intervention, and Picture Exchange Communication System (PECS), a picture-based AAC system with underlying principles in ABA, on spoken language development in 39 children with ASD aged 4 to 6 years who were using less than 10 words at the start of intervention. The authors reported that 79% of children in the PECS group learned to use the AAC system to make requests and comments (Schreibman & Stahmer, 2014). In addition, children in this group gained on average 80 words as assessed via parent report, and 6 months in expressive language as assessed via direct child assessment (Schreibman & Stahmer, 2014). The authors reported no group differences in expressive language gains, with both groups showing similar increases in their expressive communication following intervention. On closer inspection though, it is evident that there was substantial individual variability in spoken language gains for children in the PECS group in particular, with children starting intervention with on average 6 less words than the PRT group, and gaining 5 words more than the PRT group at exit (Schreibman & Stahmer, 2014). Thus, while results were not statistically significant, a gain of 6 words for children who initially have few to no spoken words, represents modest but likely clinically significant outcome (Schreibman & Stahmer, 2014).
A number of systematic reviews have also been conducted to investigate the state of the evidence for the effectiveness of AAC use with individuals with ASD (Ganz et al., 2012; Logan, Iacono, & Trembath, 2016). Ganz et al. (2012) conducted a meta-analysis of 24 single case studies investigating the use of aided AAC systems with children with ASD. The findings indicated that aided AAC systems had overall large effects on behavioural outcomes (communication skills, social interaction skills, academics, and managing challenging behaviours), with PECS and SGD having the largest effects on communication (making requests verbally, with pictures or via SGD; symbol comprehension; and non-word vocalisations) for children with ASD compared to other picture-based supports (Ganz et al., 2012). While positive results are emerging for the use of AAC for supporting expressive communication in children with ASD, until recently, research investigating outcomes following AAC interventions has predominately been built on studies in which AAC was used as a focused intervention and using experimental single case design (Iacono, Trembath, & Erickson, 2016).

**The Use of AAC Within Comprehensive Intervention Programs**

Augmentative and alternative communication is commonly incorporated into comprehensive intervention programs for children with ASD, in order to support both comprehension and expression of language (Mesibov et al., 2004; Prizant et al., 2003; Romski et al., 2015; Schlosser & Blischak, 2001), and to assist with behavioural regulation (e.g., Paynter, Riley, Beamish, Scott, & Heussler, 2015). The TEACCH Autism Program (Treatment and Education of Autistic and related Communication handicapped CHildren; Mesibov et al., 2004), and the SCERTS® program (Social Communication, Emotional Regulation and Transactional Support; Prizant et al., 2003) are two comprehensive intervention programs that incorporate AAC into learning opportunities within naturalistic settings. When incorporated into early intervention programs, AAC is used within naturalistic
learning environments (Sennott et al., 2016). Clinicians and educators model concepts using AAC (i.e., aided language modeling), and teach curriculum via this multimodal approach, with the goal to increase children’s communicative opportunities for learning language (Drager, 2009). In this way, AAC is believed to support comprehension by helping link pictures to words, and words to objects and events (Drager et al., 2006; Reichle et al., 2016).

There is emerging evidence for the use of AAC within comprehensive intervention programs for children with ASD (Boyd et al., 2014; Kasari et al., 2014; Virues-Ortega, Julio, & Pastor-Barriuso, 2013). Kasari et al. (2014), for example, examined the potential benefits of including a SGD within a comprehensive developmental-behavioural intervention program for 61 children with ASD aged 5 to 9 years who had minimal spoken language (< 20 spoken words). In their study, the children who received the blended developmental behavioural intervention with SGD showed statistically significant superior increases in spontaneous spoken language when compared to children who received the blended condition without SGD (Kasari et al., 2014). While the findings of the Kasari et al. (2014) study point to potential for AAC-infused interventions to support spoken language development for children who are minimally verbal, there were considerable individual differences in outcomes following intervention, which is common across studies (Ganz, Lashley, & Rispoli, 2010; Ganz, Mason, et al., 2014; Ganz, Rispoli, Mason, & Hong, 2014), and therefore a need for research investigating factors contributing to these differences.

**Predictors of Expressive Language Change Within Comprehensive Early Intervention**

A number of variables have been shown to be associated with developmental outcomes following early intervention for children with ASD (Harris & Handleman, 2000; Perry et al., 2011). Perry et al. (2011), for example, investigated predictors of outcomes in 332 children with ASD aged 2 to 7 years receiving community-based intensive behavioural intervention. The authors documented that chronological age at intake, cognitive level,
adaptive behaviour scores, and autism symptomatology were all related to outcomes following the intervention, with cognitive functioning the strongest predictor of outcome (Perry et al., 2011). These findings have been replicated across studies documenting that children who enter early intervention when they are younger, have higher cognitive functioning, and fewer ASD symptoms have reportedly better outcomes that children who are older and have more complex developmental profiles (Eapen, Črnčec, & Walter, 2013; Ellis Weismer & Kover, 2015; Harris & Handleman, 2000). While it is documented that children who show more complex developmental profiles have poorer outcomes, variables such as chronological age, cognitive level and autism symptomatology are not helpful for informing intervention decisions (Yoder, Watson, & Lambert, 2015), given that these traits have been shown to be relatively stable over time (Dietz, Swinkels, Buitelaar, van Daalen, & van Engeland, 2007). Furthermore, even among children who present with low cognitive functioning and high ASD behaviours, there are still significant differences in outcomes, indicating that these variables alone do not explain all of the variability (Bal et al., 2016).

In addition to broad predictors of outcome (Perry et al., 2011), recent attempts to understand variability have investigated underlying mechanisms for learning by focusing on behaviours relevant to language development (Crais, Watson, & Baranek, 2009; Kasari, Paparella, Freemna, & Jahromi, 2008). Consequently, there is evidence that children who enter early intervention with better joint attention and imitation abilities, and propensity to engage in object play, show the largest gains in language development (Bopp & Mirenda, 2011; Poon et al., 2012; Smith, Mirenda, & Zaidman-Zait, 2007; Yoder & Stone, 2006a, 2006b), and that targeting these behaviours during early intervention supports the emergence of language (Goods, Ishijima, Chang, & Kasari, 2013; Kasari, Freeman, & Paparella, 2000; Wong, 2013). However, few studies have identified whether these variables are equally important to predicting outcomes in all programs, or if they are only relevant to programs in
which the behaviours are included as targets of the intervention (Yoder & Compton, 2004; Yoder & Stone, 2006a, 2006b). In addition, despite providing information relevant to predicting outcomes and informing targets of intervention, there is still considerable variability in outcomes for children receiving interventions in which key behaviours are directly targeted, and there is a need for a more fine-grained approach to analysis (Kasari et al., 2008; Schertz, Odom, Baggett, & Sideris, 2013). To this end, not only is there a need to continue examination of outcomes at the group level, including comparison of interventions, there is also a need to look at within group changes including connection between child and hypothesised active ingredients of intervention programs (Stahmer et al., 2011; Stahmer et al., 2016; Vivanti et al., 2013).

One recognised approach to investigating individual differences is to identify key components of intervention, and measure children’s responses to these components, and relationship with outcomes (Pellecchia et al., 2015). It has been theorised that variability in how children respond to core components of different programs might help predict change within particular intervention approaches (Gulsrud et al., 2015; Vivanti et al., 2013). Vivanti et al. (2013) investigated this hypothesis in 21 children with ASD receiving group-based Early Start Denver Model (ESDM), a comprehensive intervention approach which targets key developmental behaviours using structured teaching within naturalistic settings (Rogers & Dawson, 2010). In particular, the ESDM incorporates specific social learning techniques within daily routines in order to promote intrinsic reinforcement for individual children and generalisation of skill development (Rogers & Dawson, 2010). In their study, Vivanti et al. (2013) predicted that individual differences in social learning processes would be associated with children’s development within the ESDM given the focus on social learning techniques embedded into everyday activities. The findings indicated that the ESDM might be particularly suited to children who showed propensity to engage with objects in a functional,
goal directed manner, could interpret the goals of other’s actions, and imitated others goal-directed behaviours (Vivanti et al., 2013). While Vivanti et al. (2013) documented the potential of this approach to account for individual differences in the ESDM, this approach has not yet been applied to interventions incorporating AAC, given that ESDM does not typically include AAC as a key component of the program (Rogers & Dawson, 2010).

**Predictors of Expressive Language Change Within AAC Interventions**

There is emerging research investigating factors associated with children’s outcomes following AAC interventions (Brady, Thiemann-Bourque, Fleming, & Matthews, 2013; Flippin, Reszka, & Watson, 2010; Ganz et al., 2011; Ganz, Mason, et al., 2014; Ganz, Rispoli, et al., 2014). In their review of the literature, Flippin et al. (2010) investigated the potential influence of pre-intervention child characteristics on predicting outcomes following PECS intervention (Bondy & Frost, 1994). The authors documented that joint attention abilities, object exploration, and imitation abilities emerged as possible predictors of PECS effectiveness for children aged 1 to 11 years. In addition, Flippin et al. (2010) reported that while gains in spoken language were relatively modest across Phase IV PECS level attainment which focuses on increasing sentence structure (e.g., “I want X”) emerged as possible program characteristic associated with spoken language outcomes.

More recently, Ganz, Mason, et al. (2014) investigated the impact of pre-intervention child characteristics (speech level, diagnosis, age, and type of AAC) on the effectiveness of three different types of aided AAC (PECS, SGD and “other picture-based AAC” (p. 516)), including the differential impact on spoken language development. In their review, Ganz, Mason, et al. (2014) documented that children who began intervention with spoken language showed larger gains compared to children who began intervention without any spoken language. In addition, the authors documented that PECS was more effective with children with ASD and comorbid cognitive impairments, and that PECS and SGD were more effective
for preschool children aged 5 years and under compared to “other picture-based AAC” (Ganz, Mason, et al., 2014, p. 516). While research investigating change within AAC interventions is emerging, including identification of possible moderating effects of interventions, there is a need for a more fine-grained approach to analysis in order to investigate the substantial heterogeneity in outcomes reported for this population (Ganz, 2015).

Predicting Expressive Language Change Within AAC-Infused Comprehensive Programs

Taken together, the findings from research investigating individual variability in response to comprehensive programs, as well as focused AAC interventions, suggest that a range of child-related factors may be relevant to predicting outcomes (Brady et al., 2013; Ganz et al., 2011; Ganz, Mason, et al., 2014). Thus, for children receiving comprehensive interventions in which AAC is a key component, it is possible that their response to AAC will impact their change within the program more broadly, including development of expressive language skills, a hypothesis yet to be tested. Three variables that might contribute to outcomes within AAC-infused comprehensive intervention programs include, children’s visual attention to AAC (Trembath, Vivanti, Iacono, & Dissanayake, 2015), propensity to engage with the AAC system functionally including, object play (McDuffie et al., 2012), and ability to derive symbolic relationship between symbols (pictures) and the objects, actions, and events they represent (Allen & Lewis, 2015).

Visual attention. Given that the use of AAC embedded into comprehensive interventions for children with ASD is largely a modeling based intervention (e.g., visual schedules, use of aided language modeling) (Drager, 2009) and relies on the assumption that children are looking, it is possible that children who visually attend during teacher instructions (e.g., while a teacher points to pictures on a visual timetable) are more likely to
benefit than children who do not look (Trembath et al., 2015). Historically, children with ASD have been described as visual learners (Goldstein, 2002; Hodgdon, 1995) and proponents of AAC have used this as a reason for recommending AAC for children with ASD (Romski & Sevcik, 1996). Rose, Trembath, and Bloomberg (2015) examined visual attention towards an unaided AAC system (key word sign) and subsequent sign production in three children with ASD aged 3 to 4 years. Rose et al., 2015 did not identify a significant association between visual attention and performance (i.e., sign production); however, the authors acknowledged that the small sample size, and low instances of signing, may have impacted on capturing any relationships that might have existed. Trembath et al. (2015) used eye tracking to examine patterns of visual attention to AAC, and their relationship with task performance (i.e., the child’s manipulation of objects following the instruction), in 25 children with ASD, 19 children with global developmental delay, and 17 children who were described as typically developing. The children were exposed to two conditions, one in which an actor instructed them to complete a task using speech only, and the other condition in which the actor provided the instruction using speech and pictures (AAC condition). Trembath et al. (2015) reported no group differences in visual attention between children with ASD and the comparison groups; however, they did note a correlation between children’s visual attention to the pictures (i.e., proportion of fixations) and performance in children with ASD (Trembath et al., 2015). Given the importance of visual attention for modeling based interventions such as AAC (Drager, 2009), and the findings from the Trembath et al. (2015) study regarding visual attention and performance, there is a need for research investigating the relationship between children’s propensity to visually attend to AAC during teacher instruction and outcomes for interventions in which AAC is a key component.
Object play. When used as an aided system, AAC typically employs the use of objects/pictures, and involves manipulation of these objects/pictures in a functional, goal-directed way in order to communicate, for example, a child selects or points to a picture card on a communication board and exchanges the card with their communication partner (Bondy & Frost, 1994). Functional use of objects typically emerges during the first and second year of life, and is associated with cognitive and language development (Lyytinen, Laakso, Poikkeus, & Rita, 1999; Lyytinen, Poikkeus, & Laakso, 1997). There is evidence that children with ASD who demonstrate higher object play show stronger communication and developmental skills in preschool and early school years (Poon et al., 2012). Therefore, it is possible that children’s functional, goal directed use of objects might be related to their change within intervention in which AAC is a program element, given that object use forms an essential component of the intervention (McDuffie et al., 2012).

Yoder and Stone (2006a) compared the effectiveness of Responsive Education and Prelinguistic Milieu Teaching (RPMT), a play-based communication intervention, and PECS on the development of spoken language in 36 children with ASD aged 21 to 54 months (mean age 33.6 months) who were described as nonverbal (using < 20 spoken words). The authors investigated whether response to the two interventions varied by pre-treatment object exploration, given that both approaches use access to objects as rewards for communicative attempts, though only RPMT teaches functional play with objects. Initial object-exploration was measured using an adapted version of the Developmental Play Assessment (DPA; Lifter, 2001) and was classified as the number of different toys touched during three 5-min samples (3 sets of toys, each sample 5-min each). The findings indicated that children who showed higher object exploration prior to intervention benefited more from PECS in terms of the development of non-imitated words post intervention (Yoder & Stone, 2006a). Thus, the
findings of the Yoder and Stone (2006a) study provide evidence to suggest that children’s use of objects might be particularly relevant to outcomes within AAC intervention.

In contrast, a recent study by Yoder et al. (2015) investigated predictors of language development in 87 children with ASD aged 20 to 47 months (mean age 34.7 months) who were described as nonverbal (< 20 spoken words), and reported that object play did not make a unique contribution to predicting expressive language growth for the participants in the study (Yoder et al., 2015). In their study, Yoder et al. (2015) investigated empirically and theoretically driven predictors of receptive and expressive language change in order to identify “value-added predictors” (p. 1254), that is, variables that predict variability in outcomes while controlling for effects of other putative predictors. Thus, Yoder et al. (2015) acknowledged that it was possible that object play was not found to make a significant contribution because it may have been highly correlated with other measures included in the model, which had all been found to be associated with outcomes in previous research (Poon et al., 2012). Another explanation is that because the participants in the Yoder et al. (2015) study were all nonverbal at entry and 40% remained nonverbal at exit, it is possible that no relationship was found because a large minority of children showed little change in expressive language abilities. Finally, Yoder et al. (2015) did not provide detail on the intervention the children received, and the extent to which propensity to engage with objects might have been relevant, as it is for AAC interventions. Therefore, more research is needed investigating the relationship between children’s use of objects and outcomes in intervention programs in which object manipulation is a central component.

**Symbolic word learning.** Children with ASD are commonly recommended picture-based AAC systems for supporting communication development (Ganz, 2015). In order for children to gain the full potential benefits of AAC it is important that they understand what the pictures represents and that the pictures are being used refer to referent objects and events
There is research to suggest that children’s understanding of pictures, including an ability to form links between symbols and referents, may impact on their ability to learn from and use AAC effectively (Ganea, Preissler, Butler, Carey, & DeLoache, 2009). For children who are typically developing, symbolic understanding of pictures emerges as early as 18 months (Allen & Carey, 2004), and is reportedly linked to later language development (Bates & Hammel, 2014). Children with ASD, however, are reported to show difficulties understanding the symbolic nature of pictures, possibly impacting on their ability to use pictures referentially (Allen & Lewis, 2015), and on word learning and language development more broadly (Ganea et al., 2009).

There are multiple theories for the mechanisms underpinning word learning abilities (Diesendruck, 2008; Nelson, 1981). Fast mapping has been used to describe the process in which children learn associations between words and referents with relatively minimal exposure (Heibeck & Markman, 1987). To illustrate, a parent might point to a picture of a flower while providing the verbal label (i.e., linguistic mapping) during shared book reading, resulting in the child learning the connection between the label and the picture. While the ability to form associations between labels and referents (fast mapping) is important for language development (Bates & Hammel, 2014), it is also critical that children learn the representational nature of the picture, that is, that pictures can be used to extend to other stimuli depicting the same referent (Poulin-Dubois & Graham, 2008). For example, when the child sees a flower in the garden, she or he recognises that it is also a referent of the newly learnt word ‘flower’. Children with ASD are reported to have difficulty understanding the referential nature of pictures (Allen, Hartley, & Cain, 2015; Hartley & Allen, 2015; Preissler, 2008), which may contribute to expressive language differences in this population. Preissler (2008) examined word learning in children with ASD aged 5 to 9 years and found that children with ASD learned associations between picture-word and picture-object relations
(i.e., one to one mappings) via an associative mechanism, rather than demonstrating an understanding the referential nature of pictures. This finding has been reported in other studies investigating symbolic word learning in children with ASD (Allen et al., 2015; Hartley & Allen, 2015); though the relationship with language has not been investigated.

Venker, Kover, and Ellis Weismer (2016) examined the relationship between fast mapping abilities (word-object associations) and concurrent expressive language skills in 53 children with ASD. In their study, Venker et al. (2016) reported differences in expressive language abilities between children who showed no comprehension of a newly learnt novel word, and children who identified the novel referent (object) and produced the verbal label in response to a verbal request, with children who successfully learnt the novel word showing higher expressive language abilities. However, while the Venker et al. (2016) study offered insight into the possible role of word learning in explaining varied language abilities for children with ASD, the authors employed a word learning task that relied on children forming one to one mappings only, and thus did not investigate the extent to which understanding the symbolic nature of pictures might be linked to language. Theoretically, it is plausible that symbolic word learning abilities in children with ASD might be related to their expressive language abilities, given that word learning appears to represent possible progression towards symbolic development, and language is a symbolic form of communication (Braddock & Armbrecht, 2016; Lloyd & Karlan, 1984). However, to date, this relationship has not been investigated for children with ASD who display a broad range of expressive language ability.

In addition to being a potential underlying mechanism for explaining varied language abilities in children with ASD, it is also possible that symbolic word learning abilities might play a role in predicting expressive language outcomes (Brady et al., 2013; Luyster & Lord, 2009; McDuffie et al., 2006). In the same study, Venker et al. (2016) documented significant differences in expressive language measured 2 years after initial measures of word learning,
with children who were unable to learn the novel word showing significantly lower
expressive language scores than children who showed both comprehension and expression of
the novel word. Few studies have investigated the relationship between word learning and
language (Luyster & Lord, 2009; Venker et al., 2016), and no studies have investigated the
relationship between referential word learning and language abilities longitudinally, which
might be valuable to understanding the emergence of expressive language in this population.
It is also possible that symbolic word learning abilities might be particularly important for
expressive language development within interventions that enforce the relationship between
symbols and referents, such as AAC interventions (Ganea et al., 2009). Therefore, there is a
need for research investigating the relationship between symbolic word learning abilities in
children with ASD and both concurrent and expressive language development, in order to
determine the degree to which propensity to understand the symbolic nature of pictures is
linked to expressive language development.

Summary

Children with ASD show significant variability in their communication development
(Anderson et al., 2007; Norrelgen et al., 2014). This is true even for children who access
early intervention from a young age and present with similar pre-intervention profiles (Bal et
al., 2016; Vivanti et al., 2013). Based on available evidence, there is substantial variability in
expressive language development in children with ASD (Anderson et al., 2007; Pickett et al.,
2009). However, differences in sampling measures employed in individual studies means that
comparison across studies is difficult (Tager-Flusberg et al., 2009), and therefore few and
inconsistent population level estimates of communication outcomes exist (Anderson et al.,
2007; Magiati et al., 2011; Norrelgen et al., 2014). Therefore, there is a need for research
documenting the emergence of expressive language in children with ASD receiving
community-based early intervention. Furthermore, there is a need to document the emergence
of expressive language for children who have a broad range of expressive language abilities, and using ecologically valid measures that could be used by clinicians to document change within intervention (Kasari et al., 2013; Tager-Flusberg et al., 2009). Detailed descriptions of the emergence of expressive language in this population is crucial to understanding the underlying mechanisms contributing to language differences, and advance science towards a situation in which clinicians are able to make evidence-informed decisions to tailor intervention to suit the needs of individual children (Gordon, 2010; Kasari, 2010; Lord, 2010). While a number of variables are documented to be associated with language development and outcomes within early intervention, there is a need for a more fine-grained approach to analysis in order to identify variables that might help inform future service provision including, change within programs (Stahmer et al., 2011; Stahmer et al., 2016). One approach taken to investigating individual differences in change within intervention is to identify key components of the intervention, and measure children’s responses to these variables and relationship with outcomes (Pellecchia et al., 2015; Vivanti et al., 2013).

Children with ASD are commonly recommended AAC interventions for supporting communication and language development (Ganz, 2015). There is emerging research documenting a relationship between children’s response to AAC and change within interventions in with AAC is a key component (Kasari et al., 2014). Based on previous research, visual attention and object play appear to be associated with outcomes (McDuffie et al., 2012; Trembath et al., 2015; Yoder & Stone, 2006a). Both visual attention and object play have established methods for assessing skills in children with ASD (McDuffie et al., 2012; Wilkinson & Mitchell, 2014), and there is preliminary evidence indicating relevance both within AAC interventions (Trembath et al., 2015; Yoder & Stone, 2006a) and comprehensive programs more broadly (Vivanti et al., 2013). A third factor, symbolic word learning, has been identified as challenging for children with ASD, whereby children are
reported to form associative connections between symbols and referents rather than understand the symbolic nature of the symbols (Allen et al., 2015; Hartley & Allen, 2015; Preissler, 2008). However, the relationship between symbolic word learning and expressive language abilities in children with ASD both concurrently and for predicting change within intervention, has not yet been investigated and implies the need for two complementary lines of research.

**Statement of the Aim**

The aim of this research was to investigate variability in expressive language development in children with ASD by (a) documenting the emergence of expressive language abilities for children receiving early intervention, and (b) investigating mechanisms underpinning both concurrent and longitudinal expressive language abilities for children with ASD receiving AAC-infused comprehensive early intervention.
Chapter 3: Theoretical Framework and Methodology

Theoretical Framework

This research project was situated within a positivist paradigm. From the beginning, the goal was first to develop and test a theory (hypothesis testing) based on existing research and literature, then to describe the experience through observation and measurement (Creswell, 2003). The broad assumptions brought to research regarding how knowledge is gained, that is, by observing and measuring the external reality, ultimately led to the practical decisions about how the data were collected and analysed (Creswell, 2003). Quantitative research is most commonly associated with a positivist paradigm (Mackenzie & Knipe, 2006) and was used in this project to systematically and objectively investigate the emergence of expressive language in children with autism spectrum disorder (ASD), and mechanisms underpinning both concurrent and longitudinal expressive language abilities in children with receiving early intervention.

Research Purpose

The purpose of this research was to extend science and inform the way clinicians’ working in early intervention approach individual differences in children with ASD by (a) documenting communication development for children with ASD using standardised assessments commonly employed in practice settings, and (b) taking a fine-grained approach to understanding individual differences in expressive language abilities that could contribute to understanding regarding change within programs (Stahmer et al., 2011; Stahmer et al., 2016). The first study involved documenting the emergence of expressive language for children with ASD receiving comprehensive community-based early intervention (Chapter 4). The central finding, that there was substantial variability in children’s change in expressive language within the program, paved the way for the next two studies, in which the
mechanisms underpinning individual differences in concurrent (Chapter 5) and longitudinal (Chapter 6) expressive language abilities were investigated.

This research focused on expressive language abilities as the primary outcome, as this was an observable and socially valid measure of change that is known to vary substantially among children with ASD (Ellawadi & Ellis Weismer, 2015; McConachie et al., 2015; Tager-Flusberg et al., 2009). The development of spontaneous spoken language by age five is a documented prognostic indicator for later adaptive behaviour outcomes (Howlin et al., 2004), and therefore intervention aimed at supporting early expressive language development is critical (Dawson, 2008, 2013; Dawson et al., 2012). While there are a number of evidence-based approaches for supporting communication development for children with ASD, questions remain regarding the relative effectiveness of different approaches for individual children (Camarata, 2014). In order to give all children the opportunity to reach their full potential from early intervention, a fine-grained approach to understanding individual differences related to change within intervention is needed (Stahmer et al., 2016; Vivanti, Prior, et al., 2014). There is a need to move beyond commonly reported predictors of outcome, such as cognitive functioning and ASD symptomatology as these are of little help to clinicians setting goals for their clients, or for caregivers selecting from the vast array of intervention options available (Yoder et al., 2015).

**Predictors of Change Within Early Intervention**

This research investigated *predictors of change* within, as opposed to *predictors of treatment response* to, a comprehensive community-based early intervention program for children with ASD (Yoder & Compton, 2004). Yoder and Compton (2004) defined predictors of treatment response as “change due exclusively to the treatment” (p. 163) and cautioned
against misinterpreting results of studies designed to investigate predictors of growth\(^1\). Yoder and Compton (2004) suggested that predictors of treatment response can only be assessed using single-subject designs to identify profiles of responders and non-responders, or randomised control trials to allow for comparison between children receiving different interventions (or no intervention). Through experimental control, these study designs allow for investigation into change due to effects of the intervention versus change due to other variables (Yoder & Compton, 2004). The current research project employed a methodology suited to investigating predictors of change (of which treatment response is a component of) within a community-based comprehensive intervention program for children with ASD. This preliminary investigation examined whether children’s responses to three theoretically and empirically driven factors (selected \textit{a priori}) predicted change in expressive language after 12 months of intervention.

While this research focussed on predictors of change within a particular early intervention program (augmentative and alternative communication-infused), and the findings cannot be generalised to other interventions, the methodological approach employed has the potential to stimulate further research focused on understanding variability in outcomes for children receiving other intervention programs (Stahmer et al., 2011; Stahmer et al., 2016). In doing so, a collaborative platform of research could be established which could be used to predict differential response to intervention, and guide decision making regarding intervention selection based on a child’s presenting profile (Sherer & Schreibman, 2005). Thus, while the current project investigated mechanisms underpinning change within a particular intervention program, the findings of this research should be considered

\(^1\) Yoder and Compton (2004) referred to \textit{predictors of growth}; however, this research referred to \textit{predictors of change} to indicate that not all children developed in their expressive language abilities during the course of the study.
collectively alongside findings from other research investigating children’s development within different intervention programs. In addition, this research was conducted in a community-based setting, thus lending to the ecological validity of the findings, and evidence that such research can occur with community collaboration, which is crucial to bridging the gap between research and practice.

**Research Design**

This thesis is comprised of three individual studies reporting on the results of this research. Study 1 (Chapter 4) and Study 3 (Chapter 6) employed a within-subject longitudinal cohort design to objectively investigate, measure, and analyse (a) the emergence of expressive language in children with ASD receiving early intervention (Study 1), and (b) the relationship between children’s responsiveness to a key component of the intervention (augmentative and alternative communication) and expressive language change. This type of design involves obtaining a baseline (or intake) measurement of skills and then follow up measurements collected after a specified period of time or following access to intervention (Portney & Watkins, 2000). For this research, pre-post measures were used to investigate children’s behaviour at intake into the program and then again following approximately 12 months of accessing the program curriculum. It should be noted that this research did not manipulate the intervention the children received in anyway, but investigated the emergence of expressive language for children receiving the intervention, and the relationship between children’s responsiveness to a key component of the intervention and change in expressive language. Study 3 presented in Chapter 5 of this thesis investigated individual variability in concurrent expressive language abilities in children with ASD using a within subject design with a single time point.
Ethical Approval

This project was part of a collaborative research program being conducted across Australia which aimed to (a) examine and predict communication development in children with ASD, and (b) characterise profiles of responders and non-responders of established evidence-based interventions for children with ASD in the community. The research aims and methods for the current study were independently reviewed and approved by the Griffith University Human Research Ethics Committee and gatekeeper approval at the intervention centre (AEIOU Foundation Research and Innovation Committee) where the children attended (see Appendices A and B for approval letters). Following approval, participant information sheets and consent forms were distributed to parents at participating centres in the Queensland region (see Appendix C for a copy of the participant information sheet and consent form distributed to families).

Participants

As noted within individual studies (Chapters 4, 5 and 6), participants were recruited from the AEIOU Foundation, an ASD specific centre-based early intervention program for preschool children with ASD aged 30 to 71 months. The AEIOU Foundation has 11 centres across Australia, and is the largest service provider of ASD early intervention services in the Queensland region, with 9 centres based in this state. For the current research, participants were recruited from three centres in the Queensland region; specific detail regarding recruitment is provided in the individual studies included in this thesis. As part of children’s participation in the program, their development was monitored through the use of standardised clinician administered child assessments and parent reported measures completed yearly (Paynter et al., 2015). For Study 1, data was retrospectively analysed for 246 children who attended the program between 2010 and 2015, with the aim to document emergence of expressive language in this sample of children. Participants for Study 2 and
Study 3 were recruited from new cohorts of children who entered the program in 2016 ($n = 28$) and 2017 ($n = 20$), with a total sample of 48 children whose parents consented and were eligible to participate included in these studies (48/52; 92.31% uptake). Participant characteristics for each of the individual studies are described in detail in Chapters 4, 5 and 6 of this thesis.

**AEIOU Early Intervention Program**

The AEIOU Foundation early learning and intervention program delivers a comprehensive curriculum which follows Australian Good Practice Guidelines (Roberts et al., 2016). The program aims to support preschool children with ASD in their social, communication, and cognitive development (Paynter et al., 2015). Within the program framework, practices with emerging or higher levels of evidence as categorised by the National Autism Center Standards Report (National Autism Center, 2015) are employed. To illustrate, the completion of yearly standardised assessments (at intake and 12 months or exit) aligns with the Good Practice Guideline of assessment of strengths and needs (Roberts et al., 2011), which is necessary for providing individual programming, another Good Practice Guideline (Roberts et al., 2011). Following intake assessments, children are provided with individual plans (IP) which contain details relevant to their support needs and intervention targets. Children’s IP are reviewed at least every 6 months or earlier by parent request or if goals have been met. This method of monitoring and reviewing goals on a regular basis aligns with requirements of the National Disability Insurance Scheme to continually monitor participant’s plans to work towards advancing the inclusion and participation of the individual into the community (NDIA, 2016).

The early intervention program at the AEIOU Foundation is delivered in a transdisciplinary team including early childhood educators, speech-language pathologists, occupational therapists, behaviour therapists, and paraprofessionals with training in early
childhood in a staff-child ratio of 1:2 to 1:4. Children attend the program 15-25 hours per week with most attending five days per week. Program eligibility includes a community-based diagnosis of ASD (DSM-IV and DSM-5) by a medical practitioner (paediatrician or child psychiatrist) or multidisciplinary team, and chronological age between 30 and 71 months. It should be emphasised that the goal of this research was not to evaluate the effectiveness of the program. An evaluation of the effectiveness of the program has been conducted previously (Paynter et al., 2015); however funding constraints meant that an examination of predictors within the context of the intervention trial was not possible. Paynter et al. (2015) investigated changes in intellectual and adaptive functioning and ASD behaviours in 59 children with ASD aged 3.98 years (range 2.65 to 6.05 years). Using standardised child assessments and parent questionnaires, Paynter et al. (2015) documented that after approximately 10 months of intervention, children showed gains in a range of clinically significant outcomes, including, significant increases in communication (receptive and expressive language), overall developmental level, and adaptive functioning.

The program combines a range of evidence-based strategies to support children’s early learning and development, including targeting important foundational skills for language development, as well as the use of augmentative and alternative communication (AAC) for fostering early language abilities. Core features of the program include the use of highly supportive teaching environments that support predictability and routine, both of which align with the Good Practice Guidelines described by Roberts et al. (2016). Teaching environments incorporate features designed to accommodate the way children with ASD are reported to approach learning and their environment, for example, a reported relative strength processing visual information (Goldstein, 2002; Hodgdon, 1995).

A core component of the AEIOU curriculum is the use of AAC embedded into daily activities and routines to support both comprehension and expression and participation in
classroom activities (Paynter et al., 2015). The use of AAC as part of the AEIOU program includes communication displays (e.g., visual supports) and technology (e.g., speech generating devices) embedded within the classroom environment. Visual supports are used throughout the environment, for example, class schedules, individual schedules, and individualised to the needs of the children in each classroom with regards to system, symbol and vocabulary selection (Paynter et al., 2015). At a minimum, all rooms are required to have a whole class schedule, and transitions are supported using visual supports (e.g., ‘first/then’ chart), thus, even if a child does not have an individualised AAC system prescribed to them, they are consistently exposed to visual supports in their learning environment for language and behaviour management (e.g., support with routines). Further, peer to peer interactions are encouraged, and therefore children are given multiple opportunities to engage with children whose primary method of expressive communication might be an AAC system, or at a minimum uses AAC to complement existing communication abilities. See Appendix D for evidence of how visual supports are used within the AEIOU curriculum to support comprehension.

**Fidelity.** In order to ensure fidelity of the intervention, clinician competence and adherence to the protocol is monitored as part of the program evaluation (Paynter et al., 2015). Each centre has a program manager who oversees the program and is supported by senior therapy staff who visit the centre regularly to provide support and feedback. In addition, supervision is provided to allied health professionals working directly with the children. Manuals and procedures outlining the program are provided to staff via intranet and are regularly reviewed. Staff delivering interventions complete training as appropriate either internally or externally in order to gain formal qualification and fidelity in implementation (e.g., Picture Exchange Communication System training with Pyramid Educational Consultants).
Materials and Method

Several experimental measures were used to investigate children’s initial responsiveness to AAC: visual attention (Trembath et al., 2015); object play and AAC interaction (McDuffie et al., 2012; Yoder & Stone, 2006a); and symbolic word learning (Allen et al., 2015). It was hypothesised that children’s responsiveness to these variables would be associated with changes in expressive language after 12 months of exposure to the AEIOU intervention, given the degree to which AAC was embedded into program delivery.

The primary outcome measure was expressive language and was measured using standardised assessments appropriate for use with children with ASD and commonly used in intervention research and practice (both direct child assessment and parent report were used). For all measures of expressive language children’s verbal communication (i.e., no use of AAC) was scored. Spoken language was selected as a common measure of expressive communication given that not all children involved in this research used AAC to support expression.

Visual attention. Using visual supports (e.g., visual timetables, aided language modeling) to support comprehension relies on the assumption that children are looking during teaching opportunities (Trembath et al., 2015). Therefore, this project investigated children’s visual attention to a picture-based AAC system during a simulated teaching activity. The visual attention measure was a replication of an eye tracking paradigm used by Trembath et al. (2015). Children were shown a series of videos (6 seconds each) on a computer screen with an eye-tracker strip with embedded camera attached to the bottom of the screen. The computer screen was connected to a consumer grade laptop through which the experimenter monitored the child’s fixations and adjusted the screen height before commencing the assessment as required. The separate screen also had consumer grade webcam and speakers attached in order to record the child’s behaviour during the assessment. The video stimuli
featured an actor modelling language under two conditions; using AAC (speech + pictures); and without AAC (speech only) (Trembath et al., 2015). Sixteen videos were included as part of the larger battery of testing pertaining to the broader research program. For the current project, only the eight AAC conditions were included in order to investigate children’s visual attention to the AAC system. The videos were presented in two fixed random orders (Order 1 and Order 2) with children allocated to either order using alternate allocation. During each video, the actor delivered the verbal instruction (e.g., “I want you to pick up the [object] and put it in the [container]”) while pointing to two colour photographs representing the object the child needed to pick up and the container in which the object was to be placed. The photographs were displayed on a piece of A3 cardboard presented in a fixed position facing the child. Prior to the recording, the same stimuli (four objects and four containers) were shown and labelled and placed in front of the child so that they could carry out the instructions using the available objects. Visual attention was calculated as the proportion of time spent fixating (ms) on pre-defined areas of interest (i.e., time spent visually attending to the AAC system) which included pictures of both the object and the container (Trembath et al., 2015).

**Object play.** The use of AAC commonly involves manipulation of picture cards or objects in a functional, goal-directed manner in order to communicate, for example, a child selects or points to a picture card on a communication board and exchanges the card with their communication partner (Bondy & Frost, 1994). Therefore, children’s functional, goal directed use of objects was investigated for this project. The object play measure for this research was adapted from a measure used by Vivanti et al. (2013), and was also similar to measures used in other studies investigating object exploration in children with ASD (Yoder & Stone, 2006a). For this research, children’s functional use of objects was measured during a 5-min free play activity in which children were given the opportunity to play with the same
selection of 15 different objects. Children’s spontaneous use of objects was scored as conventional/appropriate (e.g., stacking Lego), pretend or imaginative (e.g., using the Lego to build a house), or destructive (e.g., hitting the Lego pieces together), with the variable of interest coded as any behaviour that presented as conventional/appropriate (including pretend or imaginative) (see Appendix E for the coding scheme used for object play). If a child touched/held the object, this was also scored in the coding scheme, but did not contribute to the child’s functional use of objects unless the child then proceeded to use the object functionally.

**Symbolic word learning.** Children’s symbolic word learning was determined by the extent to which children demonstrated either associative (the ability to form connections between particular symbols e.g., words and pictures), or referential (recognition that pictures are used to refer to objects not physically present and not shown during initial teaching) understanding of pictures commonly used in AAC systems. Using a procedure employed by Allen et al. (2015) children were taught one novel word paired with a colour photograph and then measured on their ability to extend learning of the novel word to an object depicting the target referent. The measure consisted of five phases: training phase, word learning test, mapping test, perseveration control, and object bias control. For this research, children’s symbolic word learning was calculated from responses made during the mapping test. During this phase, children were presented with a colour photograph of the target object (shown during the training phase) and the target object and asked to identify the referent of the newly learned word. Children who selected either the target object, or the target photograph and the target object, were scored as showing referential learning, and thus an understanding of the symbolic nature of the picture. Children who selected the target photograph were scored as forming a picture-word association only. Only one trial was completed per child.
AAC interaction. Given the relationship between children’s functional use of objects and language outcomes (McDuffie et al., 2012; Poon et al., 2012), and the degree to which functional use of visual supports and picture cards is central to AAC-based interventions (Yoder & Stone, 2006a), an exploratory investigation examined children’s natural reaction to, and interaction with, a picture-based AAC system. For this measure, children were given the opportunity to engage with a picture-based AAC system for 1-min. Interaction was coded as (a) functional (e.g., turning the pages, any communicative use), (b) idiosyncratic (e.g., lining the pictures up, sitting on the book), or (c) destructive (e.g., scrunching the visuals, hitting the pages). The experimenter remained close by in case the child attempted to interact using the system, but for the most part withheld from interaction, and did not model use of the system (see Appendix F for the coding scheme used for AAC interaction).

The findings from this measure were presented at the International Meeting for Autism Research in San Francisco in May, 2017 (see Appendix G for accepted poster presentation). Results from the preliminary investigation suggested no link between children’s interaction with the picture-based AAC system and task performance at intake to the program. Therefore, this variable did not contribute to the final investigation of children’s responsiveness to AAC and expressive language change with the AAC-infused comprehensive intervention program. Nevertheless, this novel measure provided insight into both the variability of children’s actions, and the use of observable behavioural characteristics (e.g., looking at, touching) for coding cognitive processes related to interest and engagement that might be relevant to learning (Oakes et al., 1991; Turk-Browne et al., 2008). While this approach was considered developmentally appropriate for toddlers and children with ASD who were minimally verbal, the issue of ‘what was an appropriate level of looking/touching?’ arose during coding when it became apparent that beyond using communicatively and preference assessments, little research had investigated how children
were meant to interact with the AAC system (McLay et al., 2014; van der Meer et al., 2013), and how initial exploration of aided AAC systems might be relevant to predicting outcomes. Only one study was found that investigated the relationship between children’s interaction with AAC and outcomes (Cook, Rapp, Burji, McHugh, & Nuta, 2017). Cook et al. (2017) investigated factors contributing to stereotypical use of an aided AAC system designed for communication (iPad/tablet) with one child with ASD who displayed high levels of object stereotypy when pressing a button generated auditory output. While novel, findings from this study were limited with the inclusion of only one participant, and few demographic details provided about the child that could be used to further characterise the child’s behaviours within the context of the intervention.

**Outcome Measures**

Expressive language was the primary outcome measure for this research. Expressive language was selected as an observable, socially valid measure of children’s language development, given that it is commonly used to assess outcomes following early intervention for children with ASD (Ellawadi & Ellis Weismer, 2015; McConachie et al., 2015). Only children’s verbal communication (i.e., no use of AAC) was measured for this research. Spoken language was selected as a common measure of expressive language given that not all children involved in the research used AAC to support expression. In keeping with the recommended best practices for measuring and documenting expressive language in children with ASD, at least two measures for documenting expressive language were employed; direct child assessment and caregiver report (Tager-Flusberg et al., 2009). Standardised language assessments commonly employed in research and practice were used in order to add to the ecological validity of the research findings. While not a central aim of this project, because the research was conducted within a community-based setting, it was important to ensure that
the framework employed had potential to be used by clinicians working in early intervention with children with ASD to monitor change within intervention.

**Procedures**

Clinician administered assessments were conducted at the AEIOU Foundation early intervention centres by speech pathologists and supervised graduate speech pathology and psychology research students, including the first author and primary supervisor. All examiners were experienced in assessing children with ASD. Examiners were trained in assessment administration and scoring by reading assessment manuals, and through observation and supervision with more experienced examiners. Each child was assessed individually in a small room with minimal distractions.

**Data Analysis**

Data from all assessment tasks were entered into SPSS. Table 1 provides a summary of the statistical analyses used for each individual study; more detail regarding statistics employed and decisions for their use are included within the individual chapters presenting the results of this thesis (Chapters 4, 5 and 6). Input regarding the appropriateness of the statistical methods employed was gathered throughout this research through consultation with biostatisticians from QFAB Bioinformatics, University of Queensland.
**Table 1**

**Data Analysis Methods Used in Individual Studies**

<table>
<thead>
<tr>
<th>Study / Aim</th>
<th>Statistical Analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study 1</strong>&lt;br&gt;Document the proportion of minimally verbal preschool age children with ASD at entry and exit to a community-based comprehensive early intervention program.</td>
<td>Descriptive Statistics Chi-Square Test for Association</td>
</tr>
<tr>
<td><strong>Study 2</strong>&lt;br&gt;Investigate the relationship between children’s symbolic word learning and concurrent expressive language abilities in children with ASD.</td>
<td>Descriptive Statistics Kruskal-Wallis Test Fisher’s Exact Test</td>
</tr>
<tr>
<td><strong>Study 3</strong>&lt;br&gt;Investigate the relationship between children’s responses to AAC and expressive language change within AAC-infused comprehensive intervention.</td>
<td>Descriptive Statistics Correlation Analysis Hierarchical Multiple Regression Individual T-Tests Fisher’s Exact Test</td>
</tr>
</tbody>
</table>
Chapter 4: Emergence of Expressive Language in Children With ASD

Publication

This is the peer reviewed version of the following article:


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Statement of Contribution to Co-Authored Published Paper

This study was designed in collaboration with primary supervisor, Dr David Trembath and associate supervisors, Professor Deb Keen and Dr Jessica Paynter. I was responsible for preliminary data analysis of secondary data. Credibility checking was completed by Dr Jessica Paynter. I was responsible for writing the complete first draft of the manuscript. Dr Trembath, Professor Keen, and Dr Paynter, appraised the manuscript and subsequent revisions prior to submission for publication.

(Signed) ___________________________________________ (Date) 15/02/2018

Veronica Rose (student and corresponding author of paper)

(Countersigned) ____________________________________ (Date) 15/02/2018

Supervisor: David Trembath

(Countersigned) ____________________________________ (Date) 15/02/2018

Supervisor: Deb Keen

(Countersigned) ____________________________________ (Date) 15/02/2018

Supervisor: Jessica Paynter
The Proportion of Minimally Verbal Children With Autism Spectrum Disorder in a Community-Based Early Intervention Program

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Abstract

*Background:* Estimates of the proportion of children with Autism Spectrum Disorder (ASD) who are minimally verbal vary from 25% - 35%. However, there is a lack of consensus in defining minimally verbal and few detailed reports of communication outcomes for these children following intervention. The aim of this study was to explore how minimally verbal children have been defined, and to document the proportion of minimally verbal children in a group of children with ASD receiving a community based early intervention program.

*Method:* A longitudinal cohort design was used to examine the proportion of children who met criteria for minimally verbal in 246 children with ASD when they entered and exited an early intervention program.

*Results:* Overall, 26.3% of the children in this study exited the program using ‘fewer than five spontaneous and functional words’ and 36.4% exited not using ‘two word phrases’ as indicated by direct assessment. However our findings were mixed depending on measures and definitions used, with parent report indicating that as many as 29.4% of children were not ‘naming at least three objects’ consistently, and 43.3% not using ‘phrases with a noun and verb’ consistently at exit. More than half of the children who entered the program with minimal speech exited the program with a similar language profile. A small percentage of children (1.2% - 4.7%) regressed in their language level over time.

*Conclusions:* Despite advances in early intervention, and access to services at a younger age, around a quarter of individuals with ASD in this study exited early intervention with significant communication needs. Our findings are considered in relation to the literature and clinical implications and future research directions are discussed.

*Keywords:* Autism spectrum disorder; Minimally verbal; Nonverbal; Preschool; Early intervention; Communication
Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterised by impairments in social communication development, and restrictive and repetitive behaviour patterns (American Psychiatric Association 2013). Signs of ASD are usually observable under three years of age (American Psychiatric Association 2013), and early diagnosis provides the opportunity for children to access intervention at an early age (Dawson 2008; Rogers & Vismara 2008). While there is evidence to suggest that early intervention positively impacts on communication and cognitive development in individuals with ASD, individual differences in response to intervention are apparent (Trembath & Vivanti 2014). An important area of heterogeneity is in the area of spoken language (Paul et al. 2013; Kjelgaard & Tager-Flusberg 2001). Early language skills are an important predictor of later outcomes, and children presenting with complex communication needs are more likely to have associated intellectual disabilities that may impact on their social learning experiences, and communication and cognitive abilities later in life (Luyster et al. 2008; Fernell et al. 2013).

In research, communication outcomes for children with ASD are commonly reported using total scores derived from standardised assessments (Matson et al. 2010), including from communication (e.g., Preschool Language Scales) and social communication measures (e.g., Communication and Symbolic Behaviour Scales). These overall scores may fail to capture individual variability in spoken language outcomes (Charman et al. 2003), and may not be appropriate for assessing minimally verbal children with ASD (Kasari et al. 2013; Charman et al. 2003; Abbeduto et al. 2011). Tager-Flusberg et al. (2009) proposed a set of ‘spoken language benchmarks’ relating to key developmental stages (i.e., first words, word combinations, and sentences) aimed at better characterising the language abilities of children with ASD. These benchmarks highlight the importance of documenting and understanding
the variability in language outcomes for children with ASD, particularly those who exit early intervention programs with minimal spoken language.

Norrelgen et al. (2014) identified two key barriers to documenting and understanding language outcomes for children with ASD who exit intervention programs with minimal spoken language. First, they noted that as a group, children who use little or no spoken language have been inconsistently defined using a variety of terms including “minimally verbal” (e.g., Goods et al. 2013; Kasari et al. 2013; Kasari et al. 2014; Norrelgen et al. 2014; Paul et al. 2013; Woynaroksi et al. 2015); “nonverbal” (Norrelgen et al. 2014, Jonsdottir et al. 2007); and “low verbal” (Yoder & Stone 2006). The common element across definitions is the specification of the maximum number of spontaneous functional words a child uses (ranging from 5-20 words) as observed during a natural language sample and/or parent report (see Appendix for expanded definitions). Kasari et al. (2013) operationalised ‘minimally verbal’ as “fewer than 20 functional words” (p. 2) for research purposes, however, noted that in clinical contexts the “exact number of words used does not matter that much” (p. 2), and depends on a range of individual factors. In this article, we used the Kasari et al. (2013) definition to identify and review relevant studies relating to children who used “a very small repertoire of spoken words or fixed phrases that are used communicatively” (Kasari et al. 2013, p. 2).

The second barrier Norrelgen et al. (2014) identified is the lack of empirical data reporting on communication outcomes for this group of children. Indeed, there are few, and inconsistent, reports of the prevalence of children with ASD who are minimally verbal in the population or at exit from early intervention. Historically, it was suggested that 50% of individuals with ASD did not develop functional language (Rutter 1978). However, with the advent of earlier identification and intervention, more recent estimates put the figure closer to 25% - 30% (Anderson et al. 2007; Norrelgen et al. 2014; Lord et al. 2004), yet some studies
are still reporting figures of up to 50% (Kjelgaard & Tager-Flusberg 2001; Magiati et al. 2011). Differences in definition, measurement, sample characterisation, and age, make comparisons across studies difficult (Jonsdottir et al. 2007; Norrelgen et al. 2014).

Anderson et al. (2007) conducted a longitudinal study of expressive language skills in 206 children with ASD, Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS), and other Developmental Disabilities (DD). Children were under 3 years of age at the beginning of the study and were then assessed at approximately 3, 5 and 9 years of age. Anderson et al. (2007) reported that 29% of the ASD group and less than 10% of the PDD-NOS and DD children remained nonverbal (i.e., using fewer than five words daily according to the Autism Diagnostic Interview – Revised [ADI-R]). A key contribution of this study was the item level reporting of the assessment data that provided more detail regarding language level than reporting standardised scores alone. Additionally, expressive language level was indicated by the ADOS module used (e.g., ADOS Module 3 ‘Complex sentences’, ADOS Module 2 ‘Sentences but not fluent’). The reporting of item level data is consistent with the approach adopted by Tager-Flusberg et al. (2009), and provides more clarity regarding communication outcomes using standardised assessments.

Magiati et al. (2011) and Norrelgen et al. (2014) also reported item level data from standardised assessments, in an attempt to characterise the spoken language outcomes for children with ASD in early intervention studies. Magiati et al. (2011) reported outcomes for 36 children, between two and five years after they commenced community based early intensive behavioural intervention. At initial testing (mean age 3 years 4 months) only 8% of the participants had functional phrase speech as assessed using the ADI-R, increasing to 36% at Time 2 (mean age 5 years 5 months). Norrelgen et al. (2014) used item level analyses of the Vineland Adaptive Behavior Scales-II (VABS-II) to document communication outcomes for 165 children with ASD aged 4 – 6.5 years from a population-based community sample.
The authors reported that 25% of the participants in their study presented with minimal or no functional speech.

Through item level reporting and analyses using standardised tests, researchers have provided a clearer indication of spoken language level than could be provided by standard scores alone. Replication of such studies are important to gather descriptions from multiple settings, using large samples, and across populations, to gain a detailed understanding of communication outcomes for children with ASD. There is also a need to move beyond item level reporting and analyses of parent-reported measures (e.g., ADI-R, VABS-II) to include item scores from clinician administered direct assessments. Using a variety of assessments (i.e., parent/caregiver and clinician direct assessment) is important to develop a comprehensive profile of a child’s communication skills (American Speech-Language-Hearing Association 2015; Lane et al. 2013). Therefore, the overall objective of this study was to document the proportion of children who were minimally verbal in a group of children with ASD who received a community-based early intervention program. The specific aim was to analyse the proportion of children who were minimally verbal at entry and exit, using a combination of parent and clinician measures.

**Method**

The study was independently reviewed and approved by the Griffith University Human Research Ethics Committee and the Research Advisory Group at the AEIOU Organisation. Signed informed consent was obtained from parents of participating children.

**Participants and Setting**

Participants were 246 children (202 male [82.1%], 44 female [17.9%]) who attended an ASD-specific centre-based early intervention program in Australia between 2010 and 2015. The program follows a comprehensive curriculum consistent with Australian Good Practice Guidelines (Prior et al. 2011) that uses a blend of strategies with theoretical
underpinnings in behavioural and developmental approaches. Emphasis is on practices with emerging or higher levels of evidence as categorised by the National Autism Centre Standards Report (National Autism Center 2015), including the use of Augmentative and Alternative Communication systems (AAC) (Paynter, Riley, Beamish, Scott, & Heussler, 2015). Individual Education Plans (IEP) are developed for each child based on the organisation’s autism-specific curriculum (Paynter, Scott, Beamish, Duhig, & Heussler, 2012). Teaching occurs within the context of classroom routines in an early learning context including circle and mat times, free play, small group activities, and meal times (Paynter et al., 2012). The program is delivered in a transdisciplinary team including teachers, speech pathologists, occupational therapists, behaviour therapists, and paraprofessionals with training in early childhood in a ratio of 1:2 to 1:4 in a centre-based early learning ASD-specific setting. See Paynter et al. (2015) for further information on this program. Children attended the program 15-25 hours per week with most attending five days per week for an average of 14 months ($SD = 6.45$) between intake and exit assessments. Program eligibility included a community-based diagnosis of ASD (DSM-IV and DSM-5) by a medical practitioner (paediatrician or child psychiatrist) or multidisciplinary team, and chronological age between 30 and 71 months (Paynter et al., 2015). Diagnosis was verified with the Social Communication Questionnaire (SCQ) using a cut-off of 11 as recommended in previous research with pre-school age children (Lee et al., 2007), resulting in the exclusion of 18 participants from analyses ($n = 228$).

**Measures**

Communication outcomes included (A) ASD screening and diagnostic tools, (B) direct standardised assessment of the children’s expressive language skills, and (C) standardised parent-report assessment of children’s expressive language skills in home and community settings. Clinician administered assessments were conducted by staff employed
by the organisation with experience in assessing children with ASD, but who were not involved in the daily program. These staff included the fourth author who is an experienced psychologist, and staff under her direct supervision with all assessors trained in test administration and engaging in regular supervision to ensure use of standard administration procedures as per the test manuals. For parent-report measures, parents/caregivers were instructed to respond based on their child’s use of verbal communication only, excluding use of AAC.

_A1. The Social Communication Questionnaire (SCQ) (Rutter et al. 2003)_ is a parent/caregiver ASD screening checklist. We used Item 1 (“Is she/he now able to talk using short phrases or sentences?”) as a measure of spoken language level.

_A2. The Autism Diagnostic Observation Schedule (ADOS) (Lord et al. 2000)_ is a semi-structured standardised assessment of communication, social interaction, play and restricted and repetitive behaviours (Lord et al. 2000). We used item A1 of the coding scheme (“Overall level of Non-Echoed Spoken Language”) to determine children’s language level at entry and exit. Just under a third of the participants (n = 76) completed ADOS assessments at both entry and exit due to differences in data collection across centres and measures for documenting outcomes in this cohort.

_B. The Mullen Scales of Early Learning (MSEL) (Mullen 1995)_ is a standardised assessment of developmental level of young children (Mullen 1995). Items are scored along a continuum from 0 – 5, 0 indicating an incorrect or absent response, and 5 (or the highest score available) indicating full points were achieved. The total number of points available varies by item. We used the following ‘Expressive Language’ item scores to determine expressive language level: Item 11 (“Says first words”, scoring (0) 0 words, (1) Says 1 word, (2) Says 2 to 7 words, (3) Says 8 words); Item 17 (“Uses two-word phrases”, scoring (1) Yes, (0) No); Item 18 (“Picture Vocabulary”, scoring (0) Names 0-4 pictures, (1) Names 5-10
pictures, (2) Names 11-14 pictures, (3) Names 15-16 pictures, (4) Names 17 pictures, (5) Names 18 pictures”); and Item 22 (“Uses three- to four-word sentences”, scoring (1) Yes, (0) No). Only behaviours observed during direct assessment were given credit, and only children’s verbal communication (i.e., no use of AAC) was scored.

C. The Vineland Adaptive Behavior Scales – 2\textsuperscript{nd} Edition (VABS-II) (Sparrow et al. 2005) is a parent/caregiver form used to understand a child’s adaptive behaviours. Items are rated as 2 = usually, 1 = sometimes or partially, or 0 = never (Sparrow et al. 2005). We used the following ‘Talking’ item scores as per Norrelgen et al. 2014: Item 12 (“Names at least three objects [for example, bottle, dog, favourite toy, etc.]”); and Item 18 (“Uses phrases with a noun and a verb [for example, “Katie stay”; “Go home”; etc.]”).

Results

Data screening was conducted to look for possible missing data; some measures were missing due to differences in the assessment battery across sites (ADOS), parent/caregiver checklists not being returned (usually for exit assessments), missed assessments due to scheduling constraints, and a small number of children who left the program prior to assessment; these are presented in Table 1 along with the children’s chronological age at, and time between, assessments.
<table>
<thead>
<tr>
<th></th>
<th>Entry</th>
<th>Exit</th>
<th>Time between assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>age (months)</td>
<td>n</td>
</tr>
<tr>
<td></td>
<td>valid</td>
<td>missing</td>
<td>median</td>
</tr>
<tr>
<td>SCQ</td>
<td>228</td>
<td>0</td>
<td>44.00</td>
</tr>
<tr>
<td>ADOS</td>
<td>122</td>
<td>106</td>
<td>42.00</td>
</tr>
<tr>
<td>MSEL</td>
<td>226</td>
<td>2</td>
<td>44.50</td>
</tr>
<tr>
<td>VABS</td>
<td>224</td>
<td>4</td>
<td>44.39</td>
</tr>
</tbody>
</table>
Communication Outcomes Based on Screening and Diagnostic Tools

As presented in Table 2, data derived from Item 1 of the SCQ (“Is she/he now able to talk using short phrases or sentences?”) indicated that 62.5% of children were not talking in phrases/sentences at entry. At exit, this reduced to 32.1%, with a significant increase in the proportion of children using phrase speech over time, $\chi^2 (1) = 38.782, p < .001, OR = 1.95$. However, the move towards the development of phrase speech was not uniform across the sample, with two children (1.2% of sample) reported to be speaking in phrases at entry but not at exit.

Table 2

*Social Communication Questionnaire (SCQ): Item 1*

<table>
<thead>
<tr>
<th>Entry: ‘Using phrases or sentences’</th>
<th>Exit: ‘Using phrases or sentences’</th>
<th>Total $n = 168$</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>31.0% (52)</td>
<td>62.5% (105)</td>
</tr>
<tr>
<td>Yes</td>
<td>1.2% (2)</td>
<td>37.5% (63)</td>
</tr>
<tr>
<td>Total</td>
<td>32.1% (54)</td>
<td>67.9% (114)</td>
</tr>
</tbody>
</table>

Children’s scores on Item A1 of the ADOS (“Overall level of Non-Echoed Spoken Language”) at entry and exit are shown in Table 3. Of the 228 children, 76 had ADOS assessments at both time points and were included in this analysis (Entry: Module 1 = 69; Module 2 = 7; Exit: Module 1 = 48; Module 2 = 27, missing = 1, $\chi^2 (1) = 13.725, p < .001, OR = 1.44$). We were interested in the percentage of children documented to be using less than 5 spontaneous and functional words/word approximations during the assessment (i.e., score of 3, 4, or 8, see Table 3 for definitions). Overall, 26.3% of children (15.8% + 10.5%) used less than 5 functional words at their exit ADOS assessment compared to 38.2% at entry.
(21.1% + 17.1%), with a statistically significant increase in language level over time, $\chi^2 (16) = 84.153$, $p < .001$, OR = 1.45.

Table 3

*Autism Diagnostic Observation Schedule (ADOS)*

<table>
<thead>
<tr>
<th>Score</th>
<th>Exit ADOS A1</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Entry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>32.9% (25)</td>
<td>1.3% (1)</td>
</tr>
<tr>
<td>ADOS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>9.2% (7)</td>
<td>2.6% (2)</td>
</tr>
<tr>
<td>A1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6.6% (5)</td>
<td>2.6% (2)</td>
</tr>
<tr>
<td>3</td>
<td>2.6% (2)</td>
<td>7.9% (6)</td>
</tr>
<tr>
<td>4/8</td>
<td>2.6% (2)</td>
<td>0.0% (0)</td>
</tr>
<tr>
<td>Total</td>
<td>53.9% (41)</td>
<td>14.5%</td>
</tr>
</tbody>
</table>

*Note.* 0 = Regular use of utterances with two or more words; 1 = Occasional phrases only; mostly single words; 2 = recognisable single words or word approximations only; must use at least five different words during ADOS evaluation; 3 = At least one word or word approximation, but fewer than five words used during the ADOS-2 evaluation; 4/8 = no words or word approximations (depending on ADOS Module 1 or 2).

**Communication Outcomes Based on Standardised Direct Assessment**

Four items of the MSEL Expressive Language Scale were used to examine changes in the children’s spoken language skills. As per the assessment protocol adopted, only behaviours observed during assessment were scored. Table 4 presents the percentages of children who were using 0 words, 1 word, 2-7 words, and 8 or more words as scored on Item 11 of the MSEL (“says first words”). The proportion of children using 0 or only 1 word reduced from 32.8% (31% + 1.8%) at entry, to 22.8% (20.5% + 2.3%) at exit, representing a significant increase in language level over time, $\chi^2 (16) = 84.153$, $p < .001$, OR = 1.43.
Table 4

**Mullen Scales of Early Learning (MSEL): Expressive Language Item 11**

<table>
<thead>
<tr>
<th>Score</th>
<th>Exit: ‘Says first words’</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 words</td>
<td>1 word</td>
</tr>
<tr>
<td>Entry:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Says first words’</td>
<td>15.8% (27)</td>
<td>1.8% (3)</td>
</tr>
<tr>
<td>1 word</td>
<td>.6% (1)</td>
<td>0.0% (0)</td>
</tr>
<tr>
<td>2-7 words</td>
<td>2.3% (4)</td>
<td>.6% (1)</td>
</tr>
<tr>
<td>8 words</td>
<td>1.8% (3)</td>
<td>0.0% (0)</td>
</tr>
<tr>
<td>Total</td>
<td>20.5% (35)</td>
<td>2.3% (4)</td>
</tr>
</tbody>
</table>

As presented in table 5, 57.2% of children were not using “two word phrases” (Item 17) at entry, reducing to 36.4% at exit, with a significant increase in language level between entry and exit, \( \chi^2 (1) = 49.128, p < .001, OR = 1.57. \)

Table 5

**Mullen Scales of Early Learning (MSEL): Expressive Language Item 17**

<table>
<thead>
<tr>
<th>Entry: ‘Uses two-word phrases’</th>
<th>Exit: ‘Uses two-word phrases’</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>33.5% (58)</td>
<td>23.7% (41)</td>
<td>57.2% (99)</td>
</tr>
<tr>
<td>Yes</td>
<td>2.9% (5)</td>
<td>39.9% (69)</td>
</tr>
<tr>
<td>Total</td>
<td>36.4% (63)</td>
<td>63.6% (110)</td>
</tr>
</tbody>
</table>

Table 6 shows the percentage of children who accurately labelled 0, 5-10, 11-14, 15-16, 17, and 18 pictures correctly during the Picture Vocabulary task (Item 18) of the MSEL. As shown, the majority of children were not yet labelling pictures at entry (67.1%). Of the 67.1% of children who were not labelling pictures at entry, 16.8% labelled 18 pictures at exit, while 37% still could not label any pictures at exit, representing a significant increase in language ability from entry to exit, \( \chi^2 (20) = 61.532, p < .001, OR = 1.76. \)
<table>
<thead>
<tr>
<th>Entry: Picture vocabulary</th>
<th>0-4 pictures</th>
<th>5-10 pictures</th>
<th>11-14 pictures</th>
<th>15-16 pictures</th>
<th>17 pictures</th>
<th>18 pictures</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4 pictures</td>
<td>37.0% (64)</td>
<td>5.8% (10)</td>
<td>6.4% (11)</td>
<td>1.2% (2)</td>
<td>0.0% (0)</td>
<td>16.8% (29)</td>
<td>67.1% (116)</td>
</tr>
<tr>
<td>5-10 pictures</td>
<td>.6% (1)</td>
<td>.6% (1)</td>
<td>1.7% (3)</td>
<td>.6% (1)</td>
<td>0.0% (0)</td>
<td>3.5% (6)</td>
<td>6.9% (12)</td>
</tr>
<tr>
<td>11-14 pictures</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>.6% (1)</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>5.2% (9)</td>
<td>5.8% (10)</td>
</tr>
<tr>
<td>15-16 pictures</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>.6% (1)</td>
<td>.6% (1)</td>
</tr>
<tr>
<td>17 pictures</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>0.0% (0)</td>
<td>.6% (1)</td>
<td>.6% (1)</td>
</tr>
<tr>
<td>18 pictures</td>
<td>.6% (1)</td>
<td>1.2% (2)</td>
<td>1.2% (2)</td>
<td>.6% (1)</td>
<td>0.0% (0)</td>
<td>15.6% (27)</td>
<td>19.1% (33)</td>
</tr>
<tr>
<td>Total</td>
<td>38.2% (66)</td>
<td>7.5% (13)</td>
<td>9.8% (17)</td>
<td>2.3% (4)</td>
<td>0.0% (0)</td>
<td>42.2% (73)</td>
<td>100.0% (173)</td>
</tr>
</tbody>
</table>

Table 6

*Mullen Scales of Early Learning (MSEL): Expressive Language Item 18*
As presented in table 7, 68.6% of children were not “using three-to-four word sentences” (Item 22) at entry, reducing to 40.6% at exit, indicating a statistically significant decrease in proportion over time, $\chi^2(1) = 44.583, p < .001, \text{OR} = 1.63$.

Table 7

*Mullen Scales of Early Learning (MSEL): Expressive Language Item 22*

<table>
<thead>
<tr>
<th>Entry: ‘Uses three- to four- word sentences’</th>
<th>Exit: ‘Uses three- to four- word sentences’</th>
<th>Total $n = 175$</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>68.6% (120)</td>
</tr>
<tr>
<td>40.6% (71)</td>
<td>28.0% (49)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>31.4% (55)</td>
</tr>
<tr>
<td>1.7% (3)</td>
<td>29.7% (52)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Total</td>
<td>100.0% (175)</td>
</tr>
<tr>
<td>42.3% (74)</td>
<td>57.7% (101)</td>
<td></td>
</tr>
</tbody>
</table>

**Communication Outcomes Based on Standardised Parent Report**

Two items on the VABS-II ‘Talking’ Domain were used to examine changes in the children’s spoken language skills as indicated by parent report. We were interested in the percentage of children documented to “name(s) at least three objects” as indicated by item 12 of the VABS-II, and not consistently use “phrases with a noun and a verb” as indicated by item 18. We did not give full credit to children who were scored a ‘1’ indicating they “sometimes or partially” displayed this skill (i.e., score 0 or 1 rated as ‘minimally verbal’). As shown in table 8, 52.4% of children were not consistently naming at least three objects (Item 12) at entry, reducing to 29.5% of children at exit, with a significant increase in language level over time, $\chi^2(4) = 61.009, p < .001, \text{OR} = 1.78$. 

69
Table 8

The Vineland Adaptive Behavior Scales: 2nd Edition (VABS-II): Talking Item 12

<table>
<thead>
<tr>
<th>Entry: ‘Name(s) at least three objects’</th>
<th>Exit: ‘Name(s) at least three objects’</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>51.0% (50)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>49.0% (48)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>52.4% (98)</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>5.6% (5)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>94.4% (84)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47.6% (89)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>29.4% (55)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70.6% (132)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100% (187)</td>
</tr>
</tbody>
</table>

Table 9 shows the number of children reported to be using “phrases with a noun and a verb” (Item 18) as indicated by the VABS-II. In total, 73.5% of children were not consistently using two word phrases at entry, reducing to 43.2% of children at exit, with a significant increase in language level between entry and exit, $\chi^2 (4) = 62.55, \ p < .001, \ OR = 1.70$.

Table 9

The Vineland Adaptive Behavior Scales: 2nd Edition (VABS-II): Talking Item 18

<table>
<thead>
<tr>
<th>Entry: Using ‘phrases with a noun and a verb’</th>
<th>Exit: Using ‘phrases with a noun and a verb’</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>58.1% (79)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>41.9% (57)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>73.5% (136)</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>2.0% (1)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>98.0% (48)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26.5% (49)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>43.2% (80)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>56.8% (105)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100% (185)</td>
</tr>
</tbody>
</table>

We computed scores by combining responses across these two items (12 and 18) to allow comparison across studies using Norrelgen et al’s (2014) classification of ‘minimally verbal’ as “using at least three words but never or only sometimes/partially two-word phrases”, and ‘nonverbal’ as “using fewer than three words” (p.3). As shown in table 10, 53.5% of children were using less than three words at entry, and a further 20.3% were using more than three words but rarely two word phrases. At exit, 29.4% of children were still
using less than three words, and a further 15% were using three words, but not yet using two
word phrases, representing a significant increase in language level from entry to exit, $\chi^2 (4) = 65.322, p < .001$, OR = 1.66 (collapsed ‘nonverbal’ and ‘minimally verbal’).
Table 10

*Minimally Verbal Status Using Combined VABS-II Item 12 and Item 18.*

<table>
<thead>
<tr>
<th>Entry: Verbal status</th>
<th>Exit: Verbal status</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-verbal</td>
<td>Minimally verbal</td>
</tr>
<tr>
<td>Non-verbal</td>
<td>26.7% (50)</td>
<td>10.2% (19)</td>
</tr>
<tr>
<td>Minimally verbal</td>
<td>2.1% (4)</td>
<td>4.3% (8)</td>
</tr>
<tr>
<td>Phrase speech</td>
<td>0.5% (1)</td>
<td>0.5% (1)</td>
</tr>
<tr>
<td>Total</td>
<td>29.4% (55)</td>
<td>15.0% (28)</td>
</tr>
</tbody>
</table>
Comparing Parent and Clinician Ratings

To examine the extent to which different measures of children’s spoken language abilities yielded similar results, we compared the scores for each child on relevant items on the parent-completed SCQ (Item 1) and VABS-II (Item 18), with those on the clinician-administered MSEL (Item 17). To allow for comparisons across measures, and to ensure consistency with our previous analyses we categorised children who received a ‘2’ on the VABS-II as having speech, and ‘0’ (‘never’) or ‘1’ (‘sometimes/partially’) as not. We combined scores from both entry and exit assessments and found 77.8% agreement across all three measures (49.8% of the time all measures agreed ‘yes’ (to speech); and 50.2% agreed ‘no’). We also found inconsistent agreement across the three measures (i.e., two agreed, one did not) on 22.2% of occasions. In these cases, the assessment which was different (i.e., different to response on both other measures) was SCQ in 23.9%, MSEL in 42.3% and VABS in 33.8%.

Discussion

We aimed to investigate the proportion of children who were minimally verbal in a group of children who received a community-based early intervention program. Overall, 26.3% of children exited the program with fewer than five spoken words/phrases used spontaneously and communicatively as indicated by the ADOS (Kasari et al. 2013). We found that while just under half of the children in our study progressed from having minimal speech at entry (e.g., ‘says first words’, ‘uses phrases with a noun and a verb’) to some speech (e.g., using phrases/sentences on the MSEL and SCQ, and using more than five spontaneous and functional words/word approximations on the ADOS) at exit, more than half of the children who entered the program with a ‘very small repertoire of spoken words’, exited the program with similar language levels. Consistent with previous research, we also found that a small percentage of children (1.2% - 4.7% depending on item used) regressed in
their language use; although our figure was less than previously reported (Lord et al. 2004). However, previous studies have also included loss of vocalisations and fluctuating word loss in their reports, which was beyond the scope of our analysis (Lord et al. 2004).

Differences in defining ‘minimally verbal’, measures used to operationalise this, age of participants, and sampling approaches all impact on outcome comparison across studies (Jonsdottir et al. 2007; Norrelgen et al. 2014). Tager-Flusberg et al. (2009) and Kasari et al. (2013) highlighted the need to look at finer grained approaches to measuring communication outcomes in order to provide specific detail regarding overall language level. In addition, it is important that our definition of minimally verbal aligns with our measurement. Consistent with previous studies (Magiati et al. 2011; Norrelgen et al. 2014; Anderson et al. 2007), we took this approach by looking at individual test scores, rather than reporting overall standardised scores. We found significant changes in language level over time as assessed by relevant items from diagnostic and screenings tools (SCQ and ADOS). In addition, we found significant changes in language when reporting on specific items from direct assessments (MSEL). While no measure can replace the gold standard of language sampling and analysis of spoken language in natural environments to assess language use (Kasari et al. 2013), standardised assessments offer a consistent testing context, and item level reporting as used in this study (e.g., SCQ, MSEL and VABS-II), is readily available and interpretable by caregivers, clinicians and educators. Based on our definition of minimally verbal and outcome measures used, we found that while there was a significant change in language level following early intervention, a substantial number of children remained without spontaneous and functional language at exit of the program, and a small percentage regressed in their spoken language.

Our finding that 26.3% of the children in our study did not develop functional language (ADOS) was slightly lower than reported in some earlier studies (Kjelgaard &
Tager-Flusberg 2001; Anderson et al. 2007; Magiati et al. 2011). These may be attributed to differences in definition, method, participant age, and other sample characteristics. Our findings from the ADOS are consistent with those of Norrelgen et al. (2014), who documented that 25% of their participants were described as being non- or minimally verbal at 6.5 years as indicated by the VABS-II. These children were, on average, approximately 18 months older than our sample. However, our finding that 29.4% of children in our study met Norrelgen et al. (2014) criteria for ‘nonverbal’ and 15% met their criteria for ‘minimally verbal’ were considerably higher. In the Norrelgen et al. (2014) and our study, children had received approximately one to two years of intervention. When considering change in proportion over time, it is important to note that children were on average 4.5 years of age in both studies, and that magnitude of change may be greater had the studies included children who commenced intervention earlier.

An important contribution of the current study was the use of item level analysis from direct assessment, in addition to parent/caregiver report. We did find, however, relatively high reliability between parent/caregiver report and clinician administered assessments, indicating that all methods are useful for measuring and documenting language level. This is consistent with previous research in adaptive behaviour comparing caregiver and parent ratings on the VABS-II (Lane et al. 2013). However, it is important to note subtle differences between measures (e.g., “says first words” on MSEL versus “names at least three objects” on VABS-II) which could lead to differences in scoring, depending on the child’s use of nouns in his or her early spoken vocabulary. Furthermore, we propose that reporting item scores, rather than overall standard scores or age equivalents, yielded a clearer picture of children’s spoken language levels with regards to the number of words used functionally, and the complexity of their language use (i.e., single words, phrases/sentences).
While there are inherent problems with the sole reliance on standardised assessments to document communication outcomes for children with minimal spoken language (e.g., placing demands on children to understand and respond to questioning and, floor effects due to difficulties performing under strict standardised conditions) (Abbeduto et al. 2011; Kasari et al. 2013), our results suggest that item level analysis can provide further detail regarding specific language level, and we recommend this fine-grained data be reported in intervention studies (Anderson et al. 2007; Magiati et al. 2011). This would help us understand the individual variability in communication outcomes, and provide detailed insight into specific language level and use. Furthermore, using multi-informant measures also provides information regarding individual language level across settings and contexts (Abbeduto et al. 2011).

The assessment tools reported in our study are commonly used in intervention research involving children with ASD (Trembath, Westerveld, & Shellshear, in press) and have been designed for use in both clinical and research settings. Accordingly, we advocate for the consistent use of tools such as these, where possible, across settings to allow for tracking and comparison of children’s outcomes. However, we acknowledge that the cost of administering these tools and expertise required likely act as barriers to their widespread use in community based early intervention services. Fortunately, service providers routinely document children’s development in rich detail through assessment reports, file notes, staff-parent correspondence, children’s work portfolios, and educational planning documents. Increasingly, this information is being generated and stored electronically, creating the opportunity for sharing and analysis of de-identified data. The challenge is to develop and adopt a set of minimum standards for the collection and reporting of spoken language information (e.g., spoken language benchmarks; Tager-Flusberg et al., 2009) which can be
accurately interpreted and easily applied by clinicians, parents, and educators working to support the learning and development of children with ASD.

The findings of our study need to be considered with respect to several limitations. As with previous studies, population sampling, the intervention program children receive, and the outcome measures employed impact on the proportion of children found to be minimally verbal. It is likely that some high functioning children will not yet be diagnosed by preschool age (Centers for Disease Control and Prevention 2014; Anderson et al. 2007), and therefore may not have been included in our sample. Likewise, even if diagnosed, these children may not present for early intervention due to displaying higher levels of adaptive behaviour. That said, the ASD-specific centre-based early intervention program caters for children with a range of abilities and is the single largest ASD early intervention provider in the Queensland region, suggesting that it likely captures a broad range of abilities. Ideally, future research would include population level data through health or education records, however such data is not currently available in Australia, thus our approach yields an estimate based on available data.

A further limitation of this study is the focus on assessing spoken language only. As mentioned, the program the children accessed supported the use of AAC, and it is therefore possible that some children who used AAC in the program may have functional communication in other modalities which was not captured in the standardised assessments. As the parents in our study were instructed only to complete reports on communication based on spoken language, it is possible that communication conveyed via other modalities was not captured. The proportion of children who were able to use phrases or functional communication using AAC is an important question, but one that could not be answered in this study. Thus, in future research, collection of data on the use of AAC including functional
communication would be of value in characterising the full spectrum of communication outcomes.

**Future Research Directions**

Our findings point to the need for a consistent definition and protocol for assessing communication outcomes in children with ASD with little or no functional speech, for example, language sampling to gain further insight into an individual’s overall communication repertoire (Kasari et al. 2013). We encourage clinicians and researchers to specify communication outcomes and report individual outcomes in their data. We stress the need to pay closer attention to how we talk about this group of individuals presenting with little or no functional speech, and how we operationalise this for research purposes. Ultimately, we advocate movement towards a uniform definition for research purposes, including the reporting of standard measures. Given that standardised assessments such as those used in this study are frequently used in research, they provide an immediate avenue through which researchers can report finer detail, and authors of previously published research can revisit their data and publish their findings so that we can benefit from information already collected. In addition, given the use of AAC with individuals with complex communication needs, it is important to report on AAC use in addition to spoken language (e.g., number of spontaneous words/phrases/sentences used functionally using alternate communication systems). As there is increasing awareness of, and evidence supporting the use of AAC with individuals with ASD and minimal speech, it is important that we recognise and acknowledge the contribution of these systems for enhancing the communicative competence for individuals with little or no functional speech, by reporting on the use of these programs as part of an individual’s overall communication repertoire (Kasari et al. 2014; Goods et al. 2013). Finally, in addition to analysing how children with ASD communicate (i.e., spoken language, AAC, combination of modalities), future research
should also evaluate *why* children with ASD communicate, and how effectively and functionally they use their communication skills to interact and learn from their environment.

**Conclusion**

Of the participants in our study who entered the program as minimally verbal, more than half continued to present with significant communication needs at exit of the program with regards to spoken language. Nevertheless, of those who did progress from initially a very small repertoire of spoken words or fixed phrases to having some speech, a number of individuals noticeably progressed in their language skills, highlighting considerable differences in language trajectories irrespective of initial language level at entry. The findings of this research indicate that standardised assessments can be used to document communication outcomes for children with ASD with little or no functional speech, but that more attention should be given to particular items administered rather than solely standard scores. We encourage other researchers to report on item level scores in order to contribute to our understanding of the communication profiles of individuals with ASD and their response to intervention. In addition to reporting spoken language outcomes for individuals with ASD, we need to recognise the importance of documenting AAC use. While spoken language constitutes an important part of the communication process, it is important that we are also evaluating other important communication skills including, nonverbal and augmentative and alternative communication.

**Acknowledgments**

We warmly thank the children, parents and caregivers, and staff whose participation in the early intervention program and study made this research possible. In addition, our sincerest thanks go to Peggy Wong at AEIOU for her countless hours spent entering the data for the current study.
### Table 11

**Appendix: Minimally Verbal Terminology and Definitions**

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Title</th>
<th>Definition</th>
<th>Relevant outcome measure used (if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Goods et al. 2013)</td>
<td>Preschool Based JASPER Intervention in Minimally Verbal Children with Autism: Pilot RCT</td>
<td>‘Minimally verbal’ “used less than 10 spontaneous, functional, and communicative words by parent and teacher report and during the baseline or entry assessments” (p. 1051)</td>
<td>The Reynell Developmental Language Scales – Verbal Comprehension and Expressive Language mean scores. MSEL – Receptive and Expressive Language mean scores. ADOS – Confirm diagnosis</td>
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<td>(Jonsdottir et al. 2007)</td>
<td>Follow-up of Children Diagnosed with Pervasive Developmental Disorders: Stability and Change During the Preschool Years</td>
<td>‘non-verbal’ ‘overall level of language’ “(1) fewer than five words total and/or no use of speech on a daily basis; (2) words but no phrases; no</td>
<td>ADI-R and Childhood Autism Rating Scale (CARS) – Classify Diagnosis ADI-R – classify language based on A1</td>
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</table>
| Kasari et al. 2013 | Assessing the minimally verbal school-aged child with autism spectrum disorder | ‘Minimally verbal’
“Although from a clinical/educational perspective, the exact number of words used does not matter that much, researchers may want to impose a quantitative definition for this population (e.g., fewer than 20 functional words)” (p. 2). | functional use of three word phrases in spontaneous, echoed or stereotyped speech, but use of speech on a daily basis with at least five different words in the last months; (3) phrases; functional use of spontaneous, echoed or stereotyped language that, on a daily basis, involves phrases of three words or more that at least sometimes include a verb and is comprehensible to other people. Categories 1 and 2 define non-verbal status, while category 3 defines verbal status” (p. 1365). Not applicable. However discussion regarding best ways for capturing language level in minimally verbal children with ASD. |
<table>
<thead>
<tr>
<th>Study</th>
<th>Title</th>
<th>Definition</th>
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<tr>
<td>(Kasari et al. 2014)</td>
<td>Communication interventions for minimally verbal children with autism: A sequential multiple assignment randomized trial</td>
<td>‘Minimally verbal’&lt;br&gt;“fewer than 20 spontaneous different words used during the 20 minutes NLS [natural language sample]” (p. 637)</td>
<td>Transcription of Natural Language Sample (NSL) – both spoken and Speech Generator Device-produced spontaneous utterances were transcribed and coded, and mode noted. ADOS – Module 1 Peabody Picture Vocabulary Test (PPVT-4) Test of Early Language Development (TELD-3)</td>
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<td>(Norrelgen et al. 2014)</td>
<td>Children with autism spectrum disorders who do not develop phrase speech in the preschool years</td>
<td>‘minimally verbal’&lt;br&gt;“using at least three words but never or only sometimes/partially two-word phrases and an expressive age equivalent corresponding to below 24 months” (p. 3) ‘nonverbal’&lt;br&gt;“using fewer than three-words and an expressive age equivalent corresponding to below 15 months” (p. 3)</td>
<td>VABS-II- Expressive Language age equivalent scores, as well as individual items from the ‘Talking’ domain to classify language level.</td>
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<td>(Paul et al. 2013)</td>
<td>Comparing spoken language treatments for minimally verbal pre-</td>
<td>‘Minimally verbal’&lt;br&gt;“spontaneous expressive vocabulary by</td>
<td>Communication and Symbolic Behavior Scales – Caregiver Questionnaire</td>
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<td>children with autism spectrum disorders</td>
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<td>Yoder &amp; Stone 2006</td>
<td>A randomized Comparison of the Effect of Two Prelinguistic Communication Interventions on the Acquisition of Spoken Language</td>
<td>‘Minimally verbal’ and ‘preverbal’</td>
<td>‘(c) were reported to say no more than 20 different words according to a parent report on the MacArthur-Bates Communicative Development Inventories: Words and Gestures Checklist (MCDI) [Fenson et al., 2003]; and (d) produced no more than give different word roots during a 15-min language sample” (p. 3)</td>
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<td>“fewer than 20 different words used cumulatively during three communication samples” (p. 700).</td>
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<td>Communication in Preschoolers with ASD.</td>
<td>Turn-taking assessment</td>
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<td>(Yoder et al. 2014) Value-added predictors of expressive and receptive language growth initially nonverbal preschoolers with autism spectrum disorders.</td>
<td>ADOS – confirm diagnosis</td>
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<td>‘Nonverbal’ ‘(c) were reported to say no more than 20 different words according to parent report on the MacArthur Bates Communicative Development Inventories: Words and Gestures checklist (Fenson et al. 2008); and (d) produced no more than five different word roots during a 15-minute language sample’ (p. 3).</td>
<td>MacArthur Communicative Development Inventory-Words and Gestures Form (MCDI) – Raw scores</td>
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<td>Communication and Symbolic Behavior Scales – Developmental Profile Behavior Sample (CSBS) – weighted raw scores</td>
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<td>Unstructured Communication Sample (UCS) ADOS – confirm diagnosis, describe sample, measure autism symptomology</td>
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References


Chapter 5: Word Learning and Expressive Language in Children With ASD

Publication


Statement of Contribution to Co-Authored Prepared Paper

My contribution to the paper involved: This study was designed in collaboration with primary supervisor, Dr David Trembath and associate supervisors, Professor Deb Keen and Dr Jessica Paynter. I was responsible for data collection and preliminary analysis. Credibility checking was completed by Dr Jessica Paynter. I was responsible for writing the complete first draft of the manuscript. Dr Trembath, Professor Keen, and Dr Paynter, appraised the manuscript and subsequent revisions prior to submission for publication.

(Signed) _________________________________ (Date) 15/02/2018
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Supervisor: Deb Keen

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Supervisor: Jessica Paynter
Word Learning and Expressive Language in Preschool Children With Autism Spectrum Disorder (ASD)

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Abstract

*Purpose:* Children with autism spectrum disorder (ASD) have reported difficulty understanding the symbolic (picture-referent) nature of pictures, which may indicate difficulties understanding the symbolic nature of language. This study investigated the relationship between word learning and language in children with ASD.

*Method:* Forty eight children with ASD were assessed using an established word learning measure. Children were shown a novel word paired with a colour photograph, and then assessed on their ability to extend the word to an object depicting the referent. Expressive language was assessed using the MSEL and MB:CDI:WG.

*Result:* Of the children who passed the word learning test, seven showed an associative connection between the word and photograph, and twenty-four generalised the word to the referent object. Children who showed referential learning had significantly higher expressive language skills than children who failed to demonstrate word learning. The performance of eleven children who failed to demonstrate word learning but nevertheless interacted with test items is presented.

*Conclusion:* Contrary to previous investigations, the majority of children in this study showed evidence of symbolic picture understanding. This study provides preliminary demonstration of a link between word learning and expressive language, which might imply a role in predicting language outcomes.

*Keywords:* Autism spectrum disorders (ASD); Word learning; Early childhood; Expressive language; Referential learning
Word Learning and Expressive Language in Preschool Children With Autism Spectrum Disorder (ASD)

Children with autism spectrum disorder (ASD) show a continuum of communication behaviours, ranging from no use of functional language (DiStefano & Kasari, 2016) to above average language skills (Ellis Weismer & Kover, 2015). Existing hypotheses for the heterogeneity in language outcomes for this population include an inability to use social information to guide word learning (Luyster & Lord, 2009; Tenenbaum, Amso, Abar, & Sheinkopf, 2014); concomitant childhood apraxia of speech (CAS), a neurological childhood speech sound disorder resulting from impairments in planning and programming movements related to speech (Shriberg, Paul, Black, & van Santen, 2011); and/or developmental profiles consistent with developmental language disorder, a diagnosis given to children with language impairments and no known aetiology (Bishop, Snowling, Thompson, & Greenhalgh, 2016; Tomblin, 2011). However, to date none of these hypotheses has been found to account for all of the variation in language development in children with ASD. While earlier diagnosis and access to intervention has led to improved communication outcomes at the group level (Camarata, 2014), even with access to early intervention, as many as 30% of children with ASD do not develop functional spoken language by school age (Anderson et al., 2007; Norrelgen et al., 2014; Rose, Trembath, Keen, & Paynter, 2016). Given that the development of speech by school age is one of the most significant predictors of later language and adaptive functioning (DiStefano & Kasari, 2016), there is a need to understand what contributes to communication differences in children with ASD.

There is evidence to suggest that children with ASD have difficulty understanding the symbolic (picture-referent) nature of pictures (Preissler, 2008), which may in turn imply difficulties understanding the symbolic nature of language (Patrick, 2013). Researchers have investigated whether children with ASD learn novel words (labels) and pictures via an
associative (i.e., one-to-one mappings between labels and referents) or referential (i.e., recognition that labels and pictures are used to refer to objects and events not physically present and not necessarily shown during initial teaching) mechanism (Ganea, Preissler, Butler, Carey, & DeLoache, 2009). In typical development, children begin to recognise the symbolic nature of pictures from as early as 18 months (Allen & Carey, 2004), and this recognition has been linked to language development (Hartley & Allen, 2015). Pictorial understanding plays an important role in early development for both typically developing children and children with ASD; children are exposed to picture-word pairings during shared book reading, a process which encourages the development of language but relies on the assumption that children understand the symbolic nature of the pictures. For children with ASD and minimal spoken language who are learning to communicate using augmentative and alternative communication (AAC) methods, pictorial understanding becomes particularly important when children are at the latter stages of combining symbols to form multiword utterances. In contrast to typically developing children, children with ASD are documented to form associative connections between stimuli - to form picture-word (label) or picture-object connections - but not to understand the symbolic nature of pictures (Preissler, 2008). In previous research though, there has been a strong focus on group outcomes rather than individual differences. Investigating individual differences in word learning in relation to other symbolic behaviours, such as, expressive language, might help to understand the heterogeneity in language outcomes in children with ASD.

ASD, however, alerted the reader to the dearth of research investigating how children with ASD learn about pictures. Both groups (PECS and non PECS users) were matched on IQ, age, and diagnosis (using the Autism Screener Questionnaire: 15 or above used to indicate ASD diagnosis; PECS users: 21; non-PECS users: 19), but differed with regard to expressive language level (Preissler, 2008). The PECS user group were described as ‘non-verbal’ and the non-PECS users as having varied language levels, ranging from single words to talking in sentences (Preissler, 2008). The children were assessed on their ability to form picture-word and picture-object relations using a word learning paradigm which involved pairing a novel word (label) with a target picture, then in a separate trial, a different novel word (label) with a target object. For the picture-word pairing, children were then presented with the target stimuli presented during teaching (e.g., picture) and also the 3-D object, and tested on their ability to show associative pairing (i.e., by selecting the picture) or symbolic understanding of the picture (by selecting the 3-D object). The children in this study learned associations between picture-word and picture-object relations, and had difficulty understanding the symbolic nature of pictures. The author reported no significant differences between the PECS and non-PECS users on associative learning. Although no significant difference between the two groups was found, there was a trend towards children with lower language abilities selecting the target picture alone (rather than the target object) during the word-picture task than those with higher (but still delayed) language abilities. A consideration of this study was that the participants were between 5 and 9 years old; much older than when symbolic understanding of pictures is posited to emerge in typically developing children (Allen & Carey, 2004).

Allen, Hartley, and Cain (2015) went a step further from the Preissler (2008) study by investigating whether presenting multiple exemplars (differently coloured variants) compared to single exemplars (as used in Preissler, 2008; same colour target) impacted on symbolic
responding in 16 minimally verbal children with ASD (mean chronological age 9.6 years; range 4.1 – 16.2 years) and intellectual impairments (mean nonverbal standard score 57.5 as assessed using the Leiter-R; range 36 - 95). ‘Minimally verbal’ was used to refer to children receiving “PECS interventions due to impaired expressive language skills” (Allen et al., 2015, p. 7). In this study, children were presented with a photograph of an unfamiliar target object paired with a novel word during the teaching phase. There were four sessions in total in which children were presented with one unique pairing (i.e., four pairings total). The authors found that the children only showed referential word learning at above chance rates when multiple exemplars were presented during teaching. The authors hypothesised that the use of multiple exemplars might have shown children that a single verbal label can be extended to other items (Allen et al., 2015). The multiple exemplars used in this study varied in colour only, which the authors reported might serve to illustrate that the objects were similar in shape and belonged to the same category (i.e., shape bias) (Allen et al., 2015).

Allen et al. (2015) also investigated the relationship between word learning and chronological age, receptive language, non-verbal IQ, and autism severity. Using correlational and regression analysis, the authors reported that non-verbal IQ accounted for 68% of the variance in performance, and that chronological age negatively correlated with performance, which the authors state may suggest that the younger children were more likely to respond referentially (Allen et al., 2015). Given the inclusion of children with minimal spoken language, the authors were not in a position to investigate the relationship between word learning and expressive language in this study.

Hartley and Allen (2015) extended on the Preissler (2008) study by investigating the extent to which iconicity (i.e., the degree to which a symbol and its referent are perceptually similar) and language (whether novel pictures were verbally labelled by the examiner) mediated symbolic understanding of pictures in 20 children with ASD with a mean age of 9.7
years (range 5.3 to 14 years). The participants were all PECS users with varied language abilities, ranging from no spoken words to some short phrases consisting of three words (Hartley & Allen, 2015). Participants were taught a novel word (label) paired with a picture of an unfamiliar target. Pictures varied with regard to iconicity; black and white line drawing, colour line drawing, greyscale photograph, and colour photograph (Hartley & Allen, 2015). All children were exposed to all four levels of iconicity counterbalanced across two sessions (two per session) (Hartley & Allen, 2015). During the word learning test, children were presented with the target picture and the previously unseen object depicting the target referent and asked to identify the newly learned label. The authors reported that the children generalised labels to the object referent more frequently in colour picture (colour line drawings and colour photographs) conditions compared to black and white line drawings and greyscale photographs, with children making 48.6% symbolic responses during the two coloured conditions compared to 25.7% in non-colour conditions (Hartley & Allen, 2015). The authors found that providing a label for the target picture had no influence on children’s symbolic responding (Hartley & Allen, 2015). The findings of this study hold important clinical implications regarding presentation of pictures to children with ASD in order to support word learning.

The studies by Preissler (2008), Allen et al. (2015), and Hartley and Allen (2015) have provided insight into possible word learning differences in children with ASD, with a focus on the input provided to the children (i.e., iconicity, verbal labeling). Notably, the studies have included predominantly children with minimal spoken language in an attempt to target those who are most likely to benefit clinically from such research. In doing so, however, the relationship between word learning measured in this way and expressive language is yet to be investigated. While it is likely that picture-word learning and language are linked in children with ASD, as in TD children, the nature of this relationship is yet to be
examined. Furthermore, there has been a focus on group outcomes, rather than investigation of individual differences. Finally, all of the studies discussed have focused on children much older than when symbolic understanding of pictures is documented to emerge in typical development (Allen & Carey, 2004; Callaghan, 2000). The finding in the Allen et al. (2015) paper that the younger children in their study were more likely to respond symbolically warrants further investigation.

The Current Study

The overall objective of the current study was to investigate the relationship between word learning and expressive language in preschool children with ASD. The aims were to investigate (a) whether preschool children with ASD were able to learn word-picture associations (novel word and referent), (b) whether children with ASD were able to demonstrate understanding of the referential nature of pictures, and (c) whether there was a relationship between word learning and concurrent expressive language. Expressive language was conceptualised in this study as the ability to express needs using vocalisations, gestures, words and sentences (as assessed using a clinician administered standardised assessment), and the number of words produced as reported by parents (i.e., vocabulary). Additionally, this study extended on previous research by providing descriptive insights into individual variability in responses amongst children who attempted the task but ultimately failed to show successful pairing of the novel target word with the target picture, rather than focusing solely on group outcomes.

The specific research questions and predictions were:

1. Can preschool children with ASD learn word-picture associations (novel word and referent)?
2. Do preschool children with ASD recognise the referential nature of pictures?
Based on previous research, it was predicted that children with ASD would form associations between the novel word (label) and the picture, but fail to generalise the label to an object depicting the referent, and thus fail to demonstrate understanding of the referential nature the picture.

3. Do children who differ on their word learning ability also differ on expressive language and nonverbal development level as assessed using direct child assessment and parent report?

It was predicted that if children with ASD show a similar process to word learning as typically developing children, then there would be a relationship between word learning measured in this way and measures of expressive language.

4. Do children with ASD with varied language profiles demonstrate the same word learning approach?

Given the heterogeneity of children with ASD, it was expected that there would be differences in how the children responded to the word learning task.

**Method**

This study was independently reviewed and approved by the (excluded for review) and the (excluded for review). Signed informed consent was obtained from parents of participating children.

**Participants and Setting**

Participants were recruited from an ASD-specific centre-based early intervention program. The intervention program delivers a comprehensive curriculum which follows Australian Good Practice Guidelines (Prior, Roberts, Rogers, Williams, & Sutherland, 2011) to support preschool children in their social, communication, and cognitive development (excluded for review). Examples of the guidelines which are implemented into the program include providing highly supportive teaching environments where children are given
individual learning plans aimed at supporting their development. The program consists of a minimum 25 hours per week and draws on the principles from established interventions, such as, behavioural programs, and uses naturalistic teaching strategies (excluded for review). Visual supports and aids, including AAC, are one of a range of strategies used consistent with the guidelines (excluded for review). Inclusion criteria include a community-based diagnosis of ASD (DSM-IV or DSM-5) by a medical practitioner (paediatrician or child psychologist) or multidisciplinary team, and a chronological age between 30 and 71 months (excluded for review). No further inclusion or exclusion criteria were set for the current study as the researchers wanted to include participants with a broad range of abilities.

The participants were recruited from two centres affiliated with the one foundation and following the program described above. The participants were 48 children (37 male; 11 female) with a diagnosis of ASD (DSM-IV or DSM-5) who commenced at the centres in 2015, 2016, and 2017. Participants had a mean chronological age of 46.88 months (range 31.70 to 67.61 months), and mean nonverbal development level of 53.05 (range 9.28 to 93.36) as assessed using the Mullen Scales of Early Learning (MSEL; 1995). See Table 1 for a description of the participants. ASD diagnosis was further verified using the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) using ADOS-2 classification scores as cut-off.
Table 1

**Participant Characteristics**

<table>
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<tr>
<th>Measure</th>
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<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
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<tr>
<td>MB-CDI*</td>
<td>39</td>
<td>147.28</td>
<td>0</td>
<td>397</td>
<td>133.59</td>
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<td>MSEL expressive language (DQ scores)</td>
<td>46</td>
<td>44.16</td>
<td>7.05</td>
<td>89.52</td>
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<tr>
<td>Chronological age at time of MSEL assessment (months)</td>
<td>46</td>
<td>46.88</td>
<td>31.70</td>
<td>67.61</td>
<td>9.32</td>
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<tr>
<td>MSEL non-verbal development (DQ scores)</td>
<td>46</td>
<td>53.05</td>
<td>9.28</td>
<td>93.36</td>
<td>18.14</td>
</tr>
<tr>
<td>MSEL receptive language (DQ scores)</td>
<td>46</td>
<td>38.20</td>
<td>2.38</td>
<td>99.75</td>
<td>23.02</td>
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*number of words produced as reported by parents*

Note: A score of 0 on the MB-CDI indicates that the child was not yet producing any of the 397 words listed on the MB-CDI checklist.

**Measures**

Direct child assessments were administered by speech-language pathologists and supervised graduate speech-language pathology and psychology research students, including the first and second authors. All examiners were experienced in assessing children with ASD.

Each child was assessed individually in a small room with minimal distractions. The child, the experimenter, and a second adult who assisted with video recording, were present in the room.

**Expressive language.** In keeping with the recommended best practices for measuring expressive language in children with ASD (Tager-Flusberg et al., 2009), two measures of expressive language were employed; Parent report and direct child assessment.

**Parent report.** The MacArthur-Bates Communicative Development Inventory: Words and Gestures (MB-CDI: WG) is a parent completed questionnaire for assessing language and communication in infants and young children (Fenson et al., 2007). The questionnaire
consists of two parts focusing on the early signs of comprehension, a child’s first gestures, and the expansion of early vocabulary and grammar and is used with children aged 8 to 18 months, and appropriate for use with older children with developmental delays (Fenson et al., 2007). Part 1 of the measure, which includes a 396-item vocabulary checklist, was used to measure expressive language for this study, with parents highlighting words their child uses, allowing an overall count of the number of words in a child’s repertoire. Parents completed the questionnaire at home and were advised only to document speech (i.e., no use of AAC). While the MB-CDI: WG provides normative data for typical development (Fenson et al., 2007), the tool has been shown to be appropriate for use with children with ASD and other developmental delays (Charman, Drew, Baird, & Baird, 2003).

**Direct assessment.** The Mullen Scales of Early Learning (MSEL; Mullen, 1995) is a standardised assessment of developmental level of young children (gross motor, visual reception, fine motor, receptive and expressive language). Items are scored along a continuum starting at 0; 0 indicating an incorrect or absent response, and the highest score available indicating full points. The total number of points varies by item. The expressive language subscale of the MSEL was used to calculate an expressive language developmental quotient (DQ) score for each child (Expressive language age equivalent score/chronological age at time of MSEL assessment x 100) and used this as the direct measure of children’s expressive language. Only behaviours observed during direct assessment were given credit, and only children’s verbal communication (i.e., no use of AAC) was scored. In addition, this measure was used to calculate a non-verbal DQ by averaging DQs for the fine motor and visual reception scales as is common practice in ASD research (e.g., Vivanti, Dissanayake, & Victorian ASELCC Team, 2016).
The children varied considerably in their expressive language. Table 1 displays means and standards deviations for expressive language as assessed using the MB-CDI: WG and the MSEL.

**Word learning.** Using the procedure employed by Allen et al. (2015), the examiner provided instruction to children on one novel word (label) paired with a colour photograph (16 cm x 11 cm) (Teaching phase). The children were then assessed on their ability to (a) select the target photograph when presented alongside a distractor photograph, and (b) extend the newly learnt label to the actual 3-D target object. The measure consisted of four testing phases in total (see Allen et al., 2015 for further information), with the inclusion of a Perseveration Control and an Object Bias Test.

**Teaching phase.** During the teaching phase, the experimenter showed a series of 13 colour photographs to the child and labelled each photograph. Only one photograph was visible at a time and the order was kept the same for all participants. The photo set comprised of four of one target object (uncommon item from hardware store; labelled twice on each occasion, i.e., “Look, it’s a Dax. See the Dax”); five of common objects (labelled once, e.g., “Look, it’s a ball”); and four of one distractor object (a different item from hardware store; not labelled, i.e., “Look at this.”). Pictures of the same type were not presented consecutively. Therefore, during each administration of the teaching phase, children were exposed to 8 pairings of the target label with the target photograph (i.e., four photos shown once, labelled twice each turn). The distractor object was similar to the target object in size and colour (see Figure 1), but differed with regard to shape. A distractor object with similar attributes was included to reduce the possibility that one object was more salient than the other, thus potentially influencing the way the children responded (Foulsham & Underwood, 2009). During the teaching phase, participants listened to the labels and observed the photographs.
only. The teaching phase was complete after all 13 photographs had been shown once. Figure 2 shows photographs of common objects shown during the teaching phase.

**Figure 1.** Target Object and Distractor Object (photographs)

![Target object ("Look, it’s a dax! See the dax")](image1.png) ![Distractor object ("Look at this!")] (image2.png)

**Figure 2.** Common Objects Shown During Teaching Phase (photographs)

(labelled “Look, it’s a XX”)

![Common object 1](image3.png) ![Common object 2](image4.png)

![Common object 3](image5.png) ![Common object 4](image6.png)

![Common object 5](image7.png)
After the teaching phase, the following four tests were used to assess children’s novel word (label) learning. The phases were administered in a fixed order following the teaching phase (i.e., teaching phase, then word learning test, then mapping test, then perseveration control, then object bias). For each phase, children were required to make a selection from a choice of two stimuli based on the experimenters’ instructions. Instructions began with “Show me a … (e.g., Dax)”, if no response was provided, the experimenter repeated the instruction as “Give me a … (e.g., Dax)” and extended her hand to gesture give. Examples of clear intentional responses included the child, pointing to, picking up, or labelling the item, and showing it to the experimenter (as per Preissler, 2008). If children were unable to provide a clear response to any of the trial items, their behaviours were recorded descriptively and have been discussed separately in the results. In addition, only responses made in direct response to the examiners request (i.e., within the testing phase) were scored as correct. These criteria were necessary to ensure reliability between coders and to ensure replicability.

**Word learning test.** To assess whether children had formed an association between the novel word (label) and target photograph, the experimenter presented two adjacent photographs depicting the target object and a distractor object and asked the child to show them the target (i.e., “Show me the Dax”). If the child selected the target photograph he/she was scored as having successfully formed an association between the novel word and the target photograph, and the experimenter proceeded to the next phase. If the child selected the photograph of the distractor object, he/she was given corrective feedback (“This one’s the Dax” and shown the target photo) and redirected to the teaching phase (“Let’s play this game again”). This sequence (Teaching phase then word learning test) was repeated up to three times as necessary (i.e., until the child successfully demonstrated pairing of the novel word and target photograph), giving the children three opportunities to show novel word learning. Five participants received the teaching phase twice only despite not showing correct word-
picture pairings at the word learning test due to difficulty sustaining attention. Eleven children who continued to attempt to complete the task, albeit providing the incorrect answers, were assessed on their performance at later phases to allow for exploratory analysis of individual differences in responses.

**Mapping test.** Following a correct response on the word learning test (i.e., by selecting the target picture in response to the examiner’s request), children were then presented with a photograph of the target object and the 3-D target object and asked to identify the referent of the newly learned word (“Show me a Dax”). The verbal instruction changed during the mapping test as per the procedure used in the Allen et al., (2015) study to indicate to children that selection of either stimuli (or both) would be an acceptable response during this phase (i.e., both the target picture and target object represented a “dax”). This was to measure whether the children understood the referential nature of the target photograph. Children who selected either the target object, or the target photograph and the target object, were scored as having understood the referential nature of the picture. Children who selected the target photograph alone were scored as forming a picture-word association only.

**Perseveration control.** This trial was conducted to determine whether children were perseverating on the target photograph. Children were presented with the photograph of the target object and a previously unseen common 3-D object and asked to identify the object (“Show/Give me the Horse”). Selection of the target photograph indicated perseveration (Allen et al., 2015).

**Object bias.** This trial was conducted to determine whether children showed a bias towards selecting objects. The photograph of the target object was presented alongside a 3-D distractor object, and the children were asked to identify the target photograph (“Show/Give me the Dax”). Selection of the distractor object indicated an object-bias (Allen et al., 2015).
Reliability. Reliability coding was conducted to determine the degree of agreement between individual raters (Interobserver) and the initial rater (Intraobserver). Each rater coded children’s responses to the word learning task (all phases). Ratings were compared and intraclass correlation coefficient (ICC) analysis was conducted.

Interobserver reliability. A second observer (Postgraduate speech-language pathology student) blind to the study aims and hypotheses completed reliability coding of a randomly selected 25% of all recordings. Prior to independently rating the videos, the second observer participated in coding training with the initial observer on a randomly selected two videos; one video was used to model the coding system, and the second to independently code and discuss discrepancies. From a total of 44 videos, the second observer coded 11 that had been randomly selected. Intraclass correlation analysis was conducted, and consistency among recordings was found to be high, ICC = .934 (Type A class using absolute agreement).

Intraobserver reliability. The initial observer also recoded a randomly selected 25% of all recordings (11) to determine the stability in coding between samples coded on two separate occasions. Consistency among recordings was found to be high, ICC = .989 (Type A class using absolute agreement).

Data Analysis

Descriptive statistics were used to document children’s responses during the word learning task. A Kruskal-Wallis Test was used to determine if there were differences between groups (i.e., “Failed to demonstrate word learning”, “Associative learning”, and “Referential learning”) on the two measures of expressive language. A Kruskal-Wallis Test was selected over a one way ANOVA because the expressive language measures were not normally distributed. A Fisher’s Exact test was used to investigate the degree of association between children’s responses during the mapping test and responses during the object bias test, to
determine if children selected the object during the mapping test due to a bias towards objects, rather than to signify referential learning.

**Results**

**Word Learning Test**

In total, 62.5% (30) of participants passed the word learning test, indicating successful pairing of the novel word (label) to the target photograph. One child was excluded from analysis due to administration error, and the remaining 33.3% (16) did not show learning of the novel word. Of these 16 children who did not show word learning during the final test phase, 12.5% (2) gave the distractor photograph, 18.75% (3) gave both photos, 18.75% (3) played with both photos (e.g., 2 children stacked them, 1 child shook them), and 50% (8) made no response. Of the children who passed the word learning test, 83.9% (26) passed with one administration of the teaching phase, 12.9% (4) required the teaching phase to be repeated once, and one participant required the teaching phases to be repeated twice (3.2%). The performance of the children who failed to demonstrate learning of the novel word (label) but nevertheless interacted with the test materials are described below (“Failed to demonstrate word learning” \[ n = 11 \]). These children received the teaching phase multiple times (54.55% twice and 45.45% three times) and still failed to demonstrate pairing of the novel word and the target picture. Six of these participants did not receive a third round of the teaching phase due to difficulty sustaining attention, but responded during the test stimulus.

**Mapping Test**

Of the children who passed the word learning test, 22.6% (7) selected the target photograph alone, indicating formation of an association between the novel word (label) and target photo. The majority of participants, 77.4% (24), selected either the target object alone (66.67% of instances) or both the target object and the target photograph (33.33% of instances) indicating referential understanding of the target photograph. Three of these
participants did not clearly give the items but matched the target object with the target photograph. These participants were considered to have achieved this phase even though the response could have been because of selection due to perceptual similarity only (Preissler & Carey, 2004).

**Failed to demonstrate word learning: Responses on mapping test.** Of the 11 children who did not demonstrate basic word learning during the word learning test, 5 children played with the target object but gave no clear response to the examiner during the mapping test phase. Three children demonstrated overt responses; one child gave the target photograph, one child gave the target object, and one child picked up the target object and said “It’s a Dax” and gave it to the examiner. One child matched the target photograph and the target object, but made no other attempt to direct the examiner’s attention to the items. One child picked up the target object and said “See the Dax” (taken from the teaching phase) and another child picked up the target object and played with it while saying “Dax”, but neither combined this action with eye contact nor clear showing or giving behaviours.

**Perseveration Control**

Of the children who passed the word learning test (31), 27 (87.1%) correctly selected the common object demonstrating disengagement from the novel target photograph. Four children incorrectly selected the target picture, indicating perseveration.

**Failed to demonstrate word learning: Responses on perseveration control.** Six children played with the common object but gave no clear response to the examiner. One child correctly gave the common object, and another child correctly showed the common object to the examiner. One child gave the target photograph to the examiner, and another child touched the target photograph but did not give it to the examiner. One child’s initial response was to play with the common object but continued to say “Dax”, and then said “Show me the Dax” and gave the target photograph to the examiner. These three later
responses could have been an indication of perseveration had the children demonstrated successful pairing of the novel word with the target photograph in the first instance.

**Object Bias**

Of the children who passed the word learning test (31), 17 (54.8%) correctly identified the target photograph, while 32.3% of children (10) selected the distractor object, indicating object bias. Four children (12.9%) matched the distractor object with the target photograph, which might have indicated difficulty discriminating between the two items due to perceptual similarity (i.e., similar colour) (Preissler & Carey, 2004).

**Failed to demonstrate word learning: Responses on object bias.** Two children correctly gave the target photograph to the examiner. One of these children picked up the distractor object first while echoing “Show me the Dax” but then gave the target photograph, which could have indicated an object interest, but the ability to still respond correctly to the task. One child incorrectly gave the distractor object, indicating an object bias (this child actually matched the two stimuli together in the first instance and then gave the distractor object when prompted to provide a response). A further two children matched the distractor object with the target photograph; again this might have been because the two items were the same colour. One child gave both the target photograph and the distractor object to the examiner. Four children made no clear response, but played with the distractor object. One child picked up the distractor object and echoed “Look at this” from the teaching phase, which could have indicated referential understanding of the distractor photograph shown during the Teaching Phase (i.e., child paired the picture with phrase the “Look at this”).

**Summary**

Overall, 14 children (45.16%) who successfully passed the word learning test showed neither perseveration on the target photograph or an object bias, thus increasing confidence that children’s responses to the word learning test were a true reflection of their word
learning ability. Children who passed the word learning test, but provided incorrect responses during the perseveration control and the object bias test, are described below.

**Associative responders.** Three children who demonstrated associative learning perseverated on the target photograph during the perseveration control. Another child selected the distractor object during the object bias test.

**Referential responders.** Four children who showed referential responding during the mapping test matched the distractor object with the target photograph during the object bias test. Eight children gave the distractor object to the examiner indicating a potential object bias. One child who showed referential learning displayed both perseveration on the target photograph and an object bias. As discussed, selection of the distractor object during the object bias test might have indicated a bias towards selecting objects, or a difficulty discriminating between the two stimuli because they were similar in colour.

A Fisher’s Exact test was conducted between children’s response during the mapping test and their response during the object bias test. There was no significant statistical association between children’s response during the mapping test and their response during the object bias test, $p = .094$. While the results were not statistically significant there was a tendency (54.2%) for children who selected the target object during the mapping test to also select the distractor object during the object bias test. This means that for some children, a selection of the target object during the mapping test could have been a result of a bias towards objects, rather than a sign of referential learning.

**Word Learning and Expressive Language**

Please note that all children who participated in the word learning measure and had measures of concurrent expressive language at the time of writing the results are included in the results below. See Table 2 for a description of children’s language levels based on their response to the word learning test.
Table 2.

*Children’s Expressive Language Based on Word Learning Ability*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Failed to demonstrate word learning</th>
<th>Associative learning</th>
<th>Referential learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB-CDI*</td>
<td>n 14</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>79.36 (114.53)</td>
<td>127.50 (153.25)</td>
<td>214.89 (113.57)</td>
</tr>
<tr>
<td>Range</td>
<td>0 - 380</td>
<td>0 - 397</td>
<td>9 - 392</td>
</tr>
<tr>
<td>MSEL expressive language (DQ scores)</td>
<td>n 16</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>34.28 (17.81)</td>
<td>40.75 (23.13)</td>
<td>54.07 (16.33)</td>
</tr>
<tr>
<td>Range</td>
<td>7.05 – 66.55</td>
<td>8.01 – 83.95</td>
<td>25.59 – 89.52</td>
</tr>
</tbody>
</table>

*number of words produced as reported by parents

**MSEL.** Kruskal-Wallis Tests were conducted to determine if there were differences in MSEL expressive language DQ, and MSEL DQ scores between groups that differed on their observed word learning ability: “Failed to demonstrate word learning” (*n* = 16), “Associative learning” (*n* = 7) and “Referential learning” (*n* = 22).

Distributions of MSEL expressive language DQ scores were not similar for all groups, as assessed by visual inspection of a boxplot. The mean ranks of MSEL expressive language scores were statistically significantly different between groups, \( \chi^2 (2) = 10.590, p = .005 \). Pairwise comparisons were performed using Dunn (1964) procedure with a Bonferroni correction for multiple comparisons. Adjusted *p*-values are presented. Values are mean ranks unless otherwise stated. Post hoc analysis revealed statistically significant differences in MSEL expressive language DQ scores between the “Failed to demonstrate word learning” (15.81) and “Referential learning” (29.41) (*p* = .005) groups, but not the “Failed to demonstrate word learning” (15.81) and the “Associative learning” (19.29) (*p* = 1.00), or the “Associative learning” (19.29) group and the “Referential learning” (29.41) (*p* = .227) group.
Distributions of nonverbal development level were similar for all groups, as assessed by visual inspection of a boxplot. Median nonverbal development scores increased from children who “Failed to demonstrate word learning” (46.08), to “Associative learning” (55.11), to “Referential learning” (59.57), but the differences were not statistically different between groups, $\chi^2 (2) = 5.432, p = .066$.

**MB-CDI.** A Kruskal-Wallis Test was also conducted to determine if there were differences in MB-CDI Number of Words used between groups that differed on their observed word learning ability: “Failed to demonstrate word learning” ($n = 14$), “Associative learning” ($n = 6$) and “Referential learning” ($n = 18$).

Distributions of MB-CDI values were not similar for all groups, as assessed by visual inspection of a boxplot. The mean ranks of MB-CDI values were statistically significantly different between groups, $\chi^2 (2) = 9.920, p = .007$. Pairwise comparisons were performed using Dunn (1964) procedure with a Bonferroni correction for multiple comparisons. Adjusted $p$-values are presented. Values are mean ranks unless otherwise stated. Post hoc analysis revealed statistically significant differences in MB-CDI values between the “Failed to demonstrate word learning” (13.07) and “Referential learning” (25.31) ($p = .006$) groups, but not the “Failed to demonstrate word learning” (13.07) and the “Associative learning” (17.08) ($p = 1.00$), or the “Associative learning” (17.08) group and the “Referential learning” (25.31) ($p = .347$) group.

**Discussion**

The aim of this study was to investigate novel word-picture learning in preschool children with ASD. The study extended on previous research by looking at the relationship between word-picture learning and expressive language as assessed using parent report and direct child assessment. In addition, the study investigated word learning at an age at which these skills are usually established in typically developing children, but at which the children
who participated in the study were showing varied expressive language skills. Based on previous research, it was hypothesised that a large proportion of the children in the study sample would have word learning difficulties (Allen et al., 2015; Preissler, 2008). However, given that word learning is documented to be linked to language development in typically developing children (Callaghan, 2000), it was expected that the children in the current study who did show word learning abilities would have overall higher levels of expressive language compared to those who did not show signs of word learning.

First, a large minority (33.3%) of the participants in the current study failed to demonstrate word learning despite up to three repetitions of the teaching phase (i.e., 24 verbal pairings of the novel target word with the target photograph). This is in contrast to the participants in the Allen et al. (2015) study where all children passed the word learning test with one (86%) or two repetitions (14%) of the training stage. It is possible that children’s ability to attend to the task and provide a correct response was a result of the age of the participants in this study, given that the participants were on average 69 months younger than the participants in the Allen et al. (2015) study. While none of the children in the Preissler (2008) study failed to demonstrate word learning, around half needed multiple repetitions of the training phase, with one child requiring up 19 pairings of the novel word with the target object. Given the participants in the Preissler (2008) study were closer in age to those included in the current study (although approximately 45 months older), the findings support that younger children might have difficulty demonstrating word learning abilities in preliminary testing, however, if successful, demonstrate higher levels of referential learning when compared to older children. One reason for the larger percentage of older children who were able to pass the word learning task might be due to prior experience with teaching methods (during intervention) which resemble the procedure employed in the current study.
Contrary to previous investigations with older children, the majority of children in the current study (78.57%) demonstrated referential word learning by extending their learning of the novel word (label) to an object depicting the target referent. This was in contrast to the findings of the Hartley and Allen (2015) study where only 48.6% of children showing referential learning when teaching phases included differently coloured variants of the target object, and 25.7% when teaching phases included non-colour conditions (as used in the current study). This difference could be due to sampling, given that the participants in the current study were on average much younger than those included in previous investigations (Allen et al., 2015; Hartley & Allen, 2015; Preissler, 2008). This is perhaps not surprising given that language is highly variable in the younger years, and that some children who present with language delays will end up developing some degree of language (Ellis Weismer & Kover, 2015). However, it is suggested that looking at word learning abilities during these early years as a mechanism for language learning might help to differentiate these children, and have potential implications for both research and clinical work. From a research perspective, focusing on younger children and studying their word learning skills during this critical stage of development could have important implications for intervention, if word learning skills are found to be malleable to intervention and critical for later language development. Further investigation using a longitudinal study of children over time is needed to determine if there is relationship between word learning abilities during the preschool years and later language development. This difference could also be due to the method of teaching itself, as in the Hartley and Allen (2015) study, the target picture was shown in isolation and then the child was required to correctly select the target picture from an array of pictures on 5 consecutive trials before moving through test phases. While the inclusion of multiple measures for word learning likely ensured children had in fact learnt the association between the target word and the target photograph (i.e., not related to chance responding), it
is possible that the method used in the Allen et al. (2015) study supported associative responding by encouraging more pairings of the novel word and target picture during the training phases. Irrespective of the sampling differences, this preliminary investigation provides evidence in support of preschool children with ASD and varied language abilities showing referential understanding of pictures, indicating that there is much variability across age and language level.

There was a significant difference in expressive language between children who were unable to demonstrate novel word learning and those who demonstrated referential understanding of the photograph. This finding supports the suggestion that the process of word learning might help drive (or at least reflect) language learning for some preschool children with ASD (Patrick, 2013), that is, an understanding of the symbolic nature of pictures, might serve as a building block, or demonstrate evidence for, the development of other symbolic behaviours, including the development of language. There were no significant group differences in expressive language however, between children who were unable to demonstrate novel word learning and those who responded associatively, and those who responded associatively, and those who responded referentially. However, because only six children demonstrated associative learning during the mapping task, it is possible that having such a small number in this group might have impacted on the statistical comparisons made between children whose responses showed associative learning and children who failed to demonstrate word learning, and children who showed associative learning and children who showed referential responding. It is possible that word learning in children with ASD is likely influenced by a range of factors, which might have explained these varied results. For example, when thinking about the participants in the current study, word learning abilities could have been due to varying levels of attention and motivation for the task. While there was no significant difference between children’s nonverbal development based on word
learning ability, it is worth noting that nonverbal development varied substantially even among children who displayed similar expressive language profiles. This might have contributed to the nonsignificant finding, which was in contrast to previous investigations documenting an association between nonverbal development and word learning abilities (Allen et al., 2015; Venker, Kover, & Ellis Weismer, 2015).

A unique contribution of the current study was inclusion of descriptive accounts of individual differences in task response among children who failed to show successful pairing of the novel word and the target photograph after three trials, but nevertheless attempted to respond. A number of children echoed the label modelled during the Teaching Phase while looking at the stimuli (i.e., for both the target photograph and also the distractor object), and other children showed items to the examiner. These observations suggest that, rather than conceptualising associative and referential learning as either ‘present’ or ‘absent’ skills, they should be considered dimensionally. Accordingly, children who respond in partial, including idiosyncratic, ways to the task may be amenable to intervention. Possible reasons for why some children were unable to show novel word learning when prompted in the first instance, but demonstrated learning at later phases, may have been due to increased processing time required (Hedvall et al., 2013), more exposures needed to the target, or difficulty understanding the instruction (Hudry et al., 2010), all of which are important considerations for treatment planning. It is possible that the inability to respond to the examiner’s requests for a response (“Show/Give me…”), and also to provide a contingent response, may have been influenced by the social difficulties documented for children with ASD (Luyster & Lord, 2009). An important consideration for future studies would be to include the ability to follow such instructions as either inclusion criteria into the study, or as a pre-test measure. Looking at the word learning task, if a child was not able to select the correct target it might be assumed that the child lacked the skill required to complete the task (i.e., an understanding
of the referential nature of pictures), but actually, social difficulties may have contributed to the child’s ability to attend to the instruction and provide a contingent response. For example, in the word learning task used in this study, clear parameters were set regarding a successful response and relied on the child’s ability to provide a clear intentional response to the examiner. While this strengthened the study with regards to replicability and not wanting to over interpret individual behaviours, it is acknowledged that some children’s responses might have been missed due to inherent difficulties with initiation and response to joint attention. Future researchers, and certainly clinicians, might choose to be more flexible in accepting responses in order to best assess and characterise children’s word learning abilities. This is particularly important for intervention planning, and could occur as part of extension testing during intake assessments and/or discussion with parents regarding a child’s potentially communicative behaviours (Keen, Sigafoos, & Woodyatt, 2000). It is unlikely though that social difficulty alone is the sole contributor, if it has any impact at all (Gliga, Elsabbagh, Hudry, Charman, & Johnson, 2012).

The findings of this preliminary investigation need to be considered with respect to a number of limitations. To begin, the sample was relatively small, however comparable to previous studies in this area (Allen et al., 2015; Hartley & Allen, 2015; Preissler, 2008). Given the intention was to extend on previous research by looking closely at individual differences, the smaller sample allowed the opportunity to report this in detail. There was also no control group of typically developing children to compare children’s performance to. However, again this aligned with the intention to investigate individual differences within a group of preschool children with ASD and varied language abilities in an attempt to understand mechanisms underpinning differences within this heterogeneous population. With regard to the word learning task, while assumed optimal conditions were provided for learning (e.g., quiet rooms), this may not have been representative of children’s natural
learning environment (Carey & Bartlett, 1978) or their individual learning preferences. It is also possible that some children failed to demonstrate successful pairing of the target word with the target picture due to the method in which the novel target was displayed. For example, it is possible that by limiting the number of teaching trials to a maximum of three, children who would have benefitted from additional trials (i.e., more exposure) to learn the novel word were excluded. In the current sample though, children’s ability to sustain attention appeared to impact on completing the task items and therefore it was felt that the limit was justified. Finally, just over half of the participants (54.2%) in the current study who included the target object in their response during the mapping test, incorrectly included the distractor object in their response during the object bias. Therefore, for these participants it is not possible to determine whether their selection during the mapping test was a true reflection of referential learning, or just a preference for objects. In light of this potential word learning bias, future studies should include additional trials (i.e., multiple novel word pairings) to measure children’s referential learning and obtain an overall percentage of referential learning.

In the current study a single novel word test was administered per participant, and it was therefore not possible to investigate whether children’s responses to the test stimulus were due to chance responding (i.e., 50/50 chance of selecting the ‘correct’ stimulus). This is acknowledged as a limitation and it is strongly recommended that future studies investigate chance responding by including additional trials with different words and testing success against chance, as was done in the Allen et al. (2015) study. As discussed in a previous study Preissler and Carey (2004), a selection of both the target photograph and the target object at the mapping test could also have indicated that the child recognised that the two stimuli were perceptually similar, rather than the child understanding the referential nature of the target photograph. This may also have played a role during the object bias task, where a number of
children matched the distractor object with the target photograph. In the current study the target and distractor objects were the same with regard to colour, but not shape. This was so that one stimulus was not more salient (or appealing) than the other (Foulsham & Underwood, 2009), but it was necessary that the stimuli were distinguishable in some way. However, some children with ASD are reported to have difficulties understanding shape bias (i.e., that shape often signifies category) and incorrectly use colour as a basis for generalising semantic relations (Hartley & Allen, 2014). This might have occurred for children in the current study who extended their learning of the novel target to the distractor object (Tek, Jaffery, Fein, & Naigles, 2008). If this were the case, this finding might help to understand how modifying input may influence how children respond, and therefore provide potential means by which to manipulate the task to improve children’s success in word learning.

Implications and Future Research Directions

An important avenue for investigation is word learning in situations where children are naturally exposed to new words (Carey & Bartlett, 1978). This could help determine how best to support children in everyday environments in their vocabulary development. Another important consideration that warrants further exploration is the extent to which the environments children are exposed to support word learning, that is, to investigate whether children exposed to interventions aimed at directly supporting referential word learning, lead to increases in other symbolic behaviours (i.e., expressive language). Two variables of interest that were not included in the current study but could be investigated as part of future research is the extent to which overall amount of talking and exposure time to novel stimuli during teaching trials might impact on children’s word learning, thus providing important information regarding the amount of exposure required for individual children. Future studies may also seek to include a production phase in order to investigate whether there is a distinction between children who attempt to imitate or produce the novel word (label) during
teaching, and those who do not, and overall expressive language levels. In the current study, some children were heard to echo the words; however, as this was not in response to a direct request and was not the focus of the study, children’s production of the novel word was not included in the analyses, however, some responses were described. In addition, future studies could include a generalisation phase by including the target object in a different colour to investigate whether the children who showed referential learning also displayed categorical knowledge, that is, that a label is attached to an object by its shape, not colour or size (Hartley & Allen, 2014; Tek et al., 2008). Finally, longitudinal investigations of the relationship between word learning and later word acquisition (i.e., expressive language development) are necessary to investigate how word learning relates to language development over time.

Conclusions

The current study investigated picture-word learning in preschool age children with ASD, and extended on previous research by also investigating the relationship between picture-word learning and expressive language level. The majority of children in the current study showed evidence for generalisation of novel word (label) learning to an object depicting the target referent; this was in contrast to previous investigations with older children with ASD. However, in the current study children were only exposed to one test of novel word learning, and therefore these findings should be considered preliminary evidence that preschool children with ASD demonstrate referential understanding of pictures. Future studies with larger samples should re-investigate word learning abilities among children with ASD and include multiple tests of word learning to account for chance responding.

In the current study there was a significant difference in expressive language between children who were unable to demonstrate novel word learning and those who recognised the referential nature of the photograph, but no significant difference in expressive language
between children who learnt the novel word via an associative mechanism only and children who understood the referential nature of the photograph. There was also no significant difference between children’s nonverbal development based on word learning ability, but it is worth noting that there were substantial differences in nonverbal development even among children who displayed similar expressive language profiles. A number of children who were not able to demonstrate clear responses during the word learning test, showed possible learning of, or progress towards learning, the novel word in other ways, such as, by looking towards the target photograph or object at a later time in response to a request, or echoing the phrase paired with that photograph during teaching. These observations point to the likely need for a dimensional view of these skills. The focus on children’s responses (i.e., output) combined with previous investigations of input (e.g., modifying iconicity, verbal label) (Allen et al., 2015; Hartley & Allen, 2015) during measures of word learning hold important implications for clinical practice, by highlighting that some children might respond better to particular presentation over others and that children demonstrate learning in different ways. Finally, it is recommended that word learning abilities of preschool children with ASD be a particular focus of future investigations, particularly with regard to response to intervention over time.

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Declaration of Interests

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.
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Chapter 6: Predictors of Expressive Language Change for Children With ASD

Publication


Statement of Contribution to Co-Authored Prepared Paper

My contribution to the paper involved: This study was designed in collaboration with primary supervisor, Dr David Trembath and associate supervisors, Professor Deb Keen and Dr Jessica Paynter. I was responsible for data collection and preliminary analysis. Credibility checking was completed by Dr Jessica Paynter. I was responsible for writing the complete first draft of the manuscript. Dr Trembath, Professor Keen, and Dr Paynter, appraised the manuscript and subsequent revisions prior to submission for publication.

(Signed) _________________________________ (Date) 15/02/2018

Veronica Rose (student and corresponding author of paper)

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(Countersigned) _________________________ (Date) 15/02/2018

Supervisor: Deb Keen

(Countersigned) _________________________ (Date) 15/02/2018

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Predictors of Expressive Language Change for Children With Autism Spectrum Disorder Receiving AAC-Infused Comprehensive Intervention

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Abstract

Comprehensive interventions for children with autism spectrum disorder (ASD) often incorporate augmentative and alternative communication (AAC) to support both comprehension and expression; however, variability in outcomes exists even among those who access similar intervention programs. The aim of this study was to investigate predictors of expressive language change for children with ASD receiving AAC-infused comprehensive intervention. The relationships between participants’ initial responses to AAC (visual attention, object play, and symbolic word learning) and expressive language change on average 10 months later were examined. Commonly reported predictors (nonverbal development, chronological age, and ASD symptomatology) did not significantly predict change in expressive language at Step 1 of a hierarchical multiple regression. However, AAC factors entered at Step 2, taken together explained an additional 42% of the variance in expressive language change, which was statistically significant. Of these AAC factors, only object play made a unique contribution to variance, adding 25%. By focusing on processes that might be relevant to response to AAC, the findings of this study provide preliminary data that object play might be particularly relevant to predicting expressive language change for children with ASD receiving interventions incorporating AAC.

Keywords: Autism spectrum disorder; Predictors; Augmentative and alternative communication; Expressive language; Early childhood
Predictors of Expressive Language Change for Children With Autism Spectrum Disorder Receiving AAC-Infused Comprehensive Intervention

Children with autism spectrum disorder (ASD) present with differences in their expressive language development, compared to those with typical development (Paul, 2007) and other clinical populations (Leyfer, Tager-Flusberg, Dowd, Tomblin, & Folstein, 2008; Shriberg, Paul, Black, & van Santen, 2011). In addition, children with ASD show substantial individual variability when comparing individuals with ASD to each other (Anderson et al., 2007; Tager-Flusberg et al., 2009). While there are many ways to communicate (e.g., gesture, speech), natural speech is typically recognized as the most efficient and easily accessible method for communication, and therefore the development of natural speech is a common target for preschool children with ASD (Tager-Flusberg et al., 2009). However, despite access to early intervention aimed at supporting language development, there is evidence to suggest that approximately one in four individuals with ASD who access early intervention exit to school using fewer than five spoken words (Norrelgen et al., 2014; Rose, Trembath, Keen, & Paynter, 2016).

Early intervention is often recommended to support early development, with the aim to reduce the need for services later in life (Brignell et al., 2016; Iacono, Trembath, & Erickson, 2016; Romsks, Sevcik, Barton-Hulse, & Whitmore, 2015). Given the multifaceted nature of ASD, interventions that target a range of core difficulties, including expressive language, and incorporate evidence-based strategies are considered best practice (Odom, Boyd, Hall, & Hume, 2010). Augmentative and alternative communication (AAC) systems are commonly used within early intervention for children with ASD (e.g., Paynter, Riley, Beamish, Scott, & Heussler, 2015). In this context, AAC is seen as a complementary communication strategy and a bridge to symbolic communication (Light & McNaughton, 2014; Millar, 2009; Romsks et al., 2015). Accordingly, individuals are supported to
communicate using individualized AAC systems (as required), and expression using AAC is valued as an effective communication mode (i.e., output). Teachers often use Aided Language Modeling, for example, pointing to a symbol on a communication board while providing the verbal label (Drager et al., 2006), to provide instructions, and in doing so AAC is used to support understanding of language (Drager, 2009; Reichle, Ganz, Drager, & Parker-McGowan, 2016). As a result, when infused within an early intervention program, AAC might not only provide an effective communication mode, but also support receptive language, thus driving overall language development (Romski et al., 2015).

Gains in social-communication, cognition, and broader adaptive behavior have been reported at the group level for children with ASD receiving community based early interventions in which AAC is used (e.g., Boyd et al., 2014; Stahmer & Ingersoll, 2004); however, there is significant variability in outcomes even among those who access similar intervention programs (Ganz, 2015). Therefore, there is a need to understand the mechanisms associated with individual differences in order to improve outcomes. Rose et al. (2016) recommended that one way to do this is to focus on the subgroup who enter early intervention using fewer than five spoken words, and then shift to using phrase speech at exit. Norrelgen et al. (2014) also highlighted the need to look beyond scores from standardized assessment to focusing on item level data in order to characterize natural speech outcomes. Including individuals with complex developmental profiles is crucial to understanding what contributes to the significant variability in language development in this population (Tager-Flusberg & Kasari, 2013). Furthermore, by providing detailed accounts of expressive language abilities using item level data it is possible to include individuals with a range of expressive language abilities in research and investigate language development at both the group and individual level.
A number of variables have been shown to be associated with developmental change during early intervention for children on the autism spectrum. Perry et al. (2011) investigated predictors of outcome (ASD symptomatology, adaptive behavior, cognition, rate of development, and categorical progress/outcomes) for 332 children with ASD aged 2-7 years receiving community-based intensive behavioral intervention, and found that chronological age at intake, IQ, adaptive scores, and ASD symptomatology were all related to outcomes following intervention. These findings have been replicated across studies at a group level (Eapen, Črnčec, & Walter, 2016; Ellis Weismer & Kover, 2015; Woynaroski et al., 2016). However, even among those who present with low cognitive abilities and high ASD symptoms, there is substantial variability in outcomes, and therefore a need for identification of more fine-grained predictors of change (Bal, Katz, Bishop, & Krasileva, 2016; Ryan et al., 2015). Not only is there a need to continue examination of outcomes at the group level in order to optimize communication outcomes, it is also necessary to look at within group changes including the connection between child variables and hypothesized active ingredients of intervention (Camarata, 2014; Stahmer, Schreibman, & Cunningham, 2011; Yoder & Compton, 2004).

One approach to investigating individual differences is to identify key components of intervention and measure children’s responses to these variables at intervention intake and their relationship with outcomes (Kasari, Freeman, & Paparella, 2000; Smith, Mirenda, & Zaidman-Zait, 2007). It has been theorized, for example, that subtle differences in responses to certain program elements might impact on whether children are likely to respond to a particular intervention over another (Gulsrud, Hellemann, Shire, & Kasari, 2015; Pellecchia et al., 2015; Trembath & Vivanti, 2014). To illustrate, Vivanti, Dissanayake, Zierhut, and Rogers (2013) hypothesized that individual differences in learning processes thought to mediate response to the Early Start Denver Model (ESDM) (i.e., those linked to social
learning), a comprehensive treatment model that uses specific social learning strategies embedded into everyday activities (Rogers & Dawson, 2010), would be associated with outcomes following intervention. To this end, the results of their study examining change in 21 children receiving group-based ESDM early intervention, indicated that the program might be particularly suited to those who showed the propensity to use objects in a goal directed way, interpreted the goals of other’s actions, and imitated other’s goal-directed behaviors (Vivanti et al., 2013). While the potential of this approach to account for individual differences has been demonstrated, this method has not yet been applied to comprehensive early intervention programs incorporating AAC, given that ESDM does not typically include AAC as a component of the program (Rogers & Dawson, 2010).

**Predictors of Change Within AAC-Infused Comprehensive Interventions**

There is emerging research aimed at investigating factors associated with outcomes following AAC interventions (Brady, Thiemann-Bourque, Fleming, & Matthews, 2013; Flippin, Reszka, & Watson, 2010; Ganz et al., 2012, 2011, 2014). Flippin et al. (2010), for example, investigated the potential influence of pre-intervention child characteristics on predicting outcomes following the Picture Exchange Communication System (PECS; Frost & Bondy, 2002), and found that joint attention, object exploration, and imitation emerged as possible predictors of PECS effectiveness. However, Flippin et al. (2010) emphasized that given the dearth of research focused on identifying contributing factors to AAC outcomes, more research is needed. More recently, Ganz et al. (2014) investigated moderating effects of age, intervention setting and presence/absence of intellectual/developmental disorders on natural speech outcomes in response to three types of aided AAC interventions: PECS, speech-generating devices (SGD), and “other picture based AAC.” (p. 516). The authors reported that for preschool-aged children (0 to 5 years), PECS and SGD were significantly more effective than “other picture based AAC,” (p.516), and that PECS was most effective
for those with ASD and comorbid intellectual/developmental disorder (Ganz et al., 2014). While research focusing on predicting change within AAC-infused interventions is emerging, there is a need for a more fine-grained approach to analysis in order to investigate the substantial individual differences reported in this population. In addition, despite AAC-infused interventions often being recommended to children with more complex communication needs, until recently many of these individuals have been excluded from research (Tager-Flusberg & Kasari, 2013), and so there is a need for research including children with a broad spectrum of needs and abilities.

Three processes that might be relevant to developmental change within AAC-infused interventions are visual attention (Trembath, Vivanti, Iacono, & Dissanayake, 2015), functional use of objects (McDuffie, Lieberman, & Yoder, 2012; Schreibman, Stahmer, Barlett, & Dufek, 2009; Yoder & Stone, 2006), and symbolic word learning (Allen, Hartley, & Cain, 2015; Preissler, 2008). Given that the use of AAC embedded into comprehensive interventions is largely a modeling based intervention (i.e., aided language modeling) and relies on the assumption that children are looking, it is possible that propensity to visually attend during teacher instruction (e.g., while a teacher points to pictures on a visual timetable) is related to outcomes (Trembath et al., 2015). In addition, use of AAC commonly involves manipulation of visual supports (e.g., picture cards) and referent objects in a functional, goal-directed manner in order to communicate, and there is evidence for a relationship between functional use of objects and expressive language outcomes for children with ASD (McDuffie et al., 2012). However, few studies have investigated the relationship between object use and change within the context of AAC-infused comprehensive interventions (Yoder & Stone, 2006). Finally, AAC employs the use of symbols such as pictures (Beukelman & Mirenda, 2013), and relies on the assumption that children recognize the relationship between the picture, what is depicted in the picture, and that the picture can be
used for a variety of functions. Pictures are referred to as *referential* in that they can be used to depict real world objects, and can be used even when the objects are not physically present (Ganea, Preissler, Butler, Carey, & DeLoache, 2009). Given that the ability to understand and use pictures referentially is a necessary skill develop through the six stages of the commonly used AAC intervention PECS (Frost & Bondy, 2002), it is possible that symbolic word learning abilities are related to change within comprehensive interventions in which AAC is a key component.

Augmentative and alternative communication is commonly incorporated into comprehensive early intervention for children with ASD; however, little research exists examining the mechanisms underpinning individual differences within AAC-infused interventions, particularly with regard to spoken language development. It is possible that children’s responses to AAC (visual attention, object play, symbolic word learning) might impact on their development within interventions incorporating AAC. To date, these variables have not been investigated in the context of community-based comprehensive interventions for children with ASD. In this preliminary investigation, it was hypothesized that participants’ initial responses to AAC would predict change in expressive language within a program in which AAC was a component of the intervention. As an exploratory analysis, this study investigated the extent to which verbal group status at exit (minimally verbal or using phrase speech based on natural speech production) differed based on individual response to AAC at entry.

**Method**

Ethical approval was granted by (excluded for review) and gatekeeper approval by the (excluded for review). Signed informed consent was obtained from parents of all participants.

**Participants**
Participants were 48 children (37 male, 11 female) with autism spectrum disorder (DSM-IV or DSM-5) who attended an ASD specific centre-based early intervention program between 2015 and 2017. Participants had a mean chronological age of 46.88 months (range: 31-67 months), and a mean nonverbal development level of 53.05 (range: 9.28-93.36) at Time 1 (T1) as assessed using the Mullen Scales of Early Learning (MSEL; Mullen, 1995). ASD diagnosis was verified using the Autism Diagnostic Observation Schedule – second edition (ADOS-2; Lord et al., 2012), using ADOS-2 classification scores for autism spectrum as cut-off.

**Primary Outcome: Change in Expressive Language**

Expressive language change scores. The MSEL (Mullen, 1995) was used as a standardized measure of nonverbal development at T1 and expressive language change from T1 to Time 2 (T2). The MSEL is a standardized assessment of development consisting of five subtests: gross motor (not administered for this study), visual reception, fine motor, receptive language, and expressive language (Mullen, 1995). Items are scored on a continuum, with 0 indicating an incorrect or absent response, and the highest score available indicating full points were achieved. The expressive language subscale was used to calculate change scores (expressive language age equivalent at T2 – expressive language age equivalent at T1/time between assessments in months, to control for the variability in months between T1 and T2 assessments) (Vivanti & Dissanayake, 2016), which were used as the primary measure of expressive language change. Only behaviors observed during direct assessment were given credit, and only natural speech production (i.e., no use of AAC) was scored. Spoken language was selected as a common measure of expressive communication given that not all participants involved in the study used AAC to support expression. In addition, the MSEL was used to calculate a nonverbal development quotient (DQ), which was used in the analyses as a commonly reported predictor of outcome. Nonverbal DQ was calculated by
averaging DQs for the fine motor and visual reception subscales (Subscale age equivalent score/chronological age at time of MSEL assessment x 100), as is common practice in ASD research (see Vivanti & Dissanayake, 2016).

**Secondary Outcome: Change in Verbal Group Status From T1 to T2**

**Verbal group status.** In addition to change scores, the following expressive language item scores from the MSEL were used to classify verbal status: Item 11 “Says first words,” scores range from 0 to 3; and Item 17, “Uses two-word phrase,” scores range from 0 to 1 (Mullen, 1995). Using scores from these two items, participants were classified as either minimally verbal (using up to eight words but not yet using two-word phrases), or using phrase speech (using two word phrases). Categorizing speech level using individual item scores has been employed in two previous studies (see Norrelgen et al., 2014; Rose et al., 2016); however, scores have previously been based on parent responses. In their investigation, Rose et al. (2016) reported relatively high agreement (77.8%) between responses on parent questionnaires and the clinician administered MSEL, thus providing support for using comparable MSEL items.

**Predictors of Developmental Change**

**Commonly reported predictors.** Nonverbal development (previously described), ASD symptomatology, and chronological age at intake were included as commonly reported predictors of developmental change (Eapen et al., 2016; Ellis Weismer & Kover, 2015; Perry et al., 2011; Woynaroski et al., 2016).

**ASD symptomatology.** The Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003) was used as the measure of ASD symptomatology (total score). The SCQ is a 40 item parent completed questionnaire used to determine the presence of behaviors consistent with ASD (Rutter et al., 2003). A total score is derived and is commonly used as an indicator of ASD symptomatology across various groups and individuals, with higher
scores indicating greater presence of behaviors characteristic of ASD (Eapen, Črnčec, & Walter, 2013).

**Chronological age at intake.** Chronological age at intake was reported in months and determined by participants’ age at the time of their first MSEL assessment.

**AAC specific predictors.** The following three theoretically and empirically motivated predictors were included to investigate participants’ initial responses to AAC.

**Visual attention.** The visual attention measure was a replication of an eye tracking paradigm used by Trembath et al. (2015). The aim was to explore the extent to which participants attended to a picture-based AAC system when it was modelled during teaching instruction delivered during a simulated teaching activity. Participants were shown a series of videos, during which an actor modeled language under two conditions; using AAC (speech + pictures); and without AAC (speech only) (Trembath et al., 2015). For the current study only the eight AAC conditions were included in order to investigate visual attention to the AAC system only. The videos were presented in two fixed random orders (Order 1 and Order 2) with participants allocated to either order using alternate allocation. During each video, the teacher delivered a verbal instruction (e.g., *I want you to pick up the [object] and put it in the [container]*) while pointing to two color photographs representing the object to picked up and the container in which the object was to be placed. The photographs were displayed on a piece of A3 cardboard presented in a fixed position facing the child. Prior to the recording, the same stimuli (four objects and four containers) were presented (shown and labelled) and placed in front of the participant so they could carry out the instructions using the available objects (performance score not reported in this study). Visual attention was calculated by the proportion of time spent fixating (ms) on pre-defined areas of interest (i.e., time spent visually attending to the AAC system), which included pictures of both the object and the container (Trembath et al., 2015).
**Object play.** Functional use of objects was measured during a 5-min free-play activity in which participants were presented with a set of 15 different objects that afforded opportunities for goal directed actions to occur. No specific instructions were provided (e.g., *You can have a play*). This task has been used previously with preschool children with ASD (Vivanti et al., 2013). For the current study, participants’ spontaneous use of the objects was scored as conventional/appropriate, pretend or imaginative, or destructive, with the variable of interest coded as any behavior that presented as conventional/appropriate (including pretend or imaginative).

**Symbolic word learning.** This measure was used to examine the extent to which participants demonstrated either associative (i.e., the ability to form connections between particular symbols), or referential (i.e., recognition that symbols refer to objects/events not physically present) understanding of pictures commonly used in AAC systems. Using an established word learning procedure (see Allen et al., 2015), participants were taught one novel word paired with a color photograph. The measure consisted of five phases; Training phase, word learning test, mapping test, perseveration control and object bias. For the current study, symbolic word learning was determined by responses during the mapping test. During this phase, participants were presented with a color photograph of the target object (shown during the training phase) and the real target object, and asked to identify the referent of the newly learned word. Participants who selected either the target object, or the target photograph and the target object, were scored as having understood the symbolic nature of the picture. Participants who selected the target photograph were scored as forming a picture-word association only. Only one trial was completed and only clear responses of showing were coded as correct, including, pointing to or picking up and showing the experimenter the item.
Design

This study used a within-subject longitudinal (pre-post) cohort design to measure response to AAC at T1 and change in expressive language on average 10 months later. Assessments used to characterize the sample, commonly reported predictors of outcome, and three predictors specifically measuring participants’ responses to AAC were measured at T1. Developmental assessments and primary and secondary outcomes were measured at T1 and T2, with approximately 9.95 months (range: 8-13 months) between the two time points.

Intervention

The participants in this study were enrolled in a community-based comprehensive intervention program. No experimental intervention was delivered for the current study. Participants’ responsiveness to a key element of the intervention (i.e., AAC) and the relationship with outcomes was investigated in order to determine predictors of expressive language change for children receiving this particular intervention approach in the community. For this study, AAC encompassed alternative methods that were incorporated within the classroom environment to support both receptive and expressive communication along with participation in classroom activities through the use of symbolic systems, such as, communication displays (e.g., visual timetables, communication boards) and technology (e.g., speech generating devices).

The intervention program delivered a comprehensive curriculum that followed Australian Good Practice Guidelines (Prior, Roberts, Rogers, Williams, & Sutherland, 2011) to support preschool children with ASD in their social, communication, and cognitive development (excluded for review). Teaching strategies were those with emerging or higher levels of evidence as categorized by the National Autism Center Standards Report (National Autism Center, 2015). Examples of good practice guidelines included providing “highly supportive teaching environments” (Prior et al., 2011, p. 129) that supported “predictability
and routine” (Prior et al., 2011, p.129). Visual supports were used throughout the environment (e.g., class schedules, individual schedules, aided language modeling) and embedded into daily activities. Visual supports were individualized to the needs of the individuals in each classroom (e.g., visual photograph, symbol, line drawn format). At a minimum, all rooms were required to have a whole class schedule and to support transitions using visual supports, thus, even if a child did not have an individualized AAC system prescribed to them, they were consistently exposed to visual supports in their learning environment. Further, peer to peer interactions were encouraged, and therefore participants had multiple opportunities to engage with others who communicated using AAC. The program was delivered via a transdisciplinary team that included teachers, speech-language pathologists, occupational therapists, behavior therapists, and paraprofessionals with training in early childhood in a ratio of 1:2 to 1:4 in a centre-based ASD-specific setting. Participants attended the program 15-25 hr per week with most attending 5 days per week.

**Procedures**

Clinician administered assessments were conducted at the early intervention centre by speech-language pathologists and supervised graduate speech-language pathology and psychology research students, including the first and second author. All examiners were experienced in assessing children with ASD. Each participant was assessed individually in a small room with minimal distractions.

**Reliability Coding**

Reliability coding was conducted on 25% of each data set for object play and symbolic word learning to determine the degree of agreement between individual raters (Interobserver) and the initial rater (Intraobserver). Ratings were compared and intraclass correlation coefficient (ICC) analysis was conducted.
**Interobserver reliability.** Interobserver reliability between the second author and a postgraduate psychology student blind to the study aims and hypotheses was found to be high for object play, $\text{ICC} = .975$ with a 95% confidence interval from .910 to .993, $F(10,10) = 37.81, p < .001$. Interobserver reliability between the first author and a postgraduate speech-language pathology student blind to the study aims and hypotheses was also found to be high for symbolic word learning, $\text{ICC} = .934$ with a 95% confidence interval from .880 to .964, $F(43, 43) = 15.046, p < .001$.

**Intraobserver reliability.** Intraobserver reliability (first author) was found to be high for both object play, $\text{ICC} = .994$, with a 95% confidence interval from .978 to .998, $F(10,10) = 152.875, p < .001$, and symbolic word learning, $\text{ICC} = .989$, with a 95% confidence interval from .981 to .994, $F(43,43) = 95.149, p < .001$.

**Data Analysis**

A Little’s MCAR Test was conducted on the full sample and was not statistically significant, $\chi^2(42) = 44.03, p = .386$, indicating that data were missing at random. Bivariate correlations between predictors and expressive language change scores were examined first using Pearson’s correlation (continuous variables) and Point-biserial correlation (binomial variables) analysis. Hierarchical multiple regression was then used to determine the effects of the three hypothesized predictors on expressive language change within the AAC-infused intervention while controlling for nonverbal development, ASD severity and chronological age at T1. As an exploratory component, binomial logistic regression was to be run to determine the effect of initial response to AAC on the likelihood of participants who were minimally verbal at T1 ($n = 22$), developing phrase speech by T2. However, a Little’s MCAR Test was conducted (on the group of participants who were minimally verbal at T1 only) and found to be statistically significant, $\chi^2(21) = 35.11, p = .027$, indicating that data were not missing at random, thus missing values substitution (e.g., using multiple imputation) was
deemed inappropriate and listwise deletion yielded a sample size too small for meaningful
analysis. Thus, individual t-tests between groups (minimally verbal or using phrase speech at
exit) were conducted with data deleted listwise per analysis to explore intake differences
between groups. Two Fisher’s Exact tests were conducted between associative learning
(Pass/Fail) at T1 and verbal group status at T2, and referential learning (Pass/Fail) at T1 and
verbal group status at T2.

Results

Data were screened for possible missing data; some measures were missing due to
parent checklists (SCQ) not being returned (n = 9), missed assessments due to scheduling
constraints (n = 12), technical difficulties (e.g., issues with eye tracking equipment,
administration error) (n = 9), and a small number of participants who left the program prior
to their T2 assessment (n = 6). No violations of normality (e.g., kurtosis and skewness) were
found. No violations of collinearity were detected with all variables included in the
hierarchical multiple regression correlated < .80.

Expressive Language Change

There was a significant difference between T1 and T2 age equivalent scores on the
MSEL expressive language subscale at a group level. Participants gained on average 9.71
months in their expressive language skills, \( t(40) = 7.69, p < .001, d = 1.20 \). However, there
was considerable individual variability, with change ranging from declining scores of 7
months to increasing scores of 23 months. Following approximately 1 year of intervention,
the number of participants who were minimally verbal decreased from 22 (55%) to 9
(22.5%), a statistically significant difference as evaluated by McNemar’s test, \( \chi^2(1) = 11.08, p < .001 \). This change was due to 13 participants who were minimally verbal at T1 developing
phrase speech by T2.
Predictors of Expressive Language Change

The first analysis aimed to investigate the extent to which participants’ initial responses to AAC predicted change in expressive language beyond commonly reported predictors of outcome (central aim of the study). Symbolic word learning was separated into two variables: associative learning (yes/no) and referential learning (yes/no) for the analysis. As presented in Table 1, there was no statistically significant correlation between any of the commonly reported predictors and expressive language change scores. There was also no statistically significant correlation between associative learning and expressive language, or referential learning and expressive language. There were moderate statistically significant correlations between visual attention and expressive language, and between object play and expressive language.

Table 1

*Correlation Matrix between Predictors and Expressive Language Change Scores*

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chronological age</td>
<td>1</td>
<td>-.06</td>
<td>-.32</td>
<td>.19</td>
<td>.29</td>
<td>.21</td>
<td>.23</td>
<td>-.10</td>
</tr>
<tr>
<td>2. Nonverbal development</td>
<td>-.06</td>
<td>1</td>
<td>.19</td>
<td>.27</td>
<td>.38*</td>
<td>.31*</td>
<td>.07</td>
<td></td>
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<tr>
<td>3. ASD symptomatology</td>
<td>-.32</td>
<td>-</td>
<td>1</td>
<td>-.17</td>
<td>-.30</td>
<td>-.20</td>
<td>-.17</td>
<td>-.06</td>
</tr>
<tr>
<td>4. Visual attention</td>
<td>.19</td>
<td>.19</td>
<td>-.17</td>
<td>1</td>
<td>.18</td>
<td>.35*</td>
<td>.19</td>
<td>.44**</td>
</tr>
<tr>
<td>5. Object play</td>
<td>.29</td>
<td>.27</td>
<td>-.30</td>
<td>.18</td>
<td>1</td>
<td>.32</td>
<td>.29</td>
<td>.44**</td>
</tr>
<tr>
<td>6. Symbolic word learning:</td>
<td>.21</td>
<td>.38*</td>
<td>-.20</td>
<td>.35*</td>
<td>.32</td>
<td>1</td>
<td>.73**</td>
<td>.14</td>
</tr>
<tr>
<td>Associative</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Symbolic word learning:</td>
<td>.23</td>
<td>.31*</td>
<td>-.17</td>
<td>.19</td>
<td>.29</td>
<td>.73**</td>
<td>1</td>
<td>.02</td>
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<tr>
<td>Referential</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Expressive language change</td>
<td>-.10</td>
<td>.07</td>
<td>-.06</td>
<td>.44**</td>
<td>.44**</td>
<td>.14</td>
<td>.02</td>
<td>1</td>
</tr>
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</table>

*p < .05, two-tailed. **p < .01, two-tailed.*
A hierarchical multiple regression was conducted to determine if the addition of the three AAC variables improved the prediction of expressive language change beyond the contribution of commonly reported predictors of developmental change entered together. Data was deleted listwise, leaving data for 27 participants in the final regression model due to missing data.

Predictors were entered in two blocks. At Step 1, commonly reported predictors of developmental change (nonverbal development, chronological age, ASD symptomatology) were entered. At Step 2, the three hypothesized AAC predictors (visual attention, object play, symbolic word learning) were entered. As presented in Table 2, commonly reported predictors taken together explained 4% of the variance in expressive language, and did not explain a significant proportion of the variance, $F(3, 23) = .32, p = .813$. No individual predictors added significantly to the prediction of variance in expressive language change. At Step 2, AAC predictor variables added a significant increment in the variance in expressive language, explaining an additional 42% of the variance above that explained by commonly reported predictors, $F(4, 19) = 3.75, p = .021$. Overall, 46% of the variance in expressive language change was explained by the full model at Step 2, approaching statistical significance, $F(7, 19) = 2.34, p = .066$. Object play was the only variable found to make a statistically significant unique contribution of 25% of the variance in expressive language change, $p = .008$. 
Table 2

Hierarchical Multiple Regression Predicting Expressive Language Change from Commonly Reported Predictors (Step 1) and Hypothesized AAC Predictors (Step 2)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Step 1</th>
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<th>Step 2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>t</td>
<td>p</td>
<td>sr²</td>
<td>β</td>
<td>t</td>
<td>p</td>
<td>sr²</td>
</tr>
<tr>
<td>Constant</td>
<td>.29</td>
<td>.776</td>
<td>.71</td>
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Note. $R^2 = .04$ for Step 1, $p = .81$; $\Delta R^2 = .42$ for Step 2, $p = .02$

Differences in T1 AAC Variables and Verbal Group Status at T2

For participants who were minimally verbal at Time 1 ($n = 22$) it was of interest to explore what differentiated those who developed phrase speech ($n = 13$) and those who remained minimally verbal ($n = 9$) both in terms of the commonly reported predictors and the hypothesized AAC predictors. There was not a statistically significant difference in chronological age at T1 between participants who developed phrase speech at T2 ($M = 44.66$, $SD = 9.68$) and those who remained minimally verbal ($M = 43.61$, $SD = 9.94$), $t(20) = - .248$, $p = .807$, $d = .11$, with a negligible effect size. Participants who developed phrase at T2 had significantly higher nonverbal development ($M = 50.48$, $SD = 14.62$) at T1 than those who remained minimally verbal ($M = 35.18$, $SD = 12.28$), $t(20) = - 2.570$, $p = .018$, $d = 1.11$, with a large effect size. Participants who developed phrase at T2 also had significantly lower ASD
symptomatology scores ($M = 16.67, SD = 5.35$) at T1 than those who remained minimally verbal ($M = 22.50, SD = 3.59$), $t(18) = 2.695, p = .015, d = 1.23$, with a large effect size.

With regards to the hypothesized AAC predictors participants who developed phrase speech at T2 visually attended significantly more to AAC ($M = 1.19, SD = .70$) at T1 than those who remained minimally verbal ($M = .36, SD = .34$), $t(16) = -2.945, p = .01, d = 1.42$, with a large effect size. Participants who developed phrase speech at T2 also used more objects functionally at T1 ($M = 5.45, SD = 3.14$) than those who remained minimally verbal ($M = 2.75, SD = 2.38$) at T2, which approached statistical significance, $t(17) = -2.041, p = .057, d = .95$, with a large effect size. There was a statistically significant association between associative learning at T1 and verbal status at T2, $p = .024$, but no statistically significant association between referential learning at T1 and verbal status at T2, $p = .111$.

**Discussion**

This study investigated predictors of expressive language change for children with ASD receiving a community-based intervention program in which AAC was a component. This was done by investigating the relationship between responses to AAC at intake (visual attention, object play, and symbolic word learning) and expressive language change approximately 12 months later. Based on previous research, it was hypothesized that initial responses to AAC would predict change in expressive language (expressive language change scores and verbal group status). By focusing on three processes that might be relevant to change within AAC-infused interventions, the findings provide preliminary data on the characteristics of children who might experience the largest gains in spoken language within comprehensive interventions programs incorporating AAC.

As a group, the participants in this study showed improvement in their expressive language skills consistent with time, that is, after an average 9.95 months of intervention, they gained on average 9.71 months in expressive language based on scores from the MSEL.
expressive language subscale. However, as is commonly reported in early intervention research for children with ASD (see Anderson et al., 2007; Tager-Flusberg et al., 2009), there was considerable individual variability, with one participant gaining 23 months in his expressive language skills, and another showing a decrease of 7 months from T1 assessment. With regards to change in verbal group status, more than half of the participants who were classified as minimally verbal at T1 developed phrase speech at T2 (13/22; 59.1%), and none of the participants who were using phrase speech at T1 were minimally verbal at T2. This is consistent with previous research documenting a significant change in expressive language among children with ASD using similar classifications for minimally verbal and using phrase speech (Norrelgen et al., 2014; Rose et al., 2016).

Contrary to previous investigations of outcome (Bopp, Mirenda, & Zumbo, 2009; Perry et al., 2011), there were no relationships between any of the commonly reported predictors (nonverbal development, chronological age, ASD symptomatology) and expressive language change scores for the participants in this study, individually or taken together. However, there were significant associations between nonverbal development and ASD symptomatology, and change in verbal group status from T1 to T2. There are a number of possible explanations for this. First, it is possible that given the relatively small sample size that suited the investigation of individual differences, that the current study was underpowered to detect an effect using expressive language change scores. It is possible that nonverbal development and ASD symptomatology are more important predictors of change for children with more room for movement, that is, for children who initially present as minimally verbal. This hypothesis is supported by the findings of a relationship between these variables and change in verbal group status for the participants in the study who initially presented as minimally verbal. In addition, participants in this study were all at varying developmental stages and included those with complex presentations, in order to
ensure that the findings were relevant to the whole spectrum of individuals with ASD. In many previous investigations, samples are limited to children with similar profiles in order to limit the number of extraneous variables (Tager-Flusberg & Kasari, 2013). The findings of the current study are consistent with those of more recent investigations of individual differences in this population, which indicate that, for preschool age children, changes in development are observed in both younger and older children and across developmental level, thus suggesting that behaviors such as cognitive level do not explain all of the variability in outcomes for all individuals (Bal et al., 2016; Vivanti et al., 2013).

With regards to the three hypothesized AAC predictors, there was a relationship between visual attention to AAC and change in expressive language, and between object play and change in expressive language in zero-order correlations. However, only object play was found to have a significant independent contribution in hierarchical multiple regression. These results were further supported by the findings of between group differences in visual attention and object play for participants who remained minimally verbal at T2, and those who developed phrase speech. These findings are consistent with previous research documenting a relationship between visual attention and behavioral performance cross-sectionally (Trembath et al., 2015), and separate research documenting a relationship between object play/exploration and language (McDuffie et al., 2012; Yoder & Stone, 2006) among children with ASD.

Another key finding from this research was the independent contribution of object play on change in expressive language. This finding is consistent with a study by Yoder and Stone (2006) who found that children who showed high object exploration prior to an AAC intervention (PECS; Frost & Bondy, 2002) showed greater growth rate in the number of different non-imitative words used after completion of the intervention. The findings presented by Yoder and Stone (2006) are particularly relevant to the findings of the current
study given that the intervention in the Yoder and Stone (2006) study was also an AAC intervention. In comparison, a recent study exploring value added predictors of receptive and expressive language development in 87 preschoolers with ASD, found that object play did not add value to predicting language growth (Yoder, Watson, & Lambert, 2014). Yoder et al. (2014) suggested that it was possible that object play did not add value because it might have been highly correlated with other measures. Given the authors did not provide detail regarding the extent to which object manipulation was central to the intervention provided, as it is for AAC-based interventions, it is not possible to determine whether the same result would be found if the study included an AAC-based intervention. In addition, the participants in the Yoder et al. (2015) study were all described as “non-verbal/minimally verbal” (p. 9) (< 20 reported spoken words) at entry and 40% remained non-verbal at exit, thus it is possible that no relationship was found because a significant minority of children showed minimal change in expressive language overall.

With regards to the third hypothesized AAC predictor, symbolic word learning, there were no statistically significant associations between word learning abilities and expressive language change; however, there was a significant association between associative learning and change in verbal group status. These findings indicate that for the participants in this study, the ability to learn picture-word pairings in the first instance (associative learning) had an impact on change in verbal status, but that the ability to derive symbolic meaning from the picture (referential learning) did not. It is possible that the ability to form associations between symbols and referents is an important predictor for children who show more dramatic changes in their expressive language abilities, such as, for participants in this study who initially present as minimally verbal and then developed phrase speech. Taken together, the results of the current study suggest that visual attention and object play might play a role in predicting who will develop spoken language within AAC-based interventions. The
findings also highlight a trend towards picture-word learning as a contributing factor, but more research is needed.

Clinical Implications

The findings of the current study add to the research documenting that object play, as a measure of propensity to use objects in a functional goal directed way, could be included as a simple task to inform how well children might respond to a particular intervention. While comparative studies are needed, the findings highlight that children’s use of objects might be particularly relevant for interventions in which AAC is a component, which might be due to the way objects are employed as part of AAC intervention (e.g., through the use of pictures/objects). The findings of the current study also provide preliminary support that the three AAC predictors taken together could add value for selecting intervention for children with ASD, and could be incorporated in future research investigating response to intervention. The finding of a relationship between visual attention to AAC at T1 and change in expressive language for the participants in this study reinforces the importance of maintaining a child’s visual attention while giving instructions. However, while eye tracking provided an objective measure of looking to AAC, a limitation of eye tracking is that it does not provide insight into exactly how much or what children are processing, nor does it inform whether there is a crucial amount of looking time needed to contribute to outcomes. It is possible that looking might simply represent greater comprehension of teacher’s actions, and thus comprehension might be driving expressive language growth. Future studies should seek to include measures of children’s engagement and comprehension during eye tracking when investigating visual attention and outcomes.

Limitations and Future Research Directions

The findings of this study need to be considered with respect to a number of limitations. First, as there was no control group, it was not possible to determine whether the
intervention was responsible for the change in expressive language for participants receiving this particular AAC-infused intervention program. It is possible that there were other variables that might have contributed to expressive language change but were not able to be assessed, given the lack of control group. Finally, in the absence of a control group of participants receiving a different intervention, it is not possible to know whether responses to the three hypothesized predictors of change within AAC interventions might also be related to change within other comprehensive intervention programs for children with ASD. Nevertheless, the current study adopted a novel approach to investigating individual differences in response to an AAC-infused intervention program that has not yet been applied to the field of AAC research. Furthermore, control groups are not always feasible in community-based research due to issues with participant recruitment. One possible approach to investigating response to intervention when a control group is not possible is through the use single case experimental designs to identify responders and non-responders of intervention on an individual basis (Yoder & Compton, 2004).

While large in comparison to other studies investigating individual differences in outcomes of early intervention for this population, the limited sample size impacted on the statistical analyses employed, and possibly on the ability to detect small effect sizes should they exist. Additionally, as the study took place in a community-based setting, a number of difficulties commonly associated with conducting community-based research were encountered, including, logistical constraints around scheduling assessments (Vivanti et al., 2017), and following up parent questionnaires (Becerra et al., 2017). Consequently, missing data impacted on the ability to conduct binomial logistic regression, which would have been better suited to address the exploratory research question of predicting change in verbal group status for participants who were minimally verbal at T1. Nevertheless, the statistical methods employed in this study were appropriate given the data set, and the results should be used to
inform future studies with larger sample sizes. In addition, by focusing specifically on spoken language captured using standardised assessment, it was not possible to document communication development in other important areas, such as, use of AAC as an expressive system. Spoken language was selected as a common measure of expressive communication given that not all participants involved in the study used AAC to support expression. The measures used to investigate change were consistent with previous studies addressing similar questions regarding individual differences and contribute to the existing research regarding factors that may be associated with outcomes for children with ASD. Future research is needed that considers AAC use a part of communication development. Finally, it was not possible to determine the exact amount of AAC exposure each participant received, including, in class, at home, with or without individualized systems, or from other intervention programs or therapies being delivered. This is a reality of other longitudinal cohort studies examining community-based interventions for children with ASD (Brady et al., 2013). Exploratory studies can be used to identify clinically relevant and feasible factors that emerge, despite the likelihood that multiple other variables might be contributing. The next step is replication in community samples with tighter control, as well as experimental studies, to more closely examine these variables in subgroups of children.

**Conclusion**

The current study investigated predictors of expressive language change for children with ASD receiving a community-based early intervention program in which AAC was a component of the intervention. Participants’ responses to two of the three hypothesized predictors of AAC based interventions, visual attention and object play, were related to expressive language change, and there was evidence to suggest that the ability to learn picture-word pairings might be relevant, but further research is needed. Using hierarchical multiple regression, commonly reported predictors of outcome (nonverbal development,
chronological age, ASD symptomatology) were not found to predict expressive language change, but the addition of the three hypothesized AAC predictors taken together led to a statistically significant difference in predicting variance in expressive language change. The findings of this preliminary investigation point to the need for future research investigating individual differences in response to AAC-based interventions for children with ASD through the use of theoretically motivated, and age and developmentally appropriate measures. Such research would inform clinical decision making regarding which intervention approach will provide an individual child with the best opportunity to reach his or her potential.
References


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Chapter 7: General Discussion

Children with autism spectrum disorder (ASD) present with substantial variability in their language development (Paul et al., 2008; Tager-Flusberg et al., 2005), and a reported 30% of children do not develop spontaneous spoken language by school age even with access to early intervention (Anderson et al., 2007; Norrelgen et al. 2014). This is particularly concerning given that the development of spoken language by age five is a documented prognostic indicator of later adaptive behaviour outcomes (Howlin et al., 2004). Thus, there is a need for research investigating the mechanisms underpinning language differences so that interventions can be adapted to suit individual needs (Stahmer et al., 2011; Stahmer et al., 2016). To date, researchers have reported that children who commence early intervention at a younger age, have higher cognitive functioning, and fewer ASD symptoms, have better outcomes than children who are older and have more complex developmental profiles (Perry et al., 2011). There is also research indicating that targeting precursors to language (e.g., joint attention, imitation, object play) as part of early intervention enhances overall communication development (Kasari et al., 2000; McDuffie et al., 2012; Wong, 2013). While these findings document the potential of these variables for predicting outcomes (Perry et al., 2011; Poon et al., 2012), these factors have not been found to account for all of the variability for all children, nor is it clear whether these variables are equally important for predicting outcomes for children receiving different intervention approaches. Therefore, there is a need for a more fine-grained approach to investigating individual differences in language development in children with ASD, in order to identify ways to meet the needs of individual children and optimise communication outcomes. This project aimed to address this need by (a) refining methods for documenting the emergence of expressive language in children with ASD receiving early intervention, and (b) investigating mechanisms underpinning both concurrent and longitudinal expressive language abilities. The findings from this research have potential
to inform future investigations aimed at understanding variability in expressive language development in children with ASD, as well as implications for understanding mechanisms contributing to language development more broadly.

This thesis has made a significant contribution to knowledge in several ways. First, this thesis is among the first outside of the Norrelgen et al. (2014) study to demonstrate the potential for using item level data from standardised assessments to document the proportion of minimally verbal children with ASD. This project extended on previous research by reporting outcomes from both parent reported and clinician administered child assessments. The findings indicated that a significant minority of children do not develop spoken language despite access to early intervention, but that many children do demonstrate significant changes in their expressive language trajectories, and thus there is a need for research investigating what contributes to these differences. Second, this research has challenged existing hypotheses surrounding language differences in this population, namely, how children with ASD interpret symbolic connections between symbols and referents (Allen et al., 2015; Hartley & Allen, 2015; Preissler, 2008), and how this might be related to expressive language abilities. Finally, by investigating social-cognitive processes that might be relevant to children’s development within interventions incorporating augmentative and alternative communication (AAC), this thesis provides preliminary data on which children might demonstrate the largest gains in spoken language within AAC-infused comprehensive interventions.

The findings from Study 1 extended on research documenting communication outcomes for children with ASD (Anderson et al., 2007; Norrelgen et al., 2014) by reporting on the emergence of language using item level data from multi-informant measures commonly employed in research and practice (Tager-Flusberg et al., 2009). The results of Study 1 indicated that while a substantial minority (26.3%) of children were minimally verbal
following approximately 12 months of intervention, there was a significant increase in
expressive language abilities for just under half of the children enrolled in the program.
While there is research indicating that language level at age two is a predictor of later
language abilities (Mayo et al., 2013), the findings from the current research of trajectories
indicate that perhaps language development is more complex in this population, and thus
there is a need for investigation of variables underpinning these differences. The findings
from Study 1 indicate that spoken language level at entry to intervention should not be used
in isolation to draw conclusions regarding later language abilities. Clinicians, educators and
parents should approach intervention on the basis that children could develop spoken
language, and thus continue to target the development of verbal abilities alongside
complementary communication goals (Light & McNaughton, 2015). Nevertheless, there is a
need to understand mechanisms underpinning differences in expressive language abilities and
change within intervention, which was addressed in Studies 2 and 3 of this thesis.

Study 2 extended on previous research looking at symbolic (picture-referent) word
learning abilities of children with ASD (Allen et al., 2015; Hartley & Allen, 2015) in order to
investigate whether differences in individual approaches to word learning were associated
with differences in expressive language abilities. The findings from Study 2 were in contrast
to previous research suggesting that children with ASD learn connections between symbols
and referents via an associative mechanism (Allen et al., 2015; Hartley & Allen, 2015;
Preissler, 2008), by providing evidence that at least some children do understand the
symbolic nature of pictures. In addition, Study 2 revealed a possible effect of symbolic word
learning abilities for explaining varied expressive language level in preschool children with
ASD, such that children who demonstrated referential understanding of the novel picture also
displayed higher concurrent expressive language abilities. The findings indicate that
mechanisms underpinning language learning in children with ASD might not be that different
to theories explaining word learning in children who are developing typically (Bates & Hammel, 2014), and other clinical populations (McDuffie et al., 2013). This raises the question as to whether language difficulties in children with ASD are unique to the disorder or indicative of a language disorder unrelated to ASD, for example, developmental language disorder (Bishop, 2003; Woynaroski et al., 2015). To this end, the findings from Study 2 advance science by helping to identify where similarities may exist between groups with regards to approaches to word learning, and thus suggesting that it is possible that strategies used to support word learning in other populations might also be relevant to supporting word learning in children with ASD.

Finally, Study 3 adopted a novel approach to investigating individual differences in response to an AAC-infused comprehensive intervention program that has not yet been applied to the field of AAC research (Vivanti et al., 2013). The findings from Study 3 challenged intervention research documenting chronological age, cognitive functioning and ASD symptomatology as putative predictors of outcome (Eapen et al., 2016; Perry et al., 2011), by suggesting that these variables are less useful for predicting change in children who show more gradual progress. Thus, the findings from Study 3 reinforced the need to investigate more sensitive predictors of outcomes (as per Vivanti, Prior, et al., 2014). By focusing on theoretically and empirically driven processes that might be relevant to change within AAC-infused interventions, the findings from Study 3 provided preliminary data on the characteristics of children who might experience the largest expressive language gains within interventions in which AAC is a key component.

Taken together, the findings from this research further demonstrate the need for an individual differences approach to investigating outcomes for children with ASD, and propose novel methods to understanding variability. While there is certainly a need to continue examination of outcomes, including the comparative effectiveness of interventions,
there is a critical need to understand how children’s individual responses to components of existing intervention programs might impact on variability in outcomes (Pickles et al., 2016; Stahmer et al., 2011; Stahmer et al., 2016). Notably, the need to understand variability in how children respond to intervention has been identified as a research goal for over a decade (e.g., Kasari, 2002), yet few researchers have employed experimental designs suitable to investigating individual differences (Vivanti et al., 2013; Yoder & Stone, 2006a, 2006b). As a result, there is a tendency to report outcomes in a manner that suggests all children with ASD approach learning in a uniform way, for example, that all children with ASD demonstrate the same approach to word learning (Allen et al., 2015; Hartley & Allen, 2015). Policy guiding decision making for service provision for children with ASD reflects this uniform approach, with decisions for what supports are provided, guided by Good Practice Guidelines (Roberts et al., 2016) that have been developed primarily based on intervention studies reporting on group outcomes and on common factors across approaches, despite recognition of the need for an individualised approach to management (Stahmer et al., 2011). Therefore, not only is there a need for researchers to adopt experimental designs suitable for investigating within group differences, there is also a need to communicate findings to policy makers guiding service provision for individuals with ASD. To this end, complementary guidelines based on an evidence-based practice framework of understanding strengths and needs of individuals combined with best research evidence and clinical expertise could be developed to inform intervention selection and evaluation for individual children.

Finally, this project reinforced the need to look beyond broad predictors of outcome to sensitive mechanisms underpinning individual differences in change within intervention (as per Vivanti, Prior, et al., 2014). By looking at the interactions between children’s responses to AAC, this research extended science by providing preliminary data on the characteristics of children who might experience the largest expressive language gains within AAC-infused
intervention programs. The findings from Study 3 extended previous research (McDuffie et al., 2012; Poon et al., 2012) documenting a relationship between children’s functional, goal directed use of objects (measured through object play tasks) and expressive language abilities by investigating this relationship in an intervention in which children’s functional use of objects was central to participation in (and potentially response to) the program itself. While the relationship between object play and language has been established (McDuffie et al., 2012; Poon et al., 2012), the mechanism underpinning this relationship is not well understood (Orr & Geva, 2015; Wetherby et al., 2007). One possible explanation is that object play demonstrates propensity to engage with intervention materials in an organised functional manner, which presumably supports children to get the most out of learning opportunities (Lyytinen et al., 1999; Lyytinen et al., 1997). Additionally, the findings of this research extended on previous studies documenting a relationship between visual attention and behavioural performance (Trembath et al., 2015) thus highlighting the importance of visual attention for modelling based interventions (Drager, 2009). Furthermore, this research provided evidence that symbolic word learning abilities might be related to reported differences in expressive language abilities for children with ASD, and might be relevant to predicting expressive language change within AAC-infused interventions. The current research investigated children’s responses to AAC (visual attention, object play, symbolic word learning) as potential predictors of outcome, but it is also possible that children’s responses to these variables might moderate intervention outcomes (Yoder & Stone, 2006a), and thus may be clinically useful in time for helping clinicians select AAC interventions (e.g., unaided versus aided) based on children’s initial propensity to interact with various intervention components (McDuffie et al., 2012).
Clinical Implications

The findings from this research have potential to inform the way researchers and clinicians approach individual differences in children with ASD. This is particularly important for the reported 50% of children who show minimal gains in response to early intervention (Camarata, 2014), and the reported 30% of children who are minimally verbal at school age despite accessing intervention (Anderson et al., 2007; Norrelgen et al., 2014). Given the dearth of research aimed at addressing “what works for whom and why?” (Trembath & Vivanti, 2014, p. 58), it is likely that these children are enrolled in intervention programs that are not individually tailored to their needs, including accessing multiple interventions, placing significant cost and time demands on children and families (Horlin et al., 2014), and with cascading effects on demand for services (Knapp et al., 2009).

This research documented the potential for using standardised assessments for characterising the emergence of expressive language in children with ASD, including, providing evidence that these assessments can be used with children who show a broad range of language abilities. By taking a novel approach to interpreting data from commonly used standardised assessments, the findings from this research reveal exciting opportunities for data sharing across studies (both retrospectively and prospectively), as well as the opportunity for data sharing between research and practice settings. For this project, individual items were reported that pertained to spoken language abilities; however, there is potential for researchers and clinicians to select individual items relating to intervention goals or study aims in order to monitor change and characterise communication or other abilities. To illustrate, earlier items on the standardised assessments employed in this research and used clinically assess early language behaviours such as gesture use (D'Souza et al., 2017), and thus might be useful for monitoring change in these behaviours and/or provide the opportunity to investigate differential response to intervention based on children’s responses.
to these items without the need for additional testing (Crais et al., 2009). Collaborative efforts between researchers and clinicians will allow for more comprehensive descriptions of developmental outcomes to be collected for children with ASD across settings. To this end, information gathered can be used to guide future experimental studies aimed at investigating ways to enhance outcomes, and ultimately guide future service provision (DiStefano & Kasari, 2016;).

Second, this project extended on previous research investigating variability in expressive language development in children with ASD (D'Souza et al., 2017; Kover et al., 2016; Venker et al., 2016). Study 2 investigated symbolic word learning abilities in preschool children where language development is known to be highly variable in an attempt to identify mechanisms underpinning varied language abilities. The findings from Study 2 suggested that symbolic word learning abilities might help differentiate between children with a few spoken words and those with spontaneous use of multiword utterances. In addition, the findings provide evidence to suggest that targeting symbolic word learning directly might help facilitate language development (McDuffie et al., 2006). Finally, the findings from Study 2 have important implications for understanding language development in children with ASD, which also could be used to understand language development in other important populations.

While preliminary in its investigation, the findings of this research provide evidence to suggest that children’s responsiveness to AAC measured at entry, might be relevant to predicting change in expressive language within comprehensive interventions incorporating AAC. While the use of AAC with children with complex communication needs has long been recognised (Lloyd et al., 1997), evidence regarding the potential of AAC to support early language abilities in children with ASD is only just emerging (Kasari et al., 2014). Through identification of theory driven predictors of change within AAC-infused intervention, this
research is among the first to investigate the possible relationship between AAC and emergence of spoken language (Brady et al., 2013). To illustrate, while object play is reported to be associated with intervention outcomes more broadly (Orr & Geva, 2015), the findings of this research indicate that propensity to engage with objects functionally might be particularly relevant to interventions incorporating AAC, and thus might predict which children will experience the largest gains in expressive language (Flippin et al., 2010; Yoder & Stone, 2006a). From a clinical perspective, this finding both supports the focus on interventions aimed at targeting object play for optimising broader developmental outcomes, and also suggests that object play might be a relevant target for optimising spoken language abilities within AAC interventions (Flippin et al., 2010; Vivanti et al., 2013). The findings of this research highlight the potential of tailoring interventions according to theoretically motivated child characteristics. Application to children with ASD and other populations should also take into account broader child characteristics such as physical skills, which may impact on performance of tasks.

**Limitations of the Study**

This research represents an initial investigation using novel approaches and therefore the findings need to be considered with respect to a number of limitations. First, in the absence of a control group the findings of this research should be interpreted as pertaining directly to the samples of children who participated in the individual studies and with the view that replication and comparison investigations are needed before findings can be generalised to children with ASD more broadly. The inclusion of a control group of developmentally matched peers in future research would provide data to determine whether the intervention was responsible for observed changes in expressive language abilities for children receiving this particular AAC-infused intervention, and/or whether other variables might have contributed to children’s expressive language change. Nevertheless, the current
study adopted a novel approach suited to investigating individual differences in response to an AAC-infused intervention program that has not yet been applied to the field of AAC research. Furthermore, control groups are not always feasible in community-based research due to issues with participant recruitment. One approach to investigating response to intervention in a heterogeneous population such as ASD is through the use single case experimental designs to identify responders and non-responders of intervention on an individual basis (Yoder & Compton, 2004). Additionally, while object play is an established predictor of outcome (Poon et al., 2012; Wetherby et al., 2007), without comparison to other programs, it is not possible to know whether children’s responses to the visual attention and symbolic word learning measures might also be relevant to predicting change within other approaches.

It is noted that Study 3 was designed to investigate change in expressive language within an AAC-infused intervention program, rather than response to intervention specifically, and measured children’s expressive language at entry and exit to intervention. It is possible that a more sensitive measure of growth would have been to measure children’s expressive language development at multiple times throughout the year and employ growth curve techniques (as per Yoder et al., 2015). It is recommended that future studies employ longitudinal techniques measuring change over time so that trajectory of emergence of language can be investigated (Vivanti, Prior, et al., 2014). Nevertheless, the pre-post design suited the exploratory nature of this investigation and provided an ecologically valid model that could be adopted by clinicians for assessing change within intervention using tools already being used as part of annual assessments to track outcomes. Furthermore, standardised assessments have restrictions regarding time between readministering due to the possibility of practice effects (e.g., children might learn or recognise test items) which may impact on the validity of the assessment. One possible way to measure change more
frequently without placing additional demands on clinicians and children could be to use individualised goals and data collected as part of children’s enrolment within intervention and already being used to document progress in order to inform service provision (Bacon et al., 2014).

This research aimed to extend science investigating predictors of outcome by identifying sensitive theoretically driven predictors of expressive language change for children with ASD receiving a particular comprehensive intervention program. A challenge to achieving this goal was developing measures that were age and developmentally appropriate for the children who presented with broad developmental profiles, while maintaining experimental control required to confidently capturing behaviours of interest (Kasari et al., 2013). In the first instance, while eye tracking provided an objective measure of looking time to AAC during teacher instruction (stimulated activity), it was not investigated whether visual attention simply reflected interest in, or comprehension of what the teacher (actor) was saying (e.g., children looking at the pictures because the actor named them) as opposed to visual attention indicating a propensity to seek information (e.g., looking to the pictures to try to make sense of what the actor was saying). Thus, it is possible that visual attention may have reflected comprehension, which in turn was associated with expressive language growth. Therefore, an inherent limitation of eye tracking is that it does not inform specifically what children are processing. In addition, the task used to measure symbolic word learning was restricted to the teaching of one novel word, and therefore, it was not possible to know with certainty whether children recognised the symbolic nature of the novel picture, or whether they selected the object due to chance of bias for objects. As indicated in Chapter 5, future studies should include additional trials in order test for chance responding. Thus, research into sensitive predictors therefore not only needs to involve
collaborative efforts across research teams in order to refine measures but also to test the feasibility of these measures for use in practice (Brady et al., 2014; Muller & Brady, 2016).

This research focused on spoken language as the primary measure of expressive language abilities; however, it is acknowledged that a more meaningful outcome for children accessing AAC interventions might have been to document communication change inclusive of AAC as an output mode. Future studies should include assessments of children’s language and communication more broadly, including nonverbal means as well as idiosyncratic communicative behaviours, in order to provide a more comprehensive profile of a child’s communication abilities (Rowland & Fried-Oken, 2010; Sigafoos et al., 1998). Augmentative and alternative communication was incorporated into this particular intervention program to support all children in their early language development irrespective of verbal language abilities. This is representative of how AAC is typically infused within comprehensive intervention programs for children with ASD (Mesibov et al., 2004; Prizant et al., 2003). The participants in this research showed a range of expressive language abilities, and not all children used AAC to support expressive communication. Spoken language was therefore selected as socially valid and objective measure of change for all children. Given the nature of how AAC is used within comprehensive intervention programs and the focus on supporting comprehension of language as well as expression, possible impacts of AAC on comprehension also warrant further investigation. This will require development of novel ways for measuring comprehension of language in this population (Brady et al., 2014; Muller & Brady, 2016).

Finally, a key limitation of this research given the focus was on investigating change within an AAC-infused intervention program was that it was not possible to determine the amount of actual exposure to AAC, if any, in other contexts. In addition, it was not possible to measure fidelity of treatment delivery given the multiple environments in which children...
could potentially have been exposed to AAC. While adherence to intervention delivered at the early intervention centre is monitored as part of organisational requirements, this was not included as part of the current investigation. These limitations are common to community-based intervention research (Brady et al., 2013; Vivanti et al., 2017), but it is important that future research attempt to control for these variables given their potential to impact on developmental outcomes (Yoder et al., 2015). There are important benefits of conducting community-based research, including, bridging the gap between research and practice by providing opportunities for open dialogue between researchers and clinicians regarding intervention outcomes, and opportunity to conduct research that has the potential to have direct meaningful impact for children with ASD and their families (Vivanti et al., 2017).

Despite a number of limitations associated with the preliminary nature of this research, the three studies presented in this thesis offered novel and ecologically valid approaches to investigating variability in expressive language development in children with ASD. Furthermore, this research provided novel insight into mechanisms underpinning individual differences in expressive language development for children with ASD receiving AAC-infused interventions. The findings from this research may be used to inform future investigations, including replication in community samples with tighter control, as well as experimental studies, to more closely examine these variables and relationship with outcomes, including comparison between intervention approaches for informing future service provision (Stahmer et al., 2011).

**Future Research Directions**

The findings of this research provide a number of important avenues for future investigation. First, the individual studies lend themselves to opportunities for further exploration. In Study 1, children were characterised as minimally verbal because they were at an age at which children who are typically developing will ordinarily have reached important
language milestones, such as, using single words to two-word combinations (Ukoumunne et al., 2012). While the terminology used in Study 1 suited the aim to identify the number of children who had minimal spoken language despite access to intervention, by characterising all children as minimally verbal it was not possible to distinguish between children who might have been in the preverbal stages of language development, albeit still delayed compared to typical language development (DiStefano & Kasari, 2016). This is a potentially important distinction to make as it might help to determine which children will remain minimally verbal and which children are delayed in their language development only, but show other signs of progression towards language acquisition (Distefino & Kasari, 2016). While this hypothesis was not investigated directly, the findings suggest that it might be prudent to make this distinction given that for children who had some spoken language, albeit limited, (i.e., minimally verbal), the majority went on to develop phrase speech, while the majority of children who had no spoken language at all at entry (i.e., non-verbal), remained non-verbal at school age. Thus retrospective investigation of the sample included in Study 1 in order to identify important precursors to language development that might distinguish children and their propensity to develop spoken language is needed. This would be possible through item level analysis of assessments already completed, an approach documented in this program of studies.

This research also included exploratory investigation of how children interacted with a picture-based AAC system upon first exposure, and whether interaction was related to outcomes more broadly. Motivation for this task stemmed from reports that the presence of restricted and repetitive behaviours characteristic of ASD might somehow impact on a child’s ability to use, and benefit from aided AAC systems (Jurgens, 2017), but a marked lack of evidence supporting or refuting this claim (Cook et al., 2017). Preliminary findings suggested no link between children’s interaction with the AAC system and response; however, it is
possible that quantifying behaviour using broad descriptions of visual attention and physical engagement did not capture behaviours relevant to predicting outcomes. Beyond communicative use of AAC and preference assessments for different systems, there is little evidence for how children should engage with aided AAC systems, and whether initial interactions are related to outcomes. It is likely that children’s exploration of AAC is an important component of learning to use the system effectively, given that object exploration is associated with developmental outcomes more broadly (Oakes et al., 1991). Future research might attempt to investigate the relationship between children’s exploration of AAC, and use of AAC for communicative purposes in an attempt to mirror research looking at object play and language development (Orr & Geva, 2015).

The fine-grained approach taken to investigating individual differences in this project has potential to advance science and practice in a number of ways. First, there is potential for application of the methodological approach used to investigate variability and change within intervention to be applied to children with ASD enrolled in other intervention programs. If clinicians and researchers were to adopt this approach to measuring change within different programs then it would help to understand differential response to intervention which would help to determine which intervention approaches individual children would benefit from most (Vivanti et al., 2013; Yoder & Compton, 2004). Clinicians working in the community intuitively tailor interventions to suit individual needs as part of evidence-based practice (Light & McNaughton, 2015), but there is a need for systematic investigation of this process in order to determine what program elements children are responding to, and how this information could be applied to supporting other individuals (Stahmer et al., 2011). This research focused on investigating abilities children bring to learning, such as propensity to visually attend, engage with materials in a functional manner, and level of symbolic understanding, although there are many other important factors that might be relevant to
predicting outcomes. While attention to more sensitive social-cognitive predictors of change and adoption of study designs that allow for investigation of predicting differential response to intervention is needed, there is a parallel need for research focused on refining how best to measure these behaviours in children with ASD who present with complex developmental profiles (Brady et al., 2014; Kasari et al., 2013; Muller & Brady, 2016). Future research which accommodates these challenges in assessing specific learning behaviours in young children, particularly for children with complex developmental profiles, will be critical to informing future studies with this population (Kasari et al., 2013; Tager-Flusberg et al., 2017).

Finally, the findings from this research have potential to inform how clinicians and researchers approach individual differences for children more broadly (Stahmer et al., 2011). Individual differences are not unique to any one condition (Bates et al., 2017), and there is recognition that ASD falls within a spectrum of neurodevelopmental disorders rather than being a distinct condition (Prior, 2003). The findings from this thesis should be used to inform future research, both in experimental design and theoretical approach, investigating variability in outcomes for all children who present with complex developmental profiles and variability in outcomes. If all researchers adopted this method to understanding individual differences, and approached their research as collaborative efforts between researchers and clinicians then there is the opportunity to extend science and practice in order to support individuals who stand to benefit most from this research. There is also the opportunity to inform policy guiding decision making regarding tailoring interventions at different stages of development to suit individual needs. Ultimately, the goal would be to develop a toolkit of resources that could be referred to in order to identify strategies that might be useful for supporting individuals at different developmental stages and to suit child and family preferences. Before such a resource can be developed, there is a need for research
investigating differential response to intervention through sensitive predictors of outcome that measure specific social-cognitive variables hypothesised to represent distinct learning processes (Stahmer et al., 2011; Vivanti, Prior, et al., 2014). Finally, such a resource would need to embrace the unavoidable unpredictability of human behaviour which makes individuals unique (Nelson, 1981), but ultimately provide a more systematic approach to adapting intervention to suit individual needs and give children the best opportunity to reach their full potential (Stahmer et al., 2016).

**Summary**

Children with ASD present with complex developmental profiles (Sherer & Schreibman, 2005), with many children recommended early intervention to support adaptive behaviour and communication abilities (Dawson, 2013). Despite overall positive findings for the majority of children with ASD, there are considerable individual differences in outcomes following intervention with some children displaying minimal to no progress (Camarata, 2014; Schreibman et al., 2009). In particular, there are significant differences in expressive language development in children with ASD (Luyster et al., 2008; Tager-Flusberg et al., 2005); however, little understanding regarding the mechanisms underpinning these differences for all children. There is emerging research documenting the benefits of AAC for supporting language development in children with ASD, and proponents suggest that it might facilitate spoken language by fostering early communication abilities (Reichle et al., 2016). To date, few studies have investigated the relationship between children’s development within AAC-infused interventions and expressive language outcomes (Brady et al., 2013). The research presented in this thesis is among the first (Brady et al., 2013) to investigate variability in expressive language development in children with ASD receiving AAC-infused intervention using theory driven quantitative methodology. The findings of this research made a significant contribution to understanding how expressive language emerges in this
population. This research has employed novel methods for characterising expressive language abilities in children with ASD, including ecologically valid measures of behaviour in order to promote collaboration across research and practice settings (Bacon et al., 2014). This research challenged previous approaches to understanding outcomes for children with ASD, by highlighting the need to report on individual differences in order to understand the substantial variability in outcomes in this population (Stahmer et al., 2016).

By focusing on three processes that might be relevant to children’s change within AAC-infused interventions, the findings of this project provide support that the three AAC predictors taken together could add value for selecting intervention for children with ASD. A strength of this research was the methodological approach taken to investigating variability in the emergence of expressive language (as per Vivanti, Prior, et al., 2014). By focusing on precursors to language development and response to program elements (i.e., AAC), the findings from this research provide preliminary data on the characteristics of children who might be particularly responsiveness to this specific intervention approach (Gulsrud et al., 2015; Pellecchia et al., 2015; Vivanti et al., 2013).

The overall objective of this research was to contribute to understanding of individual differences in language development in children with ASD in an attempt to optimise communication outcomes for all children. While heterogeneity has come to be synonymous with this population (Pickles et al., 2014), and poses particular challenges to meeting the needs of individual children (Trembath & Vivanti, 2014; Vivanti, Prior, et al., 2014), it has prompted the development of novel approaches for investigating specific processes related to development (Brady et al., 2014; Vivanti et al., 2013). In particular, the development of fine-grained approaches to determining ways to harness the individual strengths and challenges that children with ASD bring to learning, and that hold promise for predicting children’s change within intervention (Vivanti et al., 2013). The challenge remains for future
researchers to adopt methodologically sound approaches for investigating differential response to intervention (Yoder & Compton, 2004), and to develop novel measures for assessing children who present with complex developmental profiles and stand to benefit the most from research (Kasari et al., 2013; Tager-Flusberg & Kasari, 2013). Such research has the potential to transform intervention selection and evaluation to meet the needs and strengths of individuals with ASD in order to achieve optimal outcomes for each individual.
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Appendix A: Ethical Approval Griffith University Human Research Ethics Committee

GRIFFITH UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE

25-Feb-2016

Dear Dr. Trenkath,

I write further to the additional information provided in relation to the provisional approval granted to your application for ethical clearance for your project "Full Review: Communication Development in Children with Autism" (GU Ref No: ABS/02/15/HREC).

The additional information was considered by Office for Research.

This is to confirm that this response has addressed the comments and concerns of the HREC.

Consequently, you are authorised to immediately commence this research on this basis.

The standard conditions of approval attached to our previous correspondence about this protocol continue to apply.

Regards,

Rick Williams
Manager, Research Ethics
Office for Research
Bray Centre, N64 Room 0.16 Nathan Campus
Griffith University
ph: 07 3735 4375
fax: 07 373 57994
e-mail: rick.williams@griffith.edu.au
web:

Cc:

Researchers are reminded that the Griffith University Code for the Responsible Conduct of Research provides guidance to researchers in areas such as conflict of interest, authorship, storage of data, & the training of research students. You can find further information, resources and a link to the University's Code by visiting

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Appendix B: Ethical Approval AEIOU

Re: Communication Development in Children with Autism (AEIOU 2015.2)

6 February 2015

Dear Dr. Trembath and members of the research team,

This letter is to officially confirm that the AEIOU Research Advisory Group considered your proposal to conduct research with AEIOU families. The group provides its official approval for this activity valid from 06/02/2015 to 01/02/2018 (approval number 2015.2). Please note that approval from this group does not guarantee approval from centre managers, parents or children which must be sought as appropriate before commencement of research activities. Please note also that this approval is conditional to the project being carried out as described in the application and that AEIOU retains the right to withdraw from research at any time.

We wish you all the best with your research endeavours and look forward to a summary of your results upon completion of this project.

Yours faithfully,

[Signature]

Dr. Jessica Paynter, PhD, MAPS
AEIOU Research Advisory Group Secretariat
Appendix C: Participant Information Sheet & Consent Form (Parents) (text only)

Communication Development in Children with Autism

Dear Parents,

I am writing to invite you to have your child participate in a research study that my colleagues and I hope will shed new light on how to best support communication development in children with Autism Spectrum Disorder (ASD). We are seeking to involve all children who commence at AEIOU Queensland and the Victorian ASELCC in 2015, 2016, and 2017.

What are the aims of the study?

Our aim is to work with you, your child, and staff at the Centre to better understand, and ultimately predict, speech and language development in children with ASD. We want to learn more about how children learn to talk, why some children have more difficulty than others, and how best to support each child develop his or her communication skills.

Who is conducting this study?

This collaborative study is being conducted by researchers at Griffith University, Queensland (Dr David Trembath, Ms Veronica Rose [PhD candidate], Dr Marleen Westerveld, Dr Deb Keen), the AEIOU Foundation, Queensland (Dr Madonna Tucker), and La Trobe University, Melbourne (Dr Kristelle Hudry). The team are all experienced clinicians and researchers.

Who is funding this study?

Dr Trembath is leading the project as part of a National Health and Medical Research Council research fellowship. All members of the project team are conducting this study independently and we are free to report the results of this study accurately and without restriction.

What does the study involve?

There are seven parts to this study. Your child may be involved in the following (tick box):
In the first instance, we would like to complete the following assessments with your child at his or her early intervention Centre. Please note that many of these assessments will have already been completed as part of his or her program, in which case we would ask for a copy of the results to avoid repeating the tests.

- Autism Diagnostic Observation Scale (ADOS)
- Social Communication Questionnaire (SCQ)
- Mullen Scales of Early Learning (MSEL)
- Preschool Language Scales – 5th Edition
- Parent Stress Index – Short Form (PSI-SF)
- The Diagnostic Evaluation of Articulation and Phonology (DEAP)
- Macarthur Bates – Communicative Development Inventory (MB-CDI)
- Communication and Symbolic Behavior Scales – Developmental Profile (CSBS-DP)

All of these assessments are common, play-based or questionnaire-based assessments used in early childhood settings that allow us to gain a detailed understanding of your child’s social-communication development, play skills, behaviour, and independent living skills.

Secondly, we would like your child to complete a 30-minute semi-structured play session with a clinician at his or her Centre (i.e., member of the research team or staff member) to allow us to measure changes in his or her social-communication and play skills over time. This would involve sitting on the floor and playing with a box of toys that encourage play and communication (e.g., pop up toys, blocks, dolls). We would video-record the play sessions and they would be conducted under the supervision of Centre staff.
Our third goal is to gain a detailed understanding of how your child’s speech and language is developing. We would ask that your child wear a light vest containing a small, portable voice recorder for one day per month. The device is called LENA (Language ENvironment Analysis) and it is now commonly used in childhood language research. You can see full details about this approach on the web at www.lenafoundation.org. A teacher at your child’s Centre would slip the lightweight vest containing the recorder over your child’s regular clothes at the start of the day. You and teachers would be free to turn the LENA recorder on/off throughout the day if you felt it was necessary. Similarly, if you decided at the end of the day that you were unhappy with anything that was recorded we would simply delete all or part of the recording, depending on your preference.

Our fourth goal is to measure your child’s learning preferences and skills using computer-based games and play activities. Your child will be asked to sit at a table where he or she will watch a series of short videos. Each video will last around 30 seconds, and we will track his or her eye movements during the video using a small camera attached to the screen. We will also be video recording and observing your child’s behaviour during and after the videos have been played. In addition to computer-based games there will be objects for your child to play with at the table. In all, we expect the session to take 10 minutes, including breaks. We will record the session on video for our records and to assist with data collection and analysis.

Our fifth goal is to evaluate whether the way in which your child responds to the key components of a program impacts on his or her outcomes. Your child will be asked to sit at a table or on the floor and he or she will be given the opportunity to interact with an Augmentative and Alternative Communication (AAC) system (Picture based supports in book form). Your child’s initial response to the system (approximately 2
minutes) will be coded in terms of his or her initial behaviours (e.g., time spent looking/touching). Next, your child will go through a series of pictures with the clinician in order to understand his or her ability to form connections between words, pictures and objects. It is anticipated that the duration of this measure (including interaction with the system) will be approximately 15 minutes, completed only once.

To complement the above assessments, we would also like to gather information about your child’s communication and progress from staff working with your child at the Centre. To do this, we are asking clinicians involved in your child’s care at the Centre to complete a short questionnaire on communication and progress. Your child will not be directly involved in this process, but we will be asking clinicians to draw upon their knowledge of your child from (a) data they have already collect as part of your child’s participation in the program, and (b) their clinical impression of what this information means for your child’s clinical presentation.

**How will the information be used?**

We will analyse the data and publish the results in peer reviewed journals, as well as the Griffith University, La Trobe University, and AEIOU Foundation websites and newsletters. We will also present the findings at professional conferences (e.g., International Meeting for Autism Research). We will provide you and staff with a summary of the results each year. We are also happy to provide you and staff with a copy of the individual assessment results, so that you can better understand and support your child’s learning.

**How will my identity be protected?**

To protect the identity of participants, at no stage in reporting the results (e.g., journal articles, presentations) will we reveal any identifying information about you or your child. Only the researchers involved in this study will have access to the recordings and data. All information and data collected during this study will be stored in your child’s file at his or her
early intervention Centre. Electronic data will be stored on password protected computers and research servers belonging to the research team. We will destroy all records after 5 years using the University confidential waste service, in accordance with Griffith University and La Trobe University policy.

**Will I receive any benefits for participating in the study?**

This study is designed to help us better understand speech and language development in children with ASD. We cannot promise that there will be any direct benefits for you or your child from participating in this study. That said, we hope that the results of this study will lead to improvements in educational practice that will result in better outcomes for children ASD. Each year and at the end of the study, we will provide you with a summary of the key findings of the study. You will be welcome and encouraged to discuss the findings with the project team along the way, as the study progresses, and they will provide regular updates to parents and staff.

**Are there any risks associated with participating in the study?**

The assessment tasks that we will use in this study do not pose any risk to children, are all designed for children, and most are already used in your child’s early intervention Centre. The main consideration in this study is that we may be recording your child’s speech to track the emergence of language. This means that the device may also capture the speech of others (children and adults) who are nearby. We are interested to know how often children are talking at the Centre; whether they take ‘turns’ in simple conversations, and whether they are initiating interactions or mostly responding to others. We are not looking at what staff/others say or their topics of conversation. If you have any concerns about this, please do not hesitate to talk to the project team and we will do our best to accommodate any preferences you may have.

**What are your rights?**
Participation in this study is completely voluntary. You and your child are under no obligation to participate and you and your child have the right to withdraw at any time without question. It is particularly important that you are aware that your decision regarding participation in this study will not affect your relationship with staff at your child’s intervention Centre. You have the right to demand that data arising from your participation are not used in the research project provided that this right is exercised within four weeks of the completion of your participation in the project. You are asked to complete the “Withdrawal of Consent Form” or to notify the investigator by e-mail or telephone that you wish to withdraw your consent for your data to be used in this research project.

**How do you ask a question about this study or express interest in participating?**

For parents of children at AEIOU, please contact Dr David Trembath (Griffith University) via email at D.Trembath@griffith.edu.au or phone on 07 5678 0103. If your child attends the Victorian ASELCC, please speak with Dr Kristelle Hudry (K.Hudry@latrobe.edu.au). Of course, all parents are welcome to contact Dr Trembath as project leader at any time during the study.

**How do you make a complaint about this study?**

If you have any complaints or queries that the investigator has not been able to answer to your satisfaction, please contact the Secretary, Human Ethics Committee, Research Services, Griffith University, Gold Coast, QLD 4222 (ph: (0)7 373 58043).

Sincerely,

Dr David Trembath
Dr Kristelle Hudry
Ms Veronica Rose

Dr Marleen Westerveld
Dr Jessica Paynter
Dr Deb Keen
Communication Development in Children with Autism

Consent Form (Parents)

By signing below, I confirm that I have read and understood the Participant Information Sheet and in particular have noted that:

• My involvement in this research will include completing questionnaires aimed at evaluating my child’s development and I understand that my speech and that of other children might be recorded when my child is wearing the voice recorder one day per month (if applicable);

• I have had any questions answered to my satisfaction;

• I understand the risks involved;

• I understand that my participation, and that of my child, in this research is voluntary;

• I understand that if I have any additional questions I can contact Dr Trembath;

• I understand that I am free to withdraw myself or my child from the study at any time, without explanation or penalty;

• I understand that I can contact the Manager, Research Ethics, at Griffith University Human Research Ethics Committee on 3735 4375 (or research-ethics@griffith.edu.au) if I have any concerns about the ethical conduct of the project; and

• I agree to participate in the project.

• I agree for my child to participate in the project.

• I agree for audio recordings that inadvertently capture other children in the home, for whom I am a parent or legal guardian, to be included in the study.
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<th>Child’s Name</th>
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<td>Child’s Date of Birth</td>
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<td>Parent/Guardian Name</td>
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Appendix D: Visual Supports Used as Part of AEIOU Program

- Visual used for individual timetables (top left; top), and whole class schedules (left).
  - Visual used to support emergency evacuation procedure (far left), classroom rules (left), and handwashing routine (bottom).
Appendix E: Coding System Used for Object Play Task

**Object Play**

- Date:
- Examiner:
- Child:
- Duration:

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<th>Object</th>
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<th>Destructive</th>
<th>Pretend</th>
<th>Imaginative</th>
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</table>
## Appendix F: Coding System Used for AAC Interaction Task

<table>
<thead>
<tr>
<th>Time</th>
<th>Functional use/interaction</th>
<th>Other/idiosyncratic use/interaction</th>
<th>Destructive use/interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visual attention</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Functional</strong></td>
<td><strong>Communicative</strong></td>
<td><strong>Other</strong></td>
</tr>
<tr>
<td></td>
<td><em>teach</em></td>
<td><em>use</em></td>
<td>(describe)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Living the pictures up</strong></td>
<td><strong>Throwing</strong></td>
</tr>
<tr>
<td>0–5</td>
<td></td>
<td><strong>Sitting on</strong></td>
<td><strong>Pushing</strong></td>
</tr>
<tr>
<td>5–10</td>
<td></td>
<td></td>
<td><strong>Hitting</strong></td>
</tr>
<tr>
<td>11–15</td>
<td></td>
<td></td>
<td><strong>Scrunching pictures</strong></td>
</tr>
<tr>
<td>16–20</td>
<td></td>
<td></td>
<td><strong>Other</strong></td>
</tr>
<tr>
<td>21–25</td>
<td></td>
<td></td>
<td>(describe)</td>
</tr>
<tr>
<td>26–30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31–35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36–40</td>
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<td></td>
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<tr>
<td>41–45</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>46–50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51–55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56–60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Total)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* E.g., opening the front cover, turning the page, picking up the picture/place them on the front
* E.g., giving/showing — needs to be very clear — showing the picture to the examiner, placing picture with eye contact
**E.g., handling (not intentionally communicative, i.e., without eye contact or other signs of shared attention)
* Exclude intervals where visual attention/touch could not be determined (e.g., if child is out of camera view or has back turned) — draw a line through the whole interval (thus excluding other behaviors for this interval as well).
Appendix G: Accepted Abstract IMFAR 2017 (Poster)

AAC: Attention, Exploration and Response in Children With Autism

Background: Augmentative and Alternative Communication (AAC) is a commonly prescribed intervention for pre- and minimally-verbal children with Autism Spectrum Disorder (ASD). Despite widespread use and emerging evidence for its effectiveness, little research exists examining the mechanisms underpinning individual differences in response to AAC intervention. Variability in outcomes may be related to the complex social-communication needs of the children, given that AAC is generally prescribed to those with the most significant needs. However, differences in response to this intervention may also partly be related to visual attention to, and propensity to spontaneously engage with the AAC system.

Objectives: The aims of this study were to look at the relationship between (a) visual attention to, and (b) physical exploration of, a picture-based AAC system upon first exposure, and subsequent response to instructions provided by a teacher using a picture-based AAC system in a simulated activity.

Methods: Participants were children with a diagnosis of ASD between the ages of two and five years at intake to a community-based early intervention program. The extent to which children visually attended to and physically explored AAC was gathered from a free play activity, during which children were given the opportunity to interact with a picture-based AAC system for 1 minute. Five second interval coding was used to code for the presence/absence of these behaviours. Children’s responses to the picture-based AAC system were determined by their ability to carry out a set of 8 instructions delivered to them using AAC in a simulated teaching activity (e.g., “I want you to pick up the [object] and put it in the [container]”). Children received 1 point for collecting the correct item and attempting to insert it in the correct container, for a maximum of 8 points.
Results: The participants in this study visually attended to, and physically explored, the AAC system during an average of 79.39% (SD 27.33%, range 8% to 100%) and 79.38% (SD 23.78%, range 25% to 100%) of intervals, respectively. Average performance score (i.e., ability to follow instructions delivered using AAC) was 2 (25%; SD 3.01, range 0 to 8), with only two children (14.3%) achieving the highest possible score of 8. Using Spearman’s correlation coefficient, we found no relationship ($r = -.030, p = .918$) between visual attention to AAC during free play and subsequent performance, and no relationship ($r = .066, p = .822$) between physical exploration of AAC and subsequent performance.

Conclusions: Preliminary findings suggest no link between visual attention to, and exploration of, AAC, and subsequent task performance on first exposure to the system. It remains to be tested whether initial response to AAC is associated with response to interventions in which AAC is either a primary or central component in the longer term.