Comparing Tangible Symbols, Picture Exchange and a Direct Selection Response when Teaching Requesting to Two Children with Autism Spectrum Disorder

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ABSTRACT

Children diagnosed with Autism Spectrum Disorder (ASD) who fail to develop functional speech are candidates for augmentative and alternative communication (AAC) systems. One of the primary intentions of AAC is to provide an alternative method of communicating in the absence of speech (Mirenda, 2003). In order to select the most beneficial AAC system for a user, in regards to the ease of acquisition and successfully communicating with AAC systems, it is considered important to undertake research comparing various AAC systems and to assess users' preferences for using one system over another. Empirical evidence from previous studies comparing AAC indicates that users often learn to use AAC systems with varying degrees of proficiency and at various acquisition rates. Additionally, assessing users' preferences for different AAC systems has been shown to influence acquisition rates and long term maintenance of AAC systems and is suggested to be an important component when carrying out AAC intervention.

In the present study a tangible symbol (TS) communication system was compared, in terms of acquisition rates and preference, with Picture Exchange (PE) and an additional direct selection (DS) method of gaining access to desired stimuli in two young boys with ASD. Two male participants diagnosed with ASD were taught via systematic instructional procedures to request/gain access to the continuation of preferred cartoon movies by using TS, PE, and DS. Additionally, preference assessments were implemented during intervention and follow-up phases to determine whether the participants showed a preference for using one of these three requesting/access methods over the other two, and whether any such preferences remained stable throughout follow-up sessions. Results indicated that both participants successfully learned to request each of the six cartoon movies using each of the three methods. Specifically, acquisition rates for TS and PE were comparable across both participants, and overall both participants preferred to request using the TS. During intervention sessions, one participant preferred to use

DS, however this preference changed during follow-up where he chose to use TS more overall. These data suggest that TS is a viable AAC option for children with ASD who do not speak, and can be learned to a high proficiency after receiving systematic teaching procedures as used in the present study.

PUBLICATIONS AND PRESENTATIONS ARISING FROM THIS THESIS

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DECLARATION BY THE AUTHOR

The present thesis contains only the author's own work conducted in order to fulfil the requirements of this Masters degree under the supervision of Victoria University of Wellington. Work by other researchers has been referenced within the text and the contributions made by other researchers in co-authored work has been stated.

Ethical approval for this study was part of a larger research project: *Enhancing communication intervention for children with autism.* The corresponding ethical amendment letter for this is located in Appendix A. Study input and feedback on data collection and procedure implementation was received from the author's supervisor, Professor Jeff Sigafoos, and additional researchers also supervised by Jeff Sigafoos. The present study was, however, designed and implemented by the author with additional support from other researchers and colleagues. Professor Sigafoos provided on-going advice and suggestions regarding data collection, interpretation of the results, and edited the chapters for this written thesis.

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CHAPTER 1

INTRODUCTION

The Autism Spectrum Disorders (ASDs), which includes Autistic Disorder, Asperger's Disorder, and Pervasive Developmental Disorders- Not Otherwise Specified (PDD-NOS), are considered to be neurodevelopmental disorders that most likely have a biological, genetic basis, although the specific cause of ASDs remain unknown (American Psychiatric Association, 2000; Matson & Kozlowski, 2011). The prevalence of ASD is estimated at 1/88 to 1/110 live births per annum (American Psychiatric Association, 2011; Centre for Disease Control and Prevention, 2012).

ASD is characterised by a triad of impairments in (a) social interaction, (b) communication, and (c) the presence of restricted and repetitive behaviours (American Psychiatric Association, 2000; Matson & Kozlowski, 2011; Matson, Kozlowski, & Matson, 2012). Significant impairment is seen in reciprocal social interaction and the atypical presentation of various non-verbal behaviours. Behaviours such as; eye contact, gestures, facial expression, social interaction regulation, joint attention, developing age appropriate peer relationships, displaying emotional reciprocity, and awareness of others actions and feelings all develop atypically in the majority of individuals with ASD (Cohen & Donnellan, 1987; Matson & Kozlowski, 2011). Restricted, repetitive and stereotyped behaviours are also characteristics of ASD. Indeed many children with ASD display an abnormal interest in unusual topics/objects (e.g., intense interest in the history of the common garden hose). Children with ASD also often engage in repetitive motor mannerisms, and may show a general inflexibility with respect to routines (American Psychiatric Association, 2000; Matson & Kozlowski, 2011).

Arguably, it is the hallmark characteristic of impaired communication development that produces the most significant setback for integrating children with ASD into typical classrooms and most significantly affects their ability to function within society (Bondy & Frost, 2002; Matson, Kozlowski, & Matson, 2012; Mirenda, 2003). Some of the communication abnormalities which are characteristic of children with ASD include (a) stereotyped use of language, (b) an abnormal pitch, tone, rate, rhythm, or variation of language, (c) pro-noun reversal and (d) echolalia (Matson, Kozlowski, & Matson, 2012; Quill, 1997). Language comprehension may also be delayed resulting in the individual being unable to understand simple questions or comments. Children with ASD may also struggle with the pragmatic use of language, which is commonly shown through an inability to understand humour, sarcasm, or non-literal aspects of spoken language (Quill, 1997; Matson, Kozlowski, & Matson, 2012). When speech and language development is severely impaired, the child may have considerable difficulty in expressing basic wants and needs and interacting socially with others (American Psychiatric Association, 2000; Cohen & Donnellan, 1987). In fact for approximately 25% of children with ASD, the degree of communication impairment is considered severe in that they may fail to develop any appreciable amount of speech (Bondy & Frost, 2002; National Research Council, 2001; Schlosser & Wendt, 2008).

Communication

Communication occurs within a social context that demands an interaction between a speaker and a listener (Skinner, 1957). In order for communication to be deemed successful, the listener must correctly interpret what the speaker is communicating. Communication, which is functional, allows us to exert control over our environment and influence the people around us. Therefore, successful and functional communication occurs when the communicative function, which is interpreted by the listener, matches the speakers' communicative intention (Halle & Meadan, 2007).

Studies have demonstrated that young children present intentional pre-communicative behaviours prior to the acquisition of speech, such as proto-declarative pointing, eye gaze, and joint attention, all around the age of 6 months old (Bates, Camaioni, & Volterra, 1975). The foundation for the development of communicative intent is based on the awareness of social relationships between people. Communicative intent is crucial in language development as it acts to discriminate between a purposeful communicative behaviour and a behaviour which appears as communicative, due to the misinterpretation of that behaviour as being produced with some meaning (Rowland, 2009). Intentional communicative behaviours can be described as serving three primary functions: (a) behaviour regulation, where a child performs a basic behaviour indicating a request or showing a rejection for specific objects, (b) social interaction, where a child performs a socially indicative behaviour such as waving to represent a greeting, and (c) joint attention, where a child requests information by drawing another's attention towards an object of interest, or follows the gaze of another towards an object of interest (Bruce, 2005; Charman, Baron-Cohen, Swettenham, Baird, Drew, & Cox, 2003; Halle & Meadan, 2007). In addition to intentionality Theory of Mind (ToM), which describes how individuals recognise others' independent and unique thoughts, has also been viewed as an important aspect of communication development (Baron-Cohen, Tager-Flusberg, & Cohen, 1994).

Functional communication, as described by Van Dijk (1986), involves the exchange of ideas between communication partners with the intention of conveying thoughts and information which can be easily interpreted by the other. A successful communication exchange requires some method of carrying an intended meaning from one person to the other, which requires an understanding of the mind of the other, or ToM. This method can be in the form of speech, sign language, written words, or some other communication method which requires a specific object or situation, and the abstract idea of such an object or situation. It is this abstract idea of an object or situation which represents the symbolic component of communication (Van Dijk, 1986).

Spoken language, described as the optimal and most successful communication tool, is said to play a crucial role in developing and extending social networks and facilitates complex neural processes involved in co-operative planning and goal setting (Kandel, Schwartz, & Jessel, 2000). In a typically developing child, spoken language is acquired during the second and third years of life (Kandel et al., 2000; Williams, Waiter, Perra, Perrett, & Whiten, 2005). Research into language development suggests that from birth to two years of age, the language specific areas of the cortex (the temporal lobes) are influenced by critical periods (Utsunomiya, Takano, Okazaki, & Mitsudome, 1999). Critical periods are defined as optimal periods of cognitive maturation in which the learning or acquiring of skills require some crucial experience resulting in typical behaviour within the environment the individual has been exposed to (Newport, 2004). Competence in mastering specific skills, such as speech, declines the further from the critical period that such skills are attempted (Utsunomiya et al., 1999). Recognising the importance of critical periods and early neural development has led to the rationale to implement early intervention for individuals who show slow development or a significant lack of pre-language behaviours (Dawson & Zanolli, 2003; Matson & Kozlowski, 2011). Early intervention for those with ASD who lack functional communication has produced positive results regarding increased social interactive behaviours and language proficiency later in life (Bruce, 2003; Mirenda, 2001, 2003).

However, for those with ASD who fail to develop any spoken language, alternative communication modes and strategies are considered necessary in order for these children to develop functional communication skills (Mirenda, 2003; Bondy & Frost, 2002).

Augmentative and Alternative Communication

As noted before, for approximately 25% of children with ASD, the degree of communication impairment is considered severe in that they may fail to develop any appreciable amount of speech (Bondy & Frost, 2002; Matson, Kozlowski, & Matson, 2012; National Research Council, 2001; Schlosser & Wendt, 2008). According to the literature, there is a general consensus that children with ASD who have limited speech and language development by 2 to 3 years of age are candidates for AAC (Mirenda, 2003). AAC refers to specific communication systems which supplement (i.e., augment) or act as replacements (i.e., as an alternative for natural speech). Thus, in the ASD area, AAC is primarily intended for children who have little or no functional speech and thus require an alternative mode of communication to meet their daily communication needs where communication is achieved without the use of speech (Mirenda, 2001, 2003; Wendt, 2009).

AAC offers the user two main categories of systems; aided and un-aided systems. Un-aided systems are communication methods such as gestures and manual sign, which do not require any external tools for communication to be achieved. Aided systems however, require specific external systems in order to enable the user to communicate (Mirenda, 2003).

The potential advantages of teaching children with no speech to instead rely upon un-aided AAC systems instead of aided systems are the benefit of accessibility. Un-aided AAC systems, such as gestures and manual sign language, can be used in any communication setting, in any location, and within any environment as there is no restriction on the user of the availability of an external system. The only restrictions un-aided systems place on users is the sign language vocab, or gestural vocab the user has developed. An additional advantage is that both gestural communication and manual sign are symbolic forms of communication, and have been implemented in the development toward speech, the highest level of symbolic communication (Charman et al., 2003).

However, un-aided systems also come with potential disadvantages. Manual sign can only be regarded as a functional method of communicating if the communication partner can understand the message conveyed through the signing. Often AAC users with ASD are not an integral part of the sign language community, therefore it is likely that the people they are communicating with are not be fluent in sign language, or understand any sign language at all. This limits the number of individuals an AAC user communicating with manual sign can effectively and efficiently communicate with (Mirenda, 2003). In addition, gestures can be ambiguous and unclear to those who are unfamiliar with the communicator's idiosyncratic gestures (Quill, 1997). The limitation here is that communication may not be clear, and therefore fail to serve a functional purpose. Memory requirements for the use of un-aided systems may also act as a limiting factor as these systems require recall memory as opposed to recognition memory used in aided AAC systems. Recall memory demands the user scan their memory store in order to decide upon a correct response, and to then physically produce that response (Quill, 1997). In a recent study, four children with developmental disabilities were taught to use manual sign and an electronic speech generating device (SGD) to request preferred items (van der Meer et al., 2012). The participants' rate of acquisition for each system was compared and preference assessments were conducted throughout intervention and follow-up to identify whether the participants had established specific preferences for either the manual sign or the SGD. Authors found that all four participants reached a high level of proficiency for requesting with the SGD, whereas only three participants reached criteria for manual sign. Preference assessments indicated that three of the four participants preferred the SGD when requesting specific items. Reasons for these findings highlighted the difficulty found when teaching participants to request using manual sign, as the procedures to aide the participants in producing the manual signs with their hands was seemingly more challenging compared to aiding participants to select and activate the correct SGD symbol. These results also support the idea that manual sign may be harder for children to with ASD to communicate with as manual sign requires recall memory, as opposed to using recognition memory when using the SGD.

Aided systems involve the use of extra materials, such as line drawings or photographs representing items that a user can select (Mirenda, 2003). With a picture exchange (PE) system, for example, the user communicates by handing a listener a card containing a photograph or line drawing of an item they wish to request or communicate with (Mirenda, 2001; 2003). Similarly with another [electronic] visual AAC system (SGDs), the user selects line drawings or photographs presented on a screen which then produces corresponding synthesised or digitised speech-output (Lancioni, 2007). Aided AAC systems, such as PE and SGDs, have potential advantages over un-aided systems. Aided systems rely on concrete symbols, which may be pictures, line drawings, photographs, or graphic symbols, which represent specific referents. Due to the visual and concrete nature of aided systems, a potentially advantageous component is the functionality of the systems. As these aided systems are constantly available to the user when performing a communicative act, a potentially much more concise and effective communication exchange is executed between the user and the communication partner. For example, it is more likely that a child who communicates with a picture accompanied with written text may be better understood than a child who communicates via manual sign when communicating with an unfamiliar exchange partner (Quill, 1997; Rotholz, Berkowitz, & Burberry, 1989). Aided AAC systems, which are often visual, match specific profiles of children with ASD and related developmental disabilities who tend to learn at a higher proficiency when the teaching procedures involve a visual component (Mirenda & Brown, 2009; Quill, 1997). Teaching aided systems to children with ASD and/or developmental disabilities might also be easier than teaching manual sign because the user only needs to be taught to pick up a symbol, or select an icon on an iPad® screen, in comparison to teaching a user to physically create a complex sign which they must then commit to memory (van der Meer, Kagohara et al., 2012a). Furthermore, aided AAC systems demand simple motor responses (such as picking up a picture to exchange, or tapping a graphic symbol on an SGD) requiring a lower degree of fine motor control. Additionally, as previously mentioned, memory requirements placed upon users when learning to use aided AAC systems are also less demanding than un-aided systems as the system is consistently within the users view and therefore visually and physically available for the user to refer to as opposed to manual sign which is not visually available for users (Quill, 1997). Aided AAC requires the user to utilise recognition memory in order to scan all potential symbols, and then to select the correct symbol to produce a response. Un-aided systems, as previously discussed, seem to require a higher cognitive demanding task that is scanning their memory for the appropriate sign, and then physically performing it (Mirenda, 2003).

Aided AAC systems, however, also come with disadvantages. A major restriction, and the most obvious, is the underlying fact that the systems are aided. Therefore in order to communicate, the user must have access to the system. This may become problematic if the system is for some reason unavailable, damaged or lost. Previous research has also shown that certain items/activities can be difficult to pictographically represent. Specifically, children with ASD have been found to successfully acquire symbols which represent referents of noun word categories, for example, orange, dog, and bike, with apparent ease.

Symbols representing referents of verb word categories however, such as thirsty, breathing, running, have been found to be more difficult to acquire as the symbols representing these stimuli are often more abstract and do not represent the referent in a concise way (Koul, Schlosser, & Sancibrian, 2001; Kozleski, 1991). Various aided AAC systems, such as PE, require the user to perform a two-step motor movement whereby they are required to first select a symbol, and then exchange this with a communication partner. Unaided AAC systems, such as manual sign, only require a one-step motor movement in order to produce a communicative gesture.

In a study conducted by Sigafoos (1998), an AAC communication intervention which adopted an AB design was implemented for one 6 year old boy with autism. The intervention sought to teach the boy some general requesting skills for preferred items. As this particular individual had previously tried to acquire manual sign, and had failed to reach any level of proficiency with that system, a graphic AAC system was implemented to determine if a visual communication method would prove more effective. The general request which was taught required the participant to point to a graphic symbol representing the request *'want'* in order to request a preferred item which was out of reach. When the preferred item was within reach, the participant was free to access it without requesting with the graphic symbol. This latter method is an example of using a direct selection (DS) method to gain access to a preferred item. Results demonstrated that the participant successfully learned to request preferred items with a graphic symbol when the items were out of reach. In comparison to manual sign, the graphic symbol-based communication system appeared to be a useful communication mode for this child in that he quickly reached a high level of proficiency with this visual communication system, and learned to request preferred items independently.

In a systematic review of aided and un-aided AAC systems by Schlosser and Sigafoos (2006), the authors concluded that although both categories of AAC systems have potential advantages and disadvantages, both present viable communication systems which act to effectively replace speech for children with ASD and developmental disabilities. Specifically the authors concluded that manual sign induced greater eye contact from the user to the communication partner during communication exchanges in comparison to eye contact during exchanges with PE and SGDs. This was suggested to be a crucial component of an effective manual sign communicative exchange as a user must ensure that the message has been portrayed to the communication partner. In order for the user to be sure of this, they are required to ascertain whether the partner was watching. This is not required when exchanging the pictures during the PE procedure as the exchange of the picture card ensures the intended message has been successfully executed, or when activating synthesised speech output from a SGD. During the interventions documenting PE procedures, participants were more often reported to generalise the matching rule of symbols to items to novel symbols and new items. Studies within this review did not record the ability to generalise to novel signs for new items with participants using manual sign. Recognition memory, utilised in visual symbol learning and exchanging, was found to play a significant part in symbol recognition and resulted in faster acquisition rates as the symbols were visible for the users at all times. Recall memory was suggested to influence the results from studies involving manual sign interventions as the participants had to remember how to produce each sign essentially “from thin air” (p. 21). In light of these advantages and potential limitations, the authors identified relatively few documented differences between the acquisition rates for aided and un-aided systems, and conclude that both categories of AAC systems are viable methods for children with ASD however, further research is warranted (Schlosser & Sigafoos, 2006).

Visual AAC Systems

Previous research indicates that visual AAC systems can offer an effective and functional mode of communication for children with ASD (Bondy & Frost, 2002; Mirenda; 2001; 2003; Quill, 1997; Sigafoos, Green, Payne, Son, O'Reilly, & Lancioni, 2009; van der Meer et al., 2012). Visual communication systems can offer the user a clear and concrete symbol of an action, item, or emotion. The clear use of symbolic representations, which indicate simple communicative acts (Mirenda, 2003), is suggested to be a low tech method when beginning the development of communication skills for many children with ASD who experience severe communication impairment. Symbols may also act as salient visual prompts, drawing the user's attention to the symbols as methods to functionally execute successful communication (Quill, 1997; Shafer, 1993). Furthermore, visual AAC systems allow communication to become individualised to the user where actual photographs of more specific personal objects or acts can be used as symbols. This can increase the control each user may exert over their environment and may reduce confusion and frustration for both the communicator and communication partner (Bondy & Frost, 2002; van der Meer, et al., 2012b; 2012c). Visual AAC systems often require the user to initiate communication with a partner and, in-conjunction, initiate social interaction with that communication partner (Bondy & Frost 2002). In conclusion, there are numerous empirical studies providing data to suggest that visual AAC systems can be effective and efficient AAC modes for individuals with developmental disabilities and severe communication impairment

Visual communication systems however, also come with potential disadvantages. In order to successfully communicate using PE for example, the user must perform a two-step motor movement involving the selection of a specific symbol, and the exchanging of the symbol with a communication partner (Mirenda, 2003). Another potential disadvantage in the functional use of PE is that the number of pictures is limited to how many a child has access to at any given time (Bruce, 2005). In addition, fine motor control is necessary when communicating with PE and when operating an SGD, and is especially significant for users of SGD systems. For a successful voice out-put from an SGD the user must tap the correct symbol, with the correct amount of force, on the SGD screen. SGDs are often an iPod or iPad based system equipped with touch screen capabilities, where correctly selecting an icon results in activation of synthesised speech out-put. For learners using such SGD systems, fine motor control is often the determining factor when deciding whether an SGD system can be used successfully and functionally (Lancioni, 2007; Kagohara, van der Meer et al., 2010).

One of the earliest reported studies investigating a pictorial AAC system was conducted by Lancioni (1983) where three participants, two of whom were diagnosed with autism, were taught to communicate using a picture-based system. Intervention sessions began by teaching participants to associate picture cards with corresponding objects. Following this, participants were taught to; a) respond to pictures of body positions by re-creating the postures, b) re-create body postures in relation to objects, and c) imitate activities that were depicted in the pictures. The next stage involved activities requiring two children, where the participants were assigned particular roles in order to imitate the represented activity. In the final stage of intervention participants were required to select picture cards representing activities and independently perform them. Results indicated that children with autism and severe developmental delays learnt how to respond correctly to a large repertoire of picture cards and engage in active communication. Participants also displayed a high degree of generalised learning where they would respond correctly to almost all of the picture cards. Lancioni attributed the relevant success of this pictorial communication system to the iconicity of picture representations in conjunction with the concrete nature of pictures. These characteristics were suggested to help facilitate both discrimination and the capability of participants to develop meaningful associations between the pictures and referents they represented (Lancioni, 1983).

Bondy and Frost (1994) introduced the Picture Exchange Communication System (PECS) protocol which was originally designed to offer an AAC system which employed a structured training sequence and systematic teaching procedures to enable the replication of the communication intervention, and strengthen treatment integrity such that multiple interventions and results would be reliable. In conjunction with this, PECS was designed to include all crucial aspects required of individuals to successfully produce functional communication. PECS procedures follow a structured protocol which teaches picture exchange communication in six discreet phases. Phase 1 teaches the user how to perform a successful picture exchange with a communication partner. Phase 2 focuses on increasing the distance between the user and the communicator partner to encourage users to seek out communication partners, and ensure the users have a strong intent to communicate. Phase 3 teaches users to discriminate between two or more pictures in order to successfully communicate. This phase allows for the user to reach the fourth phase, where two symbol exchanges are taught, allowing for the users vocabulary to increase, and for the user to develop an idea of sentence structure. This is then expanded on during phase five where participants are taught to respond to questions like, “What do you want?”. The final phase focuses on responsive and spontaneous communication (Bondy & Frost, 1994; 2002).

Another visual AAC system which focuses on teaching functional communication through a picture-based system is what can be seen as a more generic Picture Exchange (PE) system. This system is similar to PECS except it does not necessarily involve following the PECS protocol. As with PECs, teaching a PE system tends to include teaching the learner to make an initial exchange with a communication partner, and to discriminate between multiple picture symbols (Mirenda, 2003). In a review of the literature comparing acquisition rates between PE and SGDs, Lancioni and colleagues (2007) found that 98% of participants' who were taught to use PE or SGDs to make simple requests, acquired this skill to a high level of proficiency. Thus both systems were regarded by the authors as effective communication systems to enhance functional communication skills for children with autism (Lancioni, O'Reilly, Cuvo, Singh, Sigafoos, & Didden, 2007). In another review by van der Meer & Rispoli (2010), which focused on studies using SGDs in communication interventions for children with autism, 51 children aged from 3-16 years old were taught to use SGDs. Twenty three studies were analysed within this review and positive outcomes were reported for 86% of the studies with conclusive evidence indicated in 78% of the studies. The authors concluded that SGDs are a viable and effective method for augmenting speech in children with autism due to the clear synthesised speech produced by the systems, the clear training procedures used in teaching users to successfully communicate with the system, and the instant reinforcement achieved following successful activation (van der Meer & Rispoli, 2010).

In a meta-analysis investigating single case research studies focusing on the use of visual AAC systems for children with ASD, Ganz et al. (2012) analysed 24 studies. The aim of this analysis was to determine (a) the effects of AAC systems on communication skills, challenging behaviours, social skills and academic skills for children with ASD, (b) whether AAC systems are more effective for one type of skill compared to others, and (c) does one type of AAC system prove more effective than other AAC systems. The review investigated studies involved in teaching PECS (Bondy & Frost, 2002), other PE systems, and SGD's. The Improvement Rate Difference (IRD), was used to calculate effect sizes for all 24 of the studies in order to quantitatively measure the outcomes of each study. The IRD effect size measure calculates the degree of improvement recorded by each participant across study phases (e.g., Baseline, Intervention), across the type of behavioural intervention being implemented (e.g., communication skills, challenging behaviours), and across the AAC systems used within the study. Results from the effect size analysis suggested that overall the aided AAC systems (PE, PECS and SGD) had strong positive effects on the behaviour outcomes targeted within each study. AAC systems had the largest positive impact on communication skill development for children with ASD, compared to social skills, academic skills, and challenging behaviour. However, teaching communication skills was the most common targeted behaviour across the analysed studies. In light of this finding, AAC systems positively impacted academic skills, social skills, and challenging behaviours. Authors suggest this may be due to the close interaction between social and academic skills with communication skills; hence an improvement in one may interact with the improvement seen in the other. A reduction in challenging behaviours may also be influenced by improvements in communication skills as for some children with ASD, requesting a preferred item using PECS, PE, or SGD, may now be a more viable and effective option compared to tantruming to communicate their needs.

Furthermore, a paper describing three studies comparing SGDs and PE for one boy with developmental disabilities and severely impaired communication (Sigafoos et al., 2009) provided further support for interventions focusing on visual AAC systems. In the first study, the participant was taught to request using both systems and his rate of acquisition and social interaction was analysed. During the second study the participants system preference was analysed through implementing the choice-making paradigm. This involved allowing the participant access to both systems and recording which system he chose. The third study focused on increasing the distance between the participant and his exchange partner during PE only. During this study, the participant’s social interaction was the specific focus of analysis. Results from all 3 studies indicated that both PE and SGD AAC systems are effective and viable methods to teach children with developmental disabilities. However, simply teaching these two systems to children with developmental disabilities does not imply an increase in social interaction, as social interaction was positively affected during the third study only. This study also highlights the importance of including preference assessments into AAC interventions for children as this participant performed to a higher level of proficiency with his preferred system, and reached acquisition for this system at a faster rate compared with his less preferred system.

Reported failures have also been noted in teaching individuals with developmental disabilities to select line drawings or photographs from SGD systems. In a clinical case study, one 17 year old male diagnosed with autism and ADHD was taught to request specific preferred snack items. During intervention the participant was taught to successfully activate the SGD to request the snack items. An Apple iPod Touch® was configured as a SGD via Proloquo2Go® software so that tapping each symbol produced corresponding speech out-put (e.g., tapping the snack symbol produced the message *"I want a snack please")*. Following intervention, a post training phase was implemented. It was during this phase where it was assumed poor motor skills were responsible for the participant failing to correctly operate the SGD and produce successful speech out-put. Due to this consistent failure throughout the post training sessions, researchers had thought to abandon this AAC system completely. However by slightly adjusting the teaching procedures by implementing an error-correction method whereby the participant was prompted to produce a correct response immediately following the initial verbal prompt, the participant was again able to correctly activate the SGD and produce speech out-put (Kagohara et al., 2010).

van der Meer et al. (2011), for example, provided AAC intervention to two adolescents and one adult with developmental disabilities. Intervention focused on teaching the participants to select line drawings of preferred snacks and/or toys from the display of an Apple iPod Touch®. With intervention, only two of the three participants learned to make

SGD-based requests. While the precise reason for this acquisition failure observed by van der Meer et al. (2011) appeared to be related to a reinforcement problem (i.e., the participant did not seem motivated to use the SGD to request), it is possible that some individuals may have difficulty in learning to use an aided AAC system that requires the selection of 2-dimensional symbols, such as line drawings or photographs, as they may not yet understand how pictures can symbolise an act or object. This suggestion is consistent with the iconicity hypothesis, which states that the ability to recognise specific symbols and their meaning is influenced by the extent to which the symbol accurately represents its referent (Fristoe & Lloyd, 1979; Lloyd & Fuller, 1990). According to this hypothesis it should be easier to learn to use a symbol when the symbol is highly iconic, that is when the symbol looks very much like the referent.

Symbolism and Iconicity

Typically developing children have been reported to employ pre-symbolic communication methods, such as joint attention, gestures and vocalisations, before they develop more advanced symbolic communication, such as speech (Park, 2005; Quill, 1997; Rowland & Schweigert, 2000; Wulff, 1985). In this way, before the emergence of speech, it is still possible to communicate with a child who does not speak by sharing experiences through body language, touching, or pointing to objects (Bruce, 2005). These pre-symbolic acts can act as a communication method whereby a child may gesture or indicate through body movements that they wish a specific activity to either cease or continue. This portrays a message to the communication partner regarding the child's intentions, resulting in basic communication (Bruce, 2005).

This is relevant for young children with autism, as two of the defining characteristic deficits of autism; impaired social and communication skills, might be seen as being related to a specific inability to engage in joint attention and symbolic play behaviours (Quill, 1997).

These behaviours are often apparent in typical young children during the first two years of life (Bruce, 2005; Charman et al., 2003; Kasari, Freeman, & Paparella, 2006; William, Waiter, Perra, Perrett, & Whiten, 2005). Theoretically, both joint attention and symbolic play behaviours are linked to the idea of understanding others' mental representations or ToM (Baron-Cohen, Tager-Flusberg, & Cohen, 1994; Hobson, 2002) and it is this understanding that might aide in the development of age-appropriate social skills, social understanding, and language abilities (Baron-Cohen & Swettenham, 1997). Associations between symbolic play skills and joint attention have both been implicated in the later development of language (Bruce, 2005; Charman, et al., 2003; Ungerer, & Sigman, 1981), with the combination of a failure to develop sophisticated symbolic play skills and a lack of joint attention, being a strong predictor of a diagnosis of autism (Charman et al., 2003). Therefore, joint attention, early symbolic play behaviours and the consequent understanding of symbolism is suggested to play an important role in language development in children with autism.

Evidence from the literature suggests the ability to develop an understanding of symbolism can only be achieved once a child understands an object, and how that object may represent something else (Bruce, 2005). Joint attention is the process of following the focus of another, either from person to person, or from person to object. It is considered an early cognitive skill which first emerges around six months of age. By 18 months, children will consistently follow the gaze of another. It is suggested to be an important pre-cursor to social and communication development (William et al., 2005). In order for objects to have meaning, the child must first be able to understand that an object has individual features and functions and be able to differentiate between different objects and their varied functions before representations of the object will hold any meaning (Bloom, 1990). In a study examining joint attention, children with developmental delays and Down's syndrome were compared with age-matched peers. The children with Down's syndrome demonstrated significantly lower rates of joint attention than the control group. For those children with developmental delays, the rates of joint attention were even lower (McCathren, 2000). Furthermore, the rate of joint attention was found to be a reliable predictor of later expressive language development in children with intellectual disabilities (McCathren, Yoder, & Warren, 1999). Longitudinal data was analysed for 18 children diagnosed with either autism or Pervasive Developmental Disorder (PDD) to investigate associations of joint attention and language development. Participants were assessed on play behaviours, imitation skills, and the presentation of joint attention. The effects of these behaviours were then correlated with later language development. Assessments were initially carried out at 20 months and then again at 42 months, along with language assessments. Results of this study indicated that play behaviours, imitation skills and joint attention at 20 months were correlated with language development at 42 months, and that a lack or impairment of these early behaviours resulted in delayed language development (Charman et al., 2005).

More recent research has suggested that symbolic play and joint attention can be successfully taught to children with autism and developmental delays and consequently influence communicative social interactions (Ungerer & Sigman, 1981). Children will often spend more time attending to objects of great interest, therefore when beginning an intervention to increase joint attention behaviours in children with developmental delays or autism, objects of preference to the learner would seem an appropriate starting point (Bloom, 1990). In a study investigating joint attention and symbolic play in 58 children with autism, authors found that symbolic play skills and joint attention skills can be successfully taught and these skills can be generalised to other instructors (Kasari et al., 2006). Specifically, authors found that participants who received joint attention and play intervention engaged in higher-level social interactions with their mothers compared to the control group who received no intervention. These participants also displayed a greater number of child-initiated social interactions and joint attention behaviours, post intervention (Kasari et al., 2006). Similar results had previously been documented in a study conducted by Stahmer (1995) where symbolic play was taught to seven children with autism via a pivotal response training regime. Results showed that post intervention, participants engaged in more social interactions by initiating social exchanges and responding positively to social engagements by others. These participants also developed more sophisticated symbolic play behaviours and their normal play complexity increased (Stahmer, 1995). Furthermore, significant associations have been established between joint attention, symbolic understanding, and communication (Charman et al., 2003; Kasari et al., 2006; Mundy et al., 1990). Play intervention in conjunction with language facilitation, was found to enhance social and cognitive abilities in both typical children and children with ASD (Fowler, Ogston, Roberts-Fiati, & Swenson, 1997). In a study examining 170 children with hearing loss and developmental delays, the development of symbolic play was greatly associated with an increase in the development of symbolic gestures, the number of individual words and phrases which were understood, and the number of words spoken (Yoshinaga-Itano, Snyder, & Day, 1999).

In a more recent review, Schlosser (2003) investigated the specific factors affecting graphic symbol acquisition for individuals receiving AAC intervention. Specifically, results suggested that three variables were found to exert the greatest influence upon graphic symbol learning, these being; (a) realism, (b) concreteness, and (c) iconicity. Realism refers to the degree to which a symbol realistically represents the referent. In order to realistically depict a 3-D referent, it would appear appropriate to design the symbol as a 3-D object such that when the user is requesting a 3-D object, they may be more able to imagine the preferred referent. Concreteness refers to the ability of a symbol to represent the entirety of the referent. A symbol representing an apple, a bike, or an orange for instance, is likely to be more concrete than a symbol representing heat, running, or thirsty. Symbols representing referents derived from the noun category of words are generally more concrete than symbols which seek to represent more abstract symbol-referent associations, such as those from the verb category of words (Koul, Schlosser & Sancibrian, 2001). Therefore the referent a symbol seeks to represent exerts significant influence upon the learnability of that symbol. Additionally, it has been suggested that when initially teaching symbol-based communication systems, symbols sharing both realism and concreteness are appropriate symbols to begin teaching (Koul et al., 2001; Rowland & Schweigert, 1989; 2000; Schlosser, 2003) Lastly, the ability to recognise specific symbols and their meaning is suggested to be influenced, to some extent, by the level of iconicity that symbol shares with the referent it represents.

The iconicity hypothesis was articulated by Fristoe and Lloyd (1979) to explain the importance of iconicity for learners when comprehending symbolism. Iconicity has been portrayed as any association that an individual forms, which may be based upon a recognised physical connection, between a symbol and its referent (Fristoe & Lloyd, 1979; Lloyd & Fuller, 1990). This association is mediated by the viewer, and is therefore unique to the individual (Robinson & Griffith, 1979). According to this hypothesis, a symbol which is more iconic to its referent is easier to learn compared to less iconic and more abstract symbol-referent associations (Kozleski, 1991; Lloyd & Fuller, 1990). Iconicity enables the learner to establish that one specific symbol represents one specific referent, and to generalise this idea to comprehend that other symbols represent other referents, resulting in the knowledge that specific symbols stand for the objects they represent (Stephenson & Linfoot, 1995). Since one symbol represents one referent and one referent only, the portrayed meaning is often clear and simple even if the referent is physically or temporally distant (Park, 1995; Rowland, 1990, Rowland & Schweigert, 2002).

Kozleski (1991) utilised a multiple baseline to teach four children with autism, aged from 7-13 years old, to communicate using visual AAC systems with symbols of varying degrees of iconicity. Acquisition rates of five different symbol based systems were compared. These symbol systems included: (a) photo-pictorial symbols, (b) rebus symbols, (c) Blissymbols, (d) orthography, and (e) Premack-type tokens. Results indicated that it took fewer trials for all four participants to reach acquisition for the more iconic symbols compared to those symbols employing a more abstract symbol-referent association. Similarly, another study conducted by Hurlbut, Iwata and Green (1982), which resulted in support for the iconicity hypothesis, investigated two categories of symbol systems. Blissymbols (abstract symbols) were compared with highly iconic symbols to assess three non-verbal participants' rate of acquisition, stimulus generalisation, and system maintenance. Results showed that all participants reached acquisition for both symbolic forms of communication; however it took four times as many sessions for each participant to reach acquisition for the Blissymbols system. Participants were able to generalise iconic symbols to un-learnt items, and iconic symbol use was maintained after intervention when communication with the Blissymbols system failed to be maintained. The authors also measured spontaneous communication throughout intervention sessions and showed that responses were greater with iconic symbols compared with the abstract Blissymbols. Furthermore, in another study (Angermeier, Schlosser, Luiselli, Harrington, & Carter, 2008) comparing highly iconic graphic symbols with more abstract (less iconic) symbols during the first two phases of PECS, the authors found that the iconicity of the symbol had no impact on participants' acquisition rates. However, as authors noted, the first two phases of PECS focus on the motor program of selecting and exchanging specific symbols for preferred items. Phase three of PECS introduces symbol discrimination. It is probable that the level of iconicity of symbols during Phases 1 and 2 of PECS is not as important for learning the symbols as it is during

Phase 3 (discrimination phase) of PECS. It has been previously determined that a crucial pre-requisite for symbol learning includes the ability to discriminate one specific symbol from a display of many symbols (Bloom, 1990). Furthermore, discrimination is also suggested to aide in the learning of language and cognitive development (Bruce, 2005). It has also been suggested that in order to successfully discriminate between symbols, an appropriate beginning step for individuals with ASD and developmental delays is often to begin with one-to-one correspondence training as correspondence is deemed to be crucial when learning to communicate with symbolic communication systems. Abstract symbols have been suggested as problematic for learners with ASD and related developmental disabilities due to a suggested limitation of memory capacity and representational abilities (Rowland & Stremel-Campbell, 1987).

The literature therefore tentatively supports the theory that memory for object-referent associations is greater when the object is more realistic, concrete and iconic, resulting in greater ease of acquisition, greater system maintenance, and in some cases, greater system generalisation in comparison with more abstract symbols (Bloom, 1990; Hurlbut, Iwata, & Green, 1982; Rowland & Schweigert, 1989; 2000; Schlosser, 2003; Trief, 2007). This is especially relevant when beginning teaching a child more advanced symbolic forms of communication and when implementing simple communicative methods such as requesting.

Memory: Recall versus Recognition

The process involved during a typical communicative response from an individual requires recall memory. Recall memory requires a two step cognitive process in order to be successful. First the learner must scan their internal memory stores for potential responses which would be appropriate for a particular situation. Following this, the learner must then discriminate between those responses in order to select the response most appropriate for the given situation (Light & Lindsay, 1991). It is this process which is required when communicating via an un-aided AAC system, such as manual sign. However, when communicating with an aided AAC system, such as PE, PECS, or SGD, a different process (recognition memory) seems to be required. Recognition memory requires the learner to perform a one step cognitive process because the first step of the recall memory process is not necessary. Recognition memory requires the learner to scan the visible symbolic responses laid out in-front of them, and select the correct symbol to produce the desired response. Because the symbols are both visibly and physically available to the learner, the internal scanning process is seemingly redundant, and might thus place less cognitive demands upon the learner (Berk, 2002; Mirenda, 2003).

A study conducted to investigate recall and recognition processes in communication involved an experimental group of participants suffering from moderate cognitive disabilities and memory impairment and a group of typical peers. Acquisition rates and system efficacy was compared when both groups were taught to use manual Sign, Rebuses (pictographic symbols), and Blissymbols (abstract symbols) (Goossens, 1984). Results from this study indicated that all 30 participants from both groups learned both types of graphic symbols at a faster rate compared to the manual signs. The participants who had no memory or cognitive impairment learned to communicate with the rebuses and manual sign with equal ease, while struggling to master the abstract symbols. These findings provide some support for the theory of greater cognitive demand on learners when required to use recall memory when learning un-aided AAC systems to communicate (Goossens, 1984) and consequently provides further support for the iconicity hypothesis. It has been suggested throughout the literature that children with autism show the capability to discriminate between stimuli, and this is particularly evident when the stimuli are more concrete (Sigman, Dissandyke, Arbell, &

Ruskin, 1997). Furthermore, it has been proposed that a link exists between symbolic understanding and language development (Charman et al., 2005; Ungerer & Sigman, 1981). Further influencing factors is the degree of realism, concreteness and level of iconicity a symbol shares with the referent, and what impact these variables have on the learnability of symbols (Koul et al., 2001; Schlosser, 2003). In line with these, there has been some speculation that more concrete and 3-dimensional symbol may represent a promising AAC option for some individuals with developmental disabilities (Park, 1997; Rowland & Schweigert, 1989; 2000).

2-D and 3-D Symbol Systems

While there is a vast body of research investigating the effectiveness of teaching children with autism how to communicate with 2-D symbols, such as PE (Keen, Sigafoos, & Woodyatt, 2001; Mirenda, 2001; 2003; Sigafoos, Laurie, & Pennell, 1996; van der Meer et al., 2011; 2012), PECS (Bondy & Frost, 1994; 2002; Mirenda, 2001, 2003; Sigafoos & Mirenda, 2002), and SGD's (Kagohara et al., 2010; Lancioni et al., 2007; Mirenda, 2001, 2003; van der Meer et al., 2012a, 2012b, 2012c) less research has been conducted into the potential benefits of teaching children with autism and developmental disabilities to use 3-D symbols, also known as Tangible Symbols (TS; Ali, MacFarland, & Umbreit, 2011; Lund, & Troha, 2008; Rowland & Schweigert, 1989, 2000; Trief, 2007; Turnell, & Carter, 1994).

TS systems refer to the use of permanent and concrete icons that are specifically constructed to share a clear perceptual relationship with its referent (Rowland & Schweigert, 2000; Park, 1995). TS can be 2-D symbols or 3-D objects tailored to match individual users sensory and cognitive abilities (Park, 1995). For example, a miniature figurine of a cup might serve as the TS for requesting a drink. TS can be made as exact miniature replicas of the referent, textured picture representations, or partial objects made from the same (or similar) materials as the referent they represent (Rowland & Schweigert, 2000; Trief, Bruce, Cascella, & Ivy, 2009; Park, 1995). Some researchers have suggested that importance be placed on the visual iconicity of the tangible symbols to their referents (Rowland & Schweigert, 1989; 2002), while others argue that due to the symbols concrete and sensory component, they should share a tactile resemblance to their referent as opposed to a visual resemblance (Goldware & Silver, 1998). TS have generally been used as communication aides for those with visual impairment, however as they are concrete, realistic, and iconic they may also function as viable communication tools for children with ASD and related developmental disabilities who lack speech.

Rowland and Schweigert (1989) developed a classification system to describe the levels of representation when assessing children's understanding of symbolism. According to the researchers, there are seven levels of symbolic representation; 1. pre-intentional behaviour (reflexive), 2. intentional non-communicative behaviour (behaviour functions to affect observer), 3. non-conventional pre-symbolic communication (non-conventional gestures), 4. conventional pre-symbolic communication (conventional gestures), 5. concrete symbolic communication (basic symbol correspondence), 6. abstract symbolic communication (singular spoken words, manual sign, printed words) and, 7. formal symbolic communication (combinations of abstract symbolic communication). These researchers suggested that the type of TS used to teach children to communicate should depend on their level of symbolic representation. For example, a child who has limited pre-symbolic communication (i.e., point, wave) would be taught to use TS that directly represents the referent with a one-to-one correspondence. For a child who has reached the concrete symbolic communication level (making sounds, understands objects and their meaning), a more abstract symbol may be used which in-directly represents the referent. For example, a chip wrapper which represents the referent 'chip' may be used as TS (Rowland &

Schweigert, 1989; 2000). This level of representation was proposed by authors to act as a bridge between conventional pre-symbolic communication abilities and the more advanced emergence of symbolic expression, where the learner has a firm understanding of symbolic representations, and can use higher forms of symbolic communication such as speech (Rowland & Schweigert, 2000).

In a review conducted by Park (1995), the functional use of objects of reference (i.e., TS) was investigated. The review analysed studies which used objects of reference as tools for assigning specific meaning to particular objects (Bloom, 1990; Ockelford, 1992), using objects to represent events (Aitken & Buultjens, 1992), and using objects to represent emotional and physical experiences (Wilson, 1983). Parks concluded that objects of reference may facilitate the development of communicating for those who lack speech by providing them with a basic understanding of symbolism, and act as a bridge between non-symbolic, and symbolic communication (Park, 1995). However, Park stated that there appears to be a lack of research examining exactly how such objects relate to the individuals understanding and development of symbolism within the intentional communication framework (Park, 1995).

In a study, conducted by Murray-Branch, Udavari-Solner, and Bailey (1991), textures were used as communication devices for individuals with severe intellectual and sensory impairments. In this study, the textures used were not considered to be classified as TS as they lacked any visual association with the referents they represented. Each texture was assigned a preferred item or activity to represent and these referent-texture associations were taught to each participant during phase one of the study. During phase two, participants were taught to request preferred items using the textures. Phase three of the study involved participants making choices between preferred items, and discriminating between textures. The final phase focused on teaching participants to scan for textures that represented preferred items across various environments and to make choices between multiple items on offer. Both participants displayed increases in their expressive vocabularies and were able to discriminate between at least two textures and use these textures spontaneously to request preferred items. Generalisation sessions were carried out across both trainers and environments. The authors noted several attributing factors which led to the conclusion that such a textured communication system may be a suitable option for many children with developmental disabilities. These factors included, the flexibility of the low tech system where it can be easily modified to suit the learner's communication needs, and the apparent ease to which family members and caregivers were able to use the system to quickly and efficiently communicate with the learner. However, the internal validity of the study is suggested as limited due to the lack of control described in the procedures, in that the gains made by participants are difficult to attribute to the study procedures. Furthermore, the study lacked a rigorous experimental design, instead using a more naturalistic introduction of the textures such that the participants could explore, and associate the textures with the referents. Additionally, the external validity of the present study was limited in that only two participants received the intervention.

In light of these limitations, and in conclusion to Parks (1995) review, there appears to be some merit in developing communication systems which utilise real objects to provide effective and functional alternatives to speech for individuals with intellectual disabilities who lack speech.

Tangible Symbol (TS) Literature Review

In an early study investigating TS as a potential communication system (Rowland & Schweigert, 1989), seven participants were taught to use 3-D and 2-D tangible symbols to request preferred snack items and objects, however the study only specifically describes the teaching procedures and TS used for two participants, one male and one female, (aged 4.5 and 6 years). These participants were diagnosed with severe cognitive delays as well as visual and hearing impairments. Participants were taught to request preferred items using a most to least prompt strategy where both participants were taught to discriminate between three tangible symbols over an average of 14.5 months. For one participant, the symbols were introduced sequentially, for the other participant all three symbols were introduced and taught simultaneously. Both participants learned to discriminate between the first three symbols taught. Results from long term maintenance probes showed that one participant, over a period of two years, successfully acquired at total of 22 tangible symbols, while the second participant, over a four year period, successfully acquired a total of 59 tangible symbols. Overall, all seven participants within the study acquired at least 16 TS. In terms of the main dependent variable outlined in this study; the number of TS acquired by participants to request preferred items, these data indicate a positive intervention effect in that all participants learnt to request using at least 16 TS after training. However, as there were no control conditions described (i.e., baseline phase), it is difficult to attribute these gains in TS acquisition to the intervention procedures alone, thus the positive result should be assumed with caution.

In a second study investigating the use of TS for communication purposes (Turnell & Carter, 1994), one male student aged eight years old and diagnosed with intellectual disability, athetoid quadriplegia, seizure disorder, and mild hearing loss, was taught to use 3-D TS, which were either designed to either share features with the referent, or were partial objects, to request preferred items. Intervention was staggered across each of the three preferred items/activities available for the participant to request, in order to meet the requirements of a multi-probe, multiple baseline design (Kennedy, 2005). Additional probe trials were implemented for generalisation across trainers during and after teaching. These trials were also employed for maintenance sessions post intervention. A naturalistic time delay was employed during intervention sessions to encourage independent requesting. The participant was taught to discriminate between three symbols; one of which correctly represented the preferred item on offer, and two TS which did not match the preferred item on offer and acted as a distracter symbol. The participant gained proficiency for requesting preferred items on offer for three of the four TS taught to him. Generalisation probes demonstrated that the he could successfully generalise these learnt skills to other trainers and to other environments outside of the classroom. Maintenance probes demonstrated that the learned skills were maintained for an average of nine trials after intervention sessions had ceased. Results from this study are difficult to generalise to the greater population of individuals with developmental and physical disabilities as only one participant received intervention. In addition, the participant was only taught to discriminate and use three TS. However, the use of multi-probe multiple baseline design indicated a strong experimental effect as the increased level of TS proficiency from baseline through to intervention can be attributable to the teaching procedures implemented. This study indicates that TS can be taught as a successful AAC option for children in need of a functional replacement for speech (Turnell & Carter, 1994).

A three year investigation was conducted by Rowland and Schweigert (2000) to determine whether tangible symbols may be used as an effective form of communication for children with a variety of impairment including; autism (n= 9), developmental delay (n=32), hearing impairments, (n=8), intellectual disability (n=9), medical fragility (n=6), orthopaedic impairment (n=23), seizure disorder (n=8), and visual impairment (n=23). Many of these participants shared co-morbidity with two or more of these specific diagnoses. This study investigated the hypothesis that by using TS as a communication method, children may subsequently learn to use more abstract symbols during communication. Communication was defined in this study as; requesting/rejecting, commenting, labelling, confirming or, to negate. This study involved 41 participants ranging from 3 to 18 years old. Results demonstrated that of 41 participants, 35 reached acquisition and were able to effectively communicate by exchanging the correct tangible symbols to request a desired or preferred referent. Interestingly, of the nine participants within the study who had a diagnosis of autism, eight learned to communicate with tangible symbols, indicating that this may be a viable AAC option specifically for children with ASD. During follow-up sessions, which included only 24 of the 35 participants, 21 of them had maintained the skills learned during intervention. Seven participants progressed to communicating with more abstract symbols, such as speech, while still maintaining the use of the originally taught symbols. These data suggest that TS might be a viable communication option for children with multiple impairments as a relatively large sample (n= 41) received intervention, and 85% of these participants reached a high level of proficiency with TS, with a few developing more sophisticated symbolic communication skills such as manual sign and speech. However, the lack of any described control conditions throughout the study procedures result in a limited internal validity as it remains unclear whether the increase in participants' performances can be wholly attributed to the procedures implemented during intervention.

In a fourth study evaluating TS, Trief (2007) taught 25 participants, aged from 4 to 16 years, to name activities using a TS communication system. Participants within this study were described as having severe cognitive delays, various physical disabilities, vision impairments, and ten participants were considered completely blind. The TS used were 28 whole objects or parts of whole objects affixed to cardboard squares. Each TS represented a daily activity as part of each individual's routine at school. Results from this study showed that 15 participants learned one to 28 of the TS, with five of these participants learning to independently recognise all 28 activities represented by the tangible symbols. Ten of the total participants however failed to associate any of the tangible symbols with any of the daily activities. Due to ten of the of the 25 participants failing to show any signs of TS acquisition during the whole 12 month intervention period, these data should be considered mixed. Additionally, it was unclear throughout the described methods as to; (a) the determined criteria of symbol acquisition, (b) the specific communication functions that were taught, (c) the specific reinforcement, if any, provided for a correct response. The internal validity of the study is also considered limited as due to the naturalistic study design; the apparent increase in acquisition of TS was difficult to attribute to the teaching procedures. However, 20 of the 25 participants did learn to associate TS with daily school activities, with some learning to use all 28 symbols, therefore this study shows a method of successfully incorporating TS into a school environment.

In another study Lund and Troha (2008) taught three participants, two male, one female, aged from 12 to 17 years old to use 3-D TS which were designed to share features with the referent they represented. The three participants were blind, had severe language delays and cognitive impairment. The study also focused on teaching participants to request preferred items. A multiple baseline across participants design was used. The study adopted an altered PECS strategy, focusing on the first three phases of PECS which included teaching the exchanging of TS, increasing the distance between the user and exchange partner, and discriminating between TS. During the discrimination phase, participants were taught to choose between one TS which represented a preferred item and one distracter symbol. One participant completed all three training phases and reached acquisition in 21 sessions. The two other participants progressed through the intervention and both gained acquisition for the first training phase (exchanging tangible symbols), however, due to time restraints and long acquisition rates, these two participants did not progress to the further two stages. These data indicate that the increase in TS proficiency during intervention can be attributed to the teaching procedures as the study incorporated a multiple baseline design (Kennedy, 2005), and employed an adapted version of a reliable and evidence based teaching protocol (PECS; Bondy & Frost, 2002). In addition, well established instructional strategies, such as response time delay and the least-to-most prompting hierarchy (Duker, Didden, & Sigafoos, 2004), were implemented throughout intervention. While this study demonstrated strong internal validity, the external validity was limited as only three participants received intervention, and each participant was taught to request using only one TS. In light of this, the present study indicates TS as a viable AAC option for children who are blind and have language impairments.

In 2010, Parker, Banda, Davidson and Liu-Gitz taught one 17-year-old female, who was diagnosed with autism and a rare inherited eye disease (Lebers congenital amaurosis), which left her with a severe visual impairment, to request preferred items using TS. The TS were three dimensional, and made of whole or partial objects affixed to laminated cardboard squares. The procedures followed the first five phases of the PECS protocol, specifically; (a) symbol exchange, (b) increased distance between participant and communication partner, (c) symbol discrimination, (d) the construction of multi-symbol requests and the acquisition of new symbols, and (e) a generalisation phase to a familiar environment (her local community shops). In total, the participant acquired 24 TS and was able to independently request preferred items across all five phases of the intervention, reaching a high level of requesting proficiency (70-100%) across all of the 5 phases of PECS. This study extends on the previous studies results (Lund & Troha, 2008) by implementing an adapted PECS protocol to the fifth training phase. The participant successfully created multi-symbol requests to a high level of proficiency and was successful in generalising these learnt skills to other familiar environments. This study however, adopted a sequential intervention design, therefore restricting the internal validity, and as only one participant received intervention, the external validity is also limited. In light of these limitations, these data indicate an immediate increase in TS acquisition from baseline to each subsequent PECS intervention phase, coupled with a high level of TS proficiency which was both maintained and generalised. This study therefore adds further support for the efficacy of the TS system as a viable AAC system for those with visual and language impairments.

In a study conducted by Trief, Cascella, and Bruce (2010), 51 school aged children were encouraged to use 48 TS to name items/activities, label locations, confirm or protest actions and activities, facilitate transitions, and direct the behaviours of others. The participants in this study were reported to have severe intellectual disabilities, were blind or visually impaired, and could communicate using five or less spoken words, signs, or picture-based responses. All referents were relative to the participants' daily schedules at Primary school. The TS used were whole or partial objects and were affixed to cardboard squares. The children participated in this study over a 7-month period. Results indicated that the children acquired 46 of the 48 tangible symbols, and were more likely to use the symbols in naming items and activities. This study appears promising as a large sample (n= 51) of school aged children are described to have been introduced to a large number of TS to communicate within their school context. However, multiple methodological limitations restrict any conclusions drawn from this study as it remains unclear throughout the described procedures what communicative functions the TS introduced in the study were intended for, how each TS was introduced to participants, and the number of TS each of the participants acquired. Additionally, the data collection method relied on self-reports from the trainers, therefore no reliability or procedural integrity checks appeared to have been implemented or described. Due to these limitations, no concrete effects or conclusions can be drawn from these results.

Ali, MacFarland, and Umbreit (2011) investigated TS as a communication option for four participants, three females and one male. Participants were aged between 7 to 14 years and were all described as having moderate cognitive disabilities, were blind or visually impaired. Three of the participants were diagnosed with autism, and the remaining participant was diagnosed with cerebral palsy. All four participants were taught to use 3-D TS which were designed as either whole objects, partial objects, or shared features with the referent they represented. The specific type of TS used was determined by each participant's level of symbolic understanding which was determined by administering each participant the levels of representation pre-test (Rowland & Schweigert, 1990). Participants were taught to request preferred items throughout the study. The study adopted a multiple probe design which was used in baseline and was then followed by intervention, and maintenance sessions. The study adopted an altered PECS protocol, focusing on the first three phases of PECS. Each participant was taught to discriminate between five or six TS which represented desired items, and one TS which represented a non-preferred item during the third phase of the PECS intervention procedure. All four participants reached acquisition, meeting the criteria of 80% response accuracy over 2 consecutive trials for intervention sessions. Each participant progressed to the maintenance sessions where all skills learnt were generalised to other environments. The study described strong experimental control in the form of implementing a multi-probe multiple baseline across participants design (Kennedy, 2005), indicating strong internal validity where the participants performance gains can be attributed to the teaching procedures used. In addition, participants learnt to request from three to six TS and discriminated between symbols for preferred and non-preferred items. These positive results indicate another strong experimentally designed study in support of TS as a successful AAC option for individuals with cognitive and visual impairment.

A final study into the use of TS was conducted by Trief, Bruce and Cascella (2013). These researchers adopted a naturalistic design and introduced 43 students, aged from 3 to 20 years old, to 46 standardised TS over a period of seven months. These students were blind or visually impaired, 91% of students were non-speaking, and 62% of students could not walk un-assisted. An additional 10 students were included as a control group who did not receive intervention or any of the TS. The 43 participants' who did receive intervention, were shown the TS and given an opportunity to use them in labelling activities/items, name people, comment, and to direct others' behaviours. The standardised TS were 7 x 10cm, created from corrugated cardboard, and affixed to white card. The name of the symbol was printed in both text and Braille below the symbol. Each TS represented a daily activity as part of each participant's school routine. Results from this study indicate that in total, participants were able to identify 46% of the TS introduced. A large gain in identification occurred during the first 4 months of intervention where, on average, participants performances increased by 20%. Results showed that symbols representing object and activity naming, preferred item naming, and symbols representing the directing of others' behaviours were the most common symbols identified. Although this study included a control group, the results of the intervention and control group comparison were difficult to interpret as the study implemented two types of tests to determine each participants' symbol knowledge. The control group did not receive the second type of tests to which the intervention group did receive (involving the trainer presenting two symbols to participants, and asking them to *show me* [name of symbol]) and different data was reported on for the second type of testing for the intervention group (i.e., in the first test, the number of students making correct responses was reported, whereas for the second test, the percentage of correct responses was reported). Additionally, it was unclear how the TS were introduced to participants, the number of participants who gained proficiency with TS, how many TS were introduced to each participant and, the communicative functions the TS were used for. These methodological limitations make it difficult to draw any conclusions from the results of this study.

The studies described above collectively provide some evidence that TS communication systems can be successfully taught to children with a range of developmental, physical, and sensory impairments. TS can therefore be viewed as a promising AAC mode that may be indicated for children with ASD. Specifically, the direct perceptual relationship shared between a TS and a referent is suggested to result in a more concrete and realistic symbol. Realistic and concrete symbols might be easier for children with ASD to understand in comparison with less realistic and concrete symbols (Schlosser, 2003), which often share abstract symbol-referent associations. These attributes are suggested to improve the learnability of three dimensional symbols as communication tools in comparison to other visual systems employing 2-D symbols as requesting tools, such as pictures in PE (Koul et al., 2001; Rowland & Schweigert, 2000; Trief et al., 2008). TS can be viewed as a low-tech AAC mode that is flexible and provides sensory stimulation and an iconic symbol for children to actively communicate with. It has also been implied that TS may act as a communication bridge from pre-symbolic to more advanced symbolic communication forms, such as speech (Rowland & Schweigert, 2000; Trief, 2007; Turnell & Carter, 2004; Murray-Branch et al., 1991). Therefore, while a seemingly logical AAC option, an important question to be addressed is whether this system is effective in comparison to another visual AAC system employing 2-dimensional symbols, PE, and whether users will prefer the 3-D tangible symbol system over the 2-D symbol PE system.

However, while promising, there are several limitations in the literature related to the use of TS for individuals with developmental disabilities. Specifically, only a limited number of studies investigating TS systems were located in this literature search, a lack of replication studies decreases the external validity of the results found in this group of studies, and throughout the literature, no studies comparing and contrasting TS with other AAC systems were found. In addition, methodological issues were identified in several of the intervention studies, where a lack of control, baseline procedures, and information regarding acquisition criteria, often made the results and procedures difficult to interpret. Furthermore, none of the studies teaching TS assessed user's preferences for using TS over some other AAC mode, such as PE. System preferences for users of AAC have been suggested to act as a useful method of enabling individuals to make decisions with regard to their own education goals and therapy (Sigafoos, O'Reilly, Ganz, Lancioni, & Schlosser, 2005). Giving these students the opportunity to make choices and have some say in what they prefer, and how they prefer to learn, has been indicated to improve a sense of self-determination in these individuals (Wehmeyer, 2002). The theory of self-determination states that individuals need to be autonomous and competent within their daily lives. Allowing individuals the opportunity to exert control over their lives by making their own decisions can achieve this. One method of encouraging and assessing self-determination within an AAC intervention is to implement preference assessments (Sigafoos, 1998; Sigafoos et al., 2005). Preference can be determined by assessing which system a learner 'chooses' more often, compared to other systems available to them (Sigafoos, 1998). In this way, the learner makes a choice over which communication system he/she wants to communicate with.

In a systematic review, van der Meer et al. (2011) found that individuals with developmental disabilities often indicate a specific preference for using different types of AAC systems. However, the results of this review made light of certain methodological limitations affecting the results. Preference assessments were typically conducted after participants had mastered each communication system, providing no indication of the influential effect preference may have on a learners acquisition of a particular system. Only one study within the review collected preference maintenance data, and in general, only two of the common AAC systems were assessed (SGD and PE, or SGD and manual sign) (Sigafoos, 1998; van der Meer et al., 2011). In a recent series of empirical studies, these specific limitations were addressed (e.g., van der Meer et al., 2012a; 2012b; 2012c). Specifically, PE, SGD systems and manual sign were compared across three dependent variables; the rate of acquisition, system preference, and maintenance. Results from these studies established that PE, SGD, and manual sign can be successfully taught to children with autism and developmental disabilities. System preference assessments were implemented throughout all stages of the studies, including baseline sessions, intervention sessions, post-teaching and follow-up sessions. This allowed each participant's preferences to be assessed while simultaneously learning to independently use each AAC system. By assessing preferences throughout all stages of the study, data was provided on the effect of preference for one particular system on the learners rate of acquisition, whether or not preferences were consistent throughout all phases of the study, and whether preference for one system was maintained during post teaching and follow-up maintenance phases (van der Meer et al., 2012a; 2012b; 2012c). Results showed that preferences had a significant impact on participants' rate of acquisition in that the more preferred options were generally learned quicker and that most children established clear preferences for one AAC system. Preferences, it seems, play an important role in the acquisition of AAC systems and could therefore be seen as an important component of teaching AAC systems to children with autism and developmental disabilities and should be considered when designing and implementing AAC intervention (Son, Sigafoos, O'Reilly, & Lancioni, 2006; van der Meer et al., 2012a; 2012b; 2012c).

Comparing TS, PE, and Direct Selection (DS)

Given that PE and TS both have empirical support and appear promising as AAC modes for children with autism, there would seem to be some value in comparing PE and TS as communication systems. It may also be valuable to compare these two methods with gaining access to preferred stimuli through a more direct method. The latter comparison makes sense when one considers that PE and TS systems are indirect ways of gaining access to preferred stimuli. PE and TS both require a two-step motor process involving the selection of correct 2-D picture or 3-D TS, and exchanging these with a communication partner. A child may however engage in more direct acts to access preferred stimuli, such as by simply reaching out and taking an item. Thus in considering how best to support a child in gaining access to preferred stimuli, it might also be useful to compare PE and TS with a direct selection (DS) method of gaining access to preferred stimuli. Incorporating preference assessments into the training phase and follow-up phase of the present visual AAC comparison study will contribute significantly to the literature regarding the acquisition of two communication systems based on 2-dimensional and 3-dimensional symbols, and will add to the existing AAC literature by shedding more light upon the role of user preferences during AAC intervention.

The Purpose of the Present Study

The purpose of the present study is to compare the two visual AAC systems PE and TS with a method of direct selection. These three methods are to be compared in terms of acquisition and preference for use. That is, which system do children learn the quickest and which system do they prefer (choose) to use? Two boys with ASD and aged 9 and 11 years old were taught to request the continuation of six different cartoon movies on an Apple iPad®. The study used a multiple baseline strategy across participants and followed an A-B-C design where A represented the baseline phase, B represented the intervention phase, and C represented the follow-up phase. Participants were first taught to use all three methods, PE, TS, and DS to gain access to the preferred stimuli until the acquisition criteria of 100% correct independent requests over three consecutive sessions was reached. Once this criterion was achieved, both participants were assessed in follow-up sessions, where procedures resembled baseline sessions. During this phase, participants were given the choice of what system to use, and were assessed on how well they could request using their chosen system. Preference assessments were also conducted throughout baseline sessions and every third intervention session to monitor preferences for the different options (TS, PE, and DS) prior to and during acquisition training and determine whether these preferences remained stable from intervention to the follow-up phase of this study.

This comparison study is both important and necessary as it fills a gap in the literature by providing further evidence that a TS communication system can be effectively taught as a communication system for two children with autism, and compares a 3-dimensional tangible symbol communication system with another visual 2- dimensional AAC system, PE. It is important to compare tangible symbols with other AAC systems in order to contribute to the body of literature regarding effective and functional communication systems for children who fail to develop an appreciable amount of speech. Comparisons of communication systems can aide in the development of communication intervention programmes for children with developmental disabilities and autism by providing further preliminary evidence of the effects on acquisition rates when comparing a 3-D symbol-based communication system with a 2-D picture-based communication system. The information gained from comparison studies helps both practioners and family members who work with these children to decide which AAC system may benefit their child, and therefore what type of intervention to implement whether in the classroom, or at home. This study may offer some information regarding the types of symbol-based communication systems that are available when visual AAC systems are indicated as beneficial AAC systems to teach users, how to potentially teach the use of these systems, and which systems were learnt at a faster rate and preferred by participants. Functional communication is crucial for children with ASD who have acquired no functional communication skills so they may communicate basic needs and wants, exert greater control over their environments by making choices and decisions, and be able to communicate effectively with those at home, school, and within the community. Providing effective research based means of communicating with promising AAC systems is necessary for such individuals.

CHAPTER 2

METHOD

Ethical Clearance and Informed Consent

The present study received ethical approval from Victoria University of Wellington as an amendment to a previously approved study (Ref: SEPP/2011/48-SEPP/2010/92). The relevant university ethics committee at Victoria University of Wellington approved the study procedures and all associated forms. Using these forms, parental consent, teacher consent, and consent from the principals of the children's primary schools were obtained for the two children to participate in the study. Consent was also obtained for the future publication of results (see Appendices A, B, C, and D). Assent from the two participants was not formally obtained due to their lack of language. However, both participants appeared to enjoy the communication sessions and would willingly accompany the first researcher, and other researchers, to the specified intervention rooms.

Participants

The study involved two boys, aged 9:4 and 11:10 (years: months), who met the following criteria; (a) a diagnosis of ASD, (b) children who were less than 15 years of age and whom attended primary school in the Wellington region, (c) very little or no communication skills as evidenced by age equivalency scores of 2.5 years or less on the Expressive Communication Domain of the Vineland Adaptive Behaviour Scales, second edition (Vineland-II, Sparrow et al., 2005), (d) no physical or sensory impairments which could interfere with the use of operating the PE, TS, or using the DS method, and (e) adequate motor skills, such that each participant was capable of operating each of the AAC communication systems. This was also determined through the motor domain of the Vineland-II (Sparrow et al., 2005).

Leroy.

Leroy was 11 years and 10 months old. Leroy's specific age equivalent scores across the three communication domains assessed by the Vineland Adaptive Scale (Vineland-II, Sparrow et al., 2005) were; 4:7 for receptive communication skills (moderately low), 0:8 for expressive communication skills (low), and 5:11 for written communication skills (low). Leroy was reported to have a few spoken words, but he never spoke more than one word during a session. Leroy spent approximately 2 hours per week with a speech language therapist and had a visual schedule to plan his daily routine within his special education unit classroom. For approximately 2 hours of the school day, Leroy would join in with a mainstream classroom of peers his own age. Typically, Leroy would communicate by leading a familiar adult to an object or activity of interest. Leroy was compliant when told to *listen*, *wait, stop,* and *sit down,* but appeared to be very shy when around unfamiliar people. Leroy had no known prior experience with an iPad®, TS or with the PE symbols used in this study.

Max.

Max was 9:4 (years: months) years old and had a diagnosis of ASD. He engaged in severe tantrums and self-injurious behaviours. Max reportedly had a few words however his age equivalency scores on the three communication domains assessed by the Vineland Adaptive Scale (Vineland-II, Sparrow et al., 2005) were; 1:9 for receptive communication skills (low), 1:8 for expressive communication skills (low), and 5:2 for written communication skills (low). In order to express a specific need or want, Max would typically take the hand of a familiar person and lead them to the desired item/object. Max would also vocalise when upset or frustrated. Prior to this study, Max had undergone some PE training, however it is understood that this training appeared to ‘fail’ and so was no longer pursued. Max had no prior experience with iPads® TS nor the PE symbols used in this study.

Setting and Context

The study was conducted within the children’s school environment. The children were seen individually for the one-to-one sessions in the schools’ special education resource rooms. The context was teaching the children to request the continuation of cartoon movies. The procedures were implemented in sessions of 15 to 20 minutes and occurred twice per week in a one-to-one format with the trainer (author) and the student. An Additional observer was present during 30% of the sessions conducted with each student and across each phase of the study. This person independently collected data on students’ responses and the authors’ implementation of the procedures so as to obtain inter-observer agreement and procedural integrity data.

Materials

The materials used in the research study included an Apple iPad®, six cartoon movies, two PE boards, and six individually crafted tangible symbols. Participants watched six cartoon movies on one second generation 16G Apple iPad®. All six movies were identified as reinforcing for both participants after a stimulus preference assessment had been conducted. This involved each participant watching six 3-minute segments of each of the cartoon movies. For each movie, after the 3 minute segment, the trainer paused the movie and asked, *Let me know if you want to watch some more?*. Following this verbal prompt, any reaching, vocalisations, or touching of the iPad was recorded. Based on the results from this assessment, both participants appeared to desire the continuation of each of the six cartoon movies chosen for this study. The six movies had been loaded onto the iPad and were stored in a folder labelled ‘movies’. The trainer accessed the movies for each trial. Six cartoon movies were downloaded from the Apple i-Tunes® media store prior to the research study commencing. The movies chosen included the full feature length films; Shrek, The Bugs Bunny Movie, Finding Nemo, How to Train your Dragon, The SpongeBob Square-pants movie, and Cars. Each cartoon movie was based on one main character and their adventures.

Communication Systems

Two PE boards were used in the research study, one for each of the participants. These boards were made of six individually laminated cards with a picture of the main character from each of the six cartoon movies printed in the centre upon a white back-drop. These pictures represented *Shrek*, *Bugs Bunny*, *Nemo*, *Toothless* (for the movie, *How to Train your Dragon*), *SpongeBob*, and *Lightning McQueen* (for the movie *Cars*). Each card measured approximately 5 x 5 cm. These cards were attached via small Velcro circles to a larger white laminated board measuring approximately 22 x 15cm. Figure 1 shows the PE systems that was used in the study.

Figure 1. PE board and pictures that were used in the present study

Two sets of TS were used in the research study. Each set of TS included six miniature figurines of each main character from the cartoon movies. Every TS was handcrafted from Fimeo®, a plasticene type material which, when baked, becomes solid and shares a similar texture and durability with plastic. Each figurine represented one of the six main characters from the cartoon movies. The figurines were: a miniature Shrek, a rabbit (Bugs Bunny), a red clown fish (Nemo), a black dragon with green eyes (Toothless), a miniature SpongeBob, and a red car resembling lightning McQueen (Cars). The Tangible Symbols ranged in size from 2 - 6 cm in height, 1 - 4 cm in length, and 0.5 - 1 cm in width. Although these symbols were handmade, they were created to resemble the main characters in each movie as closely as possible. Figure 2 shows the TS that was used in the study.

Figure 2. *TS used in the present study.*

Experimental Design

The experimental design involved a combination of a staggered multiple-baseline design across participants and an alternating treatments design (Kennedy, 2005).

The multiple-baseline design provides a way of determining whether there was a functional relation between changes in the dependent variable (increase in correct PE, TS, and DS responses) and introduction of the teaching procedures (independent variable). The alternating treatments design provided a way of comparing acquisition speed across the three methods (i.e., PE, TS, and DS). In addition, preference assessment probes were embedded into the design to determine whether the children chose one system more frequently compared to the other two. If so, it would suggest that that system was more preferred.

Session Configuration

Each session consisted of six trials (i.e., one trial for each of the six movies) and took approximately 15 to 20 minutes to complete. During a session, the participant was given the opportunity to request the continuation of two cartoon movies with PE, another two with TS, and the final two movies using the DS method. The order in which movies were presented and the system that the student used to request/gain continuation of that movie varied randomly across sessions. This configuration remained the same across baseline, intervention and follow-up phases of the study.

Measurement and Definition of Target Behaviours

In the present study, a response was recorded as correct if within 10 sec following the first verbal prompt, the participant selected the play icon on the iPad during a DS trial, selected and handed over the correct TS to the instructor during a TS trial, or selected and handed over the correct picture from the PE board during PE trials. Data was recorded by the primary instructor (the author of this thesis) during all sessions and across all phases. During each session in baseline, the viewing order of each cartoon movie was randomly determined and recorded. Any response from the participant was recorded including reaching, touching of any of the systems, and vocalisations. See Appendix F for an example of a data sheet for baseline sessions. During intervention sessions, the viewing order of the cartoon movies was recorded, and the order that each system was presented throughout a session was also recorded and determined randomly. The system that the child was presented with (i.e., PE, TS, or DS) was counterbalanced across the movies so that each movie was requested with each of the three modes an equal number of times. Participant responses were recorded as 'independent' (i.e., correct), or 'prompted' if the participant did not respond independently within 10 sec after the first verbal prompt.

Procedures

Baseline. During baseline sessions, the participant was seated at a table next to the primary instructor (the author of this thesis). The PE board and TS were within the child's reach, as was the Apple iPad®. The instructor initially said "Here are some movies for you to watch". The instructor then played one of the six cartoon movies, chosen at random, and played this for 1 minute. The movie was then paused and the instructor gave the first verbal prompt, "Let me know if you want to watch more of (insert name of cartoon movie)". This gave the participant the opportunity to request reinstating the movie using the PE system, the TS system, or by the DS response. During baseline, the instructor waited 10 s after giving the verbal prompt and recorded any responses from the participant including; vocalisations, reaching, touching of the PE system, TS or the iPad®. The movie was then reinstated at the end of the 10 s, regardless of the participants' response. These procedures were repeated for each of the six cartoon movies for each session.

Intervention. These procedures used within these sessions were the same as in Baseline, except that one system (i.e., PE, TS, or the iPad) was available for the participant to use for requesting the continuation of two of the six movies during each session. Therefore, one session was made up of six trials. For example, during the first trial of a session, the participant might start by requesting the continuation of *Finding Nemo* with TS. During the next trial, the same participant might have the opportunity to request the continuation of *How to Train your Dragon* with PE. On the third trial, the participant would have the opportunity to push play on the iPad® screen in order to directly select the continuation of the movie *Cars* (i.e., the DS response). The three systems were then available in the same manner for the remaining three movies. The movies were played in a rotation to avoid sequencing effects. If the child did not make a correct response with the available system within 10 s of the instructor providing the initial verbal prompt, "Let me know if you want to watch more of (insert name of cartoon movie)", then the instructor prompted a correct response using the least-to-most prompting strategy (e.g., verbal prompts followed by physical prompting). A verbal prompt involved the instructor repeating the request, "Let me know if you want to watch more (insert cartoon movie name)", or shortening the request by saying, "(Child name) let me know". If this second verbal prompt still failed to elicit a correct response from the participant, the instructor would then take the participants' hand, and assist the child to physically pick up the corresponding picture from the PE board, pick up the corresponding TS, or push the play icon on the iPad® with the participant's finger (i.e., the DS response).

Preference assessments. During a preference assessment, the participant was seated at a table next to the primary instructor. The PE board and TS were placed within the reach of the participant, as was the iPad®. The instructor initially selected a cartoon movie at random and said "We are going to watch (specific movie), You can use the Tangibles, Pictures, or Direct (pointing to each system). Then the trainer says, "What would you like to use? Choose one". The instructor then waited 10 s for the participant to choose a system by pointing or touching one of the systems. For example, if the child touched the iPad®, this was recorded as a DS choice. If a system was chosen, the participant had a further opportunity to request the specific movie on offer with this chosen system, using either TS, PE, or the DS method. If no system was chosen after 10 s, the instructor provided a second verbal prompt to "*Chose a system*" in order to elicit a response from the participant. No further prompting was implemented if the child still did not choose a system, and the movie was played for a further minute. If the participant chose a system, only this system remained on the table, the other two were removed. If the participant chose a system, but failed to correctly request the continuation for the specific cartoon movie on offer, the instructor implemented the least-to-most prompting strategy as used in intervention. Once a preferred system was chosen and used to request more of the cartoon movie, the cartoon movie played for one minute. During these sessions, the placement of each communication system would alternate each time the participant's preference was assessed to avoid placement bias. This preference assessment occurred during baseline and after every third intervention session.

Follow-up. To determine whether participants had retained the skills they had previously acquired to request more of the movies, and to assess their post intervention preferences, a total of eight follow-up sessions were conducted. These sessions were conducted at nine and two weeks after the last intervention session for both children. The procedures were the same as those in the preference assessments, where the child had the choice of choosing one system and then requesting the movie using that system. If the child made an incorrect response after the 10 s pause, by selecting the wrong TS, picture when using PE, or selecting the wrong button on the Apple iPad when using DS, the instructor would repeat the verbal prompt, but would not increase the level of prompting by applying a physical prompt.

Procedural Amendments

During the second session of follow-up, the procedures were altered for Max such that he only had to request for two of the six cartoon movies; *The SpongeBob Square pants movie,* and *How to Train Your Dragon*, as these were the only two movies which remained reinforcing for Max. This amendment was implemented as during the final sessions of intervention, Max appeared to loose interest in four of the six cartoon movies, and these two movies became the only two he preferred to watch. During follow-up, all six cartoon movies still appeared reinforcing for Leroy, so he continued to request all six of the movies.

Inter-observer Agreement

Inter-observer agreement was collected on 30% of the sessions during all phases of the study and for each student. For this, a second observer independently recorded the student's responses on a trial by trial basis. These data were then compared to the data collected by the trainer/primary observer (i.e., the author). When comparing the two sets of data, an agreement was scored if the independent observer and primary observer had recorded exactly the same type of response from the student for that trial. Any discrepancy was recorded as a disagreement. Percentages of agreement were then calculated using the formula: Agreement/(Agreements + Disagreements) x 100. Percentages ranged from 83.3 to 100%.

Procedural Integrity

Procedural Integrity (PI) checks were also conducted by the independent observer to determine whether the procedures were being implemented correctly by the trainer. The checks were carried out on 30% of all sessions across baseline, intervention, preference assessments, and follow-up sessions. The results showed that the trainer correctly implemented the procedures during all of these checks.

Data analysis

Data analysis involved the viewing of the graphed data to ascertain the participants' rate of acquisition and whether they had met criteria for each of the three systems. This involved graphing the collected data on the percentage of correct independent requesting by each participant after every completed session to determine the rate of acquisition for each system, and for each participant during each session. This was completed for each phase of the study. A separate graph was produced to show the distribution of system preference choices during each stage of the study for each participant. Further data analysis was carried out by calculating the percentage of non-overlapping data points (PND; Kennedy, 2005) by comparing the data in baseline phases to the adjacent data of intervention phases. Specifically, PND assesses the percentage of intervention data that shares quantitative values with the data collected during baseline. This calculation gives an indication of the effect size of a participant's performance during intervention compared to the performance seen in baseline. PND is calculated by adding up the number of intervention data points which overlap data points in baseline, calculating this value as a percentage of the total number of intervention trials, then taking this percentage away from 100, to show the non-overlapping data (Kennedy, 2005).

Furthermore, a data table was produced to show trials to criteria where the number of single trials each participant underwent until criteria was met across the two communication systems PE, TS, and the DS method, is displayed. The total number of trials was then tallied for each participant and for each system. This table shows which system required the least and most trials for participants to reach criteria with, and also the total number of trials each participant took to individually reach criteria for all three systems.

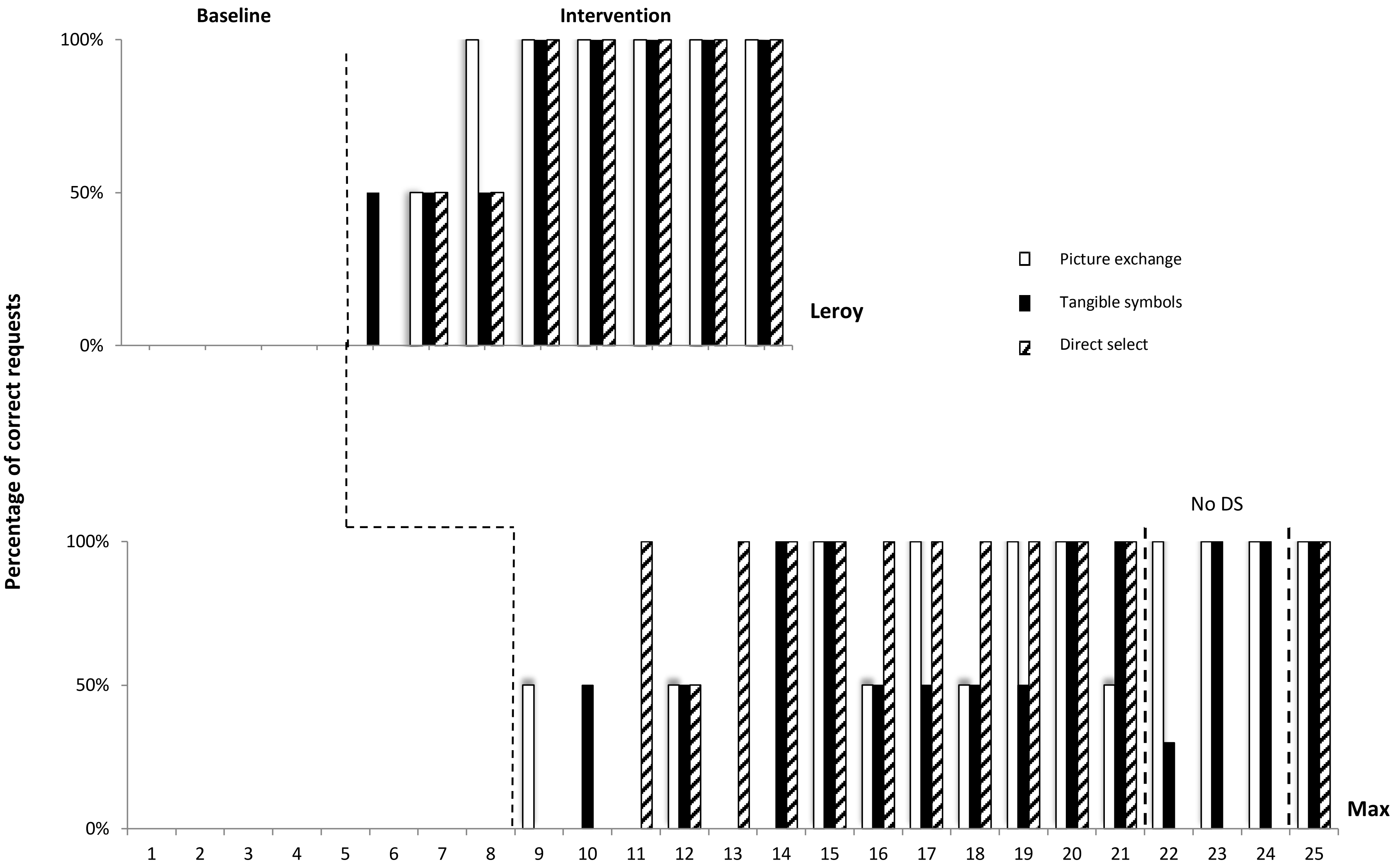
CHAPTER 3

RESULTS

Figure 3 shows the percentage of correct requests for TS, PE, and DS, for Leroy (upper panel), and Max (lower panel), during each session of the baseline and intervention phases. Where there are no graphed data (no bar showing), this means that the participant did not make any independent correct requests.

Results for Leroy: During *Baseline,* Leroy received four baseline sessions where he was given 24 opportunities to request the continuation of each of the six cartoon movies (three opportunities for each cartoon movie) using TS, PE, and DS. During these trials, Leroy never used any of the systems to produce a response. During *Intervention*, Leroy received eight intervention sessions where he was given the opportunity to request with each of the systems a total of 16 times. In total, Leroy received 48 trials where he had the opportunity to request the continuation of the six cartoon movies. During the first intervention session, Leroy produced one independent request for the continuation of the six cartoon movies with TS. During the second session, Leroy produced one request with each of the three systems to continue the cartoon movies. During the third session (trials 13-18), Leroy made two independent requests for the continuation of two of the six cartoon movies independently with PE, and requested one of the movies by using TS and one of the movies by using DS. During the next session, Leroy independently requested all six of the cartoon movies using all three of the systems. Over the following four sessions (24 trials), Leroy continued to request the movies independently with each of the three systems at 100% accuracy.

During *Baseline*, Max received eight sessions where he was given 48 opportunities to request the continuation of the six cartoon movies using PE, TS, or DS. During these trials Max made no requests using any of the three systems. During *Intervention*, Max received 18 sessions where he was given the opportunity to request with PE and TS a total of 39 times, and DS 30 times. Overall, Max received 108 trials across all three systems during intervention. Max reached criteria (100% correct over three consecutive sessions) for DS during the seventh intervention session having been given 14 opportunities. Following acquisition, DS was placed on maintenance from session 15 until the last intervention session, session 18. During these sessions, PE and TS were available to request three of the six cartoon movies during each session as DS was no longer used. Max reached criteria for PE during the 17^{th} session after receiving 35 trials in total for this system. He then reached criteria for tangible symbols in his final intervention session, session 18 after receiving 37 trials in total for this system. During the second follow-up session, the number of movies Max began to watch decreased from six to only two; 'SpongeBob square pants: The movie', and 'How to Train your Dragon'.


Baseline
Intervention
100%
50%
0%
Leroy
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Tangible symbols
Direct select
Percentage of correct requests
No DS
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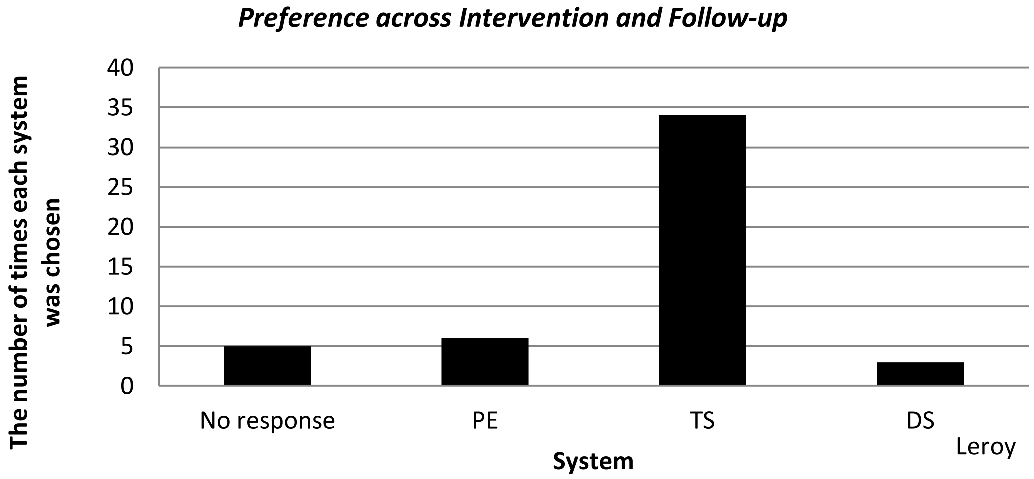
Figure 4 shows the results from the preference assessments conducted during *intervention* and *follow*-up sessions for Leroy (upper graph) and Max (lower graph). It is important to note that the trials during follow-up followed the same procedures as preference assessments. Specifically, Figure 4 shows the total number of times PE, TS, and DS was chosen when the child was given the opportunity to make a choice of systems during the intervention and follow-up sessions. Additionally, it shows on how many assessments (i.e., opportunities to make a system choice) that the participant made no selection/choice. Leroy was given a total of 76 opportunities to choose a system. Twenty-four of these occurred during baseline, four of these in intervention, and 48 of these occurred in follow-up. Max was given 96 opportunities to choose a system. Forty two of these occurred during baseline, six of these during intervention, and 48 of these occurred during follow-up.

During the *Preference assessments* that were conducted in *Baseline*, Leroy did not choose any system when given the opportunity. During *Intervention*, Leroy received a total of four preference assessments, with one assessment conducted after every third intervention session. During these assessments, Leroy chose DS once, and made no selection for the remaining three assessments. During *Follow-up*, Leroy had 48 opportunities to choose between PE, TS, and DS. He chose TS on 34 trials, PE on 6 trials, DS on 3 trials and made no selection on 5 of these trials.

During *Preference Assessments* conducted during *Baseline* with Max, he did not choose a system when given the opportunity. During *Intervention*, Max received a total of six preference assessments, which were implemented after every third intervention session. During these assessments Max chose DS four times, PE once, and made no selection during one assessment. During *Follow-up* sessions, Max had 48 opportunities to make a choice between PE, TS, and DS. He chose TS on 23 trials, PE on 16 trials, DS on 3 trials, and made no selection on 6 of these trials.



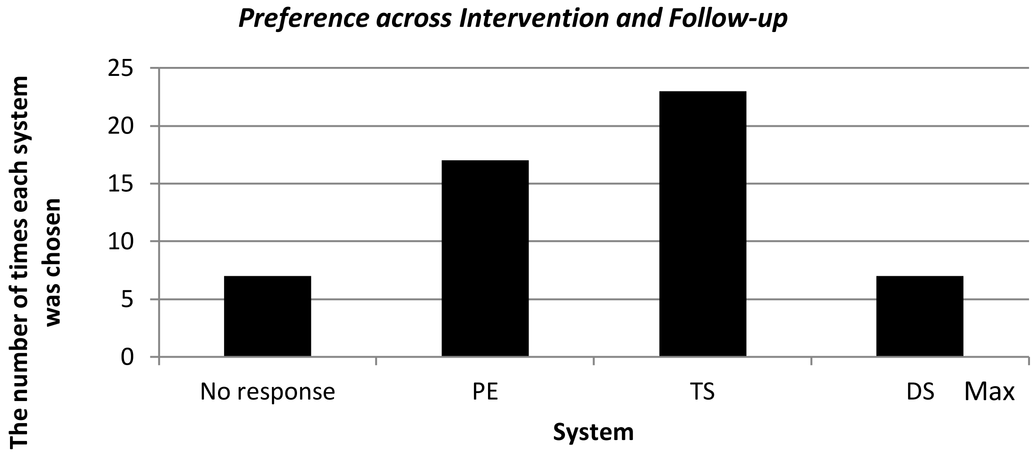


Figure 4. The number of times each system was chosen during preference assessments conducted in the intervention and follow-up sessions.

Table 1 shows the trials to criterion for each participant for PE, TS, and DS. These data came from the intervention sessions only. The acquisition criterion was defined as 100%

correct across three consecutive sessions. Leroy reached acquisition criteria in 10 trials for PE, and in 12 trials for both the TS and DS systems. Max reached acquisition criteria in 35 trials for PE, 37 trials for TS, and 14 trials for DS.

Table 1. The total number of trials required for each participant to reach Criteria for each of the three systems, PE, TS, and DS.

	Systems			
	PE	**TS**	**DS**	***Total***
Leroy	10	12	12	34
Max	35	37	14	86
Total	45	49	26	120

The result of the PND calculations was a PND for Leroy of 91.7% and 83.3% for Max. These results mean that 91.7% of Leroy's intervention data points did not overlap with his data collected during baseline, indicating that Leroy's performance improved during intervention sessions from baseline. For Max, the calculation means that 83.3% of his data points in intervention did not overlap the data collected during his baseline sessions. These high PND scores suggest that the participants' performances improved from baseline with intervention.

CHAPTER 4

Discussion

The present study compared acquisition of, and preference for, PE, TS, and DS as means of gaining access to preferred stimuli. The multiple baseline across participants and alternating treatments design showed faster acquisition of DS for Max, followed by comparable rates of learning for PE and TS. For Leroy, however, PE, TS, and DS were all learned at a comparable (and relatively rapid) rate. From a clinical perspective, one could argue that even with Max, the difference in terms of trials to criteria were not sufficiently large enough to opt for using the DS method over the other two methods. That is, the difference of 14 trials to criterion for DS versus 35 and 37 trials to criterion for PE and TS respectively represent a difference of only about 15 minutes of training time. Thus instead of using trials to criteria, clinicians might consider comparing the results of the preference assessments, where both participants appeared to show a preference for using TS. Although it is important to note that the magnitude of preference for TS versus PE and DS was not as large for Max as it was for Leroy. Thus, Leroy seemed to show a stronger preference for using TS.

The baseline to intervention comparison from the present study suggests a positive intervention main effect in that both participants learnt to request the continuation of six cartoon movies using TS, PE, and DS. This finding was confirmed by the PND calculation and the visible inspection of the graphed data. That is, visual inspection and the PND scores suggest that the intervention was effective in teaching the boys to use PE, TS, and DS because the percentage of correct responses increased only when intervention was introduced and because intervention was introduced in a staggered fashion across the two children, the changes increases in system proficiency from baseline to intervention are more likely attributable to the intervention than to history, maturation, exposure, and/or practice effects (Kennedy, 2005). A limitation however is that the intervention effects were only replicated in two participants, thus caution is necessary in extrapolating the findings to other participants. In light of this, the main finding that the systematic instructional procedures implemented during intervention appeared to be effective in teaching the two participants to gain access to preferred stimuli using TS, PE, and DS is consistent with the results of numerous pervious research showing that similar teaching procedures were effective in teaching responses to enable individuals to access preferred stimuli (Ali et al., 2011; Park et al., 2013; Lund & Troha, 2008; Turnell & Carter, 1994).

The second main findings are to be found in the analysis of results from the preference assessments. Initially, during baseline and intervention, it did not appear as if Leroy had any clear preference for PE versus TS versus DS. Max however appeared to prefer using DS to access the cartoon movies as he chose this system on four of the six preference assessments that he received during intervention. During follow-up sessions, the picture changed for Leroy in that he then seemed to show a preference for TS which he chose on 71% of choice-making opportunities. In comparison, Max showed a slightly less pronounced preference for TS over PE and DS. These data suggest that the children had a strong preference for using TS over PE or DS. This finding is consistent with previous research showing that children with developmental disabilities, including those with ASD, may show a preference for using one AAC system over others. While previous studies have suggested that such preferences may impact upon users (a) rate of learning of the preferred system, and (b) their long term maintenance in use of the preferred system (van der Meer et al., 2011; van der Meer et al., 2012c), these outcomes were not investigated in the present study due to the fact that acquisition was very rapid for both participants and for all three systems, and the fact that long-term maintenance data could not be collected due to the ending of the school year. Overall, because the children appeared to show a preference for using TS over PE and DS, the data suggest that clinicians should try to assess users' preferences for different requesting responses perhaps by using the choice-making paradigm that was implemented in the present study.

Comparing the Present Findings to Previous Literature

These main findings are consistent with the existing literature indicating similar positive effects when teaching AAC to children with ASD and developmental disabilities using systematic teaching procedures (Mirenda, 2001; 2003; Sigafoos et al., 2009; Son et al., 2006; van der Meer et al., 2011; van der Meer et al., 2012b; 2012c). Specifically, previous studies have found that using pictures as a form of communication matches specific characteristics of children with ASD. The system constantly remains within the users view thus requiring only recognition memory (Mirenda, 2003; Quill, 1997), visual stimuli might also be useful in that it has been suggested to better match the visual processing abilities, which are said to be stronger than auditory processing skills in children with ASD (Quill, 1997). Visual stimuli are also said to capitalise on the better form discrimination and object recognition skills of children with ASD (Quill, 1997). This is speculative, but consistent with some data suggesting that the visual basis of systems, such as PE and TS make them viable AAC options for many individuals with ASD and related developmental disabilities (Ganz et al., 2012; Mirenda, 2001; 2003). PE, in particular, has been recommended in part because (a) PE symbols can be tailored to meet individual needs by adopting simple symbols based upon line drawings, (b) photographs can be used to represent specific items/activities, and (c) PE offers clear symbol-referent correspondence (Quill, 1997; Schlosser, 2003). Text often accompanies the pictures used in the PE system, which has been suggested to aide in acquisition and symbol learning for some users, and has been indicated to increase the users' access to the specific meaning given by the pictorial information (Quill, 1997). PE is also often recommended because it is a simple, non-expensive, low tech system which is able to be used within school or home environments, where parents and teachers can implement communicative strategies suited to the individual. The method of communicating with PE demands the user have motor skills capable of selecting a picture, and exchanging this with a communication partner, an achievable task for many on the autism spectrum and those with developmental disabilities. Because PE is an aided system, users need only rely on recognition memory as opposed to recall memory (Mirenda, 2003; Quill, 1997), which has been suggested to place less cognitive demand upon users, allowing those who require simple and more low-tech systems to find success when using PE independently (Ganz et al., 2012; Lancioni et al., 2007; Mirenda, 2001; 2003; van der Meer et al., 2012b; 2012c). In the present study six pictures were created as part of the PE system used. The six PE symbols used in the present study represented each of the six main characters of the six cartoon movies on offer and did not include any written text. The PE system was acquired more rapidly by Leroy in comparison to Max; however both boys learned to request the preferred stimulus to a high level of proficiency during intervention after producing no correct responses during baseline sessions.

Previous studies that have investigated teaching TS communication systems to children with ASD are less numerous than studies investigating PE. The present study extends on previous research and addresses several methodological limitations identified in the TS literature. Firstly, the method of teaching the TS communication exchange used in the present study adopted a similar strategy to that used in several of the existing studies (Ali et al., 2011; Lund & Troha, 2008; Parker et al., 2010; Turner & Carter, 1994). Specifically, 2-D pictures typically used in the PE and PECS (Bondy & Frost, 2002) protocols were replaced with 3-D TS while still following the exchange procedures used in these systems. This method appeared to effectively teach the two participants in this study to use TS to request preferred items, a comparable finding to the previous studies teaching participants to request preferred items and activities (Ali et al., 2011; Lund & Troha, 2008; Parker et al., 2010; Turner & Carter, 1994). The present study also compared the acquisition rates of PE and TS for two participants. The results indicated that acquisition rates of these two systems were comparable for each participant, in that each participant learned PE and TS in a similar number of trials. To date, no other research investigating TS has included comparison analyses of TS acquisition rates with other AAC systems. Preference assessments were also implemented, where the choice-making paradigm (Sigafoos, 1998) was used. Results of these assessments indicated that both participants showed some evidence of a preference for using TS to request. Again, no other research regarding TS has incorporated any form of assessing users system preference into study procedures.

Several methodological limitations identified throughout the existing TS literature were addressed in the methods of the present study. For example, threats to the internal validity of multiple studies investigating TS (Parker et al., 2010; Rowland & Schweigert, 1989; 2000; Trief, 2007; Trief et al., 2010) were the result of; (a) a lack of experimental control (i.e., no baseline phases or, control groups), and (b) lack of rigorous experimental designs (i.e., use of sequential intervention designs or open-trial, naturalistic designs). The multiple baseline across participants coupled with an alternating treatments design (Kennedy, 2005) that was implemented in the present study enabled me to better rule out threats to internal validity that effected many previous studies evaluating TS. This helped to increase the confidence that the increases in system proficiency by each participant could be attributed to the teaching procedures used in intervention. In addition, well established instructional strategies were adopted, including a 10 second time delay and the least-to-most prompting hierarchy (Duker, Didden, Sigafoos, 2004), to promote independent responses from the participants. Inter-rate agreement and procedural integrity checks were also carried out by an independent observer during 30% of all sessions during all three phases in the present study. The results of these checks suggested that data collection was reliable and that the procedures were implemented with fidelity. Furthermore, in previous studies most participants were taught to use and discriminate between from one to three TS (Lund & Troha, 2008; Turnell & Carter, 1994). In the present study, participants were required to discriminate and use six TS to request the continuation of cartoon movies. Arguably, the greater number of symbols users can identify, use correctly, and discriminate between, makes the intervention with symbol-based communication system more functional. However, as only two participants in this study received intervention, the generality of these results are still limited.

With regards to the system preference assessments, the results found in this study are comparative to previous findings from studies investigating the effects of preferences on acquisition rates. Specifically, in a group of three studies conducted by van der Meer et al. (2012a; 2012b; 2012c) which assessed manual sign, SGD, and PE, children with ASD and developmental disabilities were able to establish clear preferences for specific AAC systems. Those participants who reached system acquisition within a fewer number of sessions were more likely to show a preference for the system they had learnt quickest compared with those who took longer to reach system acquisition. Results also demonstrated that these established system preferences remained stable throughout maintenance sessions. In the present study, Max appeared to prefer requesting with the DS method throughout intervention, however he began choosing TS more frequently during follow-up. This may indicate a similar finding to that seen in van der Meer et al. (2012c) where specific inherent features of AAC systems were initially found to be more appealing to users, such as the technological appeal of the iPad® during the early stages of intervention. Following acquisition of multiple AAC systems however, this preference may change as ease of use becomes more important for the user, as opposed to the initial appeal of the system. Additionally, TS was the last system Max reached acquisition with; therefore he may have preferred to use this system during follow-up as this was the latest system Max had mastered. These data show that Leroy preferred TS over PE and DS, and this preference was more pronounced than the TS preference seen from Max's data.

The Specific Teaching Procedures Used and Comparison of Acquisition Rates

The teaching procedures implemented during baseline, intervention, and follow-up have been shown to successfully teach two children with ASD to request the continuation of cartoon movies via PE, TS, and the DS method. Several well established instructional strategies were used throughout this study, and may have contributed to the successful outcome. First, the motivation for each request appeared to be strong due to the fact that the children really seemed to like watching these movies. During every trial, a new part of one of the six cartoon movies was played to participants. Thus the stimulus was changing and progressive, such that participants viewed a new section of the movie which followed the adventures of the main character during every session. The reinforcement value of watching one minute clips of the movies was probably improved in that the child got to view the movie immediately following each correct response. Motivation is a very important determinant of how efficacious an AAC intervention procedure will be. For example, if a participant loses interest in a reinforcer they are being taught to request, they may cease to continue requesting the item altogether. This was seen in previous studies conducted by van der Meer et al. (2011) where an apparent lack of reinforcing stimuli resulted in no acquisition for a particular participant. This failure in van der Meer et al. (2011) would seem to argue for the importance of teaching children to request highly preferred stimuli so as to hold the participant's motivation. In the present study, Leroy seemed thoroughly content to watch all of the cartoon movies for the study entirety, and he seemed eager to see the movies re-started after requesting. In comparison, Max seemed to become more selective in the segments of movie that he wanted to watch. For instance, during the *SpongeBob Square Pants movie*, Max appeared to be frustrated unless watching his favourite part, which was the credits. A similar scenario became apparent during the movie *How to Train your Dragon*, where one part of the movie was most preferred by Max. By the end of the intervention phase, Max only seemed to want to watch *Sponge-Bob* and *How to Train your Dragon*, and then only the specific parts of these movies. Therefore during the second follow-up session, Max only had to request these two cartoon movies with each of the systems.

Within the strict teaching procedures, a constant 10-second time delay was implemented immediately following the initial verbal prompt (Duker, et al., 2004). During this time, the child was provided with an opportunity to request the continuation of one of the six cartoon movies. This type of time delay procedure is often used in AAC interventions when teaching individuals with ASD and related disabilities (Sigafoos et al., 2005; van der Meer et al., 2011) and could be seen as serving three main functions. First it allows an extended period of time for the user to process the initial verbal prompt. Second, it might indicate to the user that they are expected to produce a response. And third, it might increase the frequency of independent responses by enabling trainers to fade prompting (Duker et al., 2004). The time delay used in my intervention was implemented until the participants had reached a high level of proficiency with each targeted AAC system, PE and TS, at which time they began to produce independent requests for the continuation of the cartoon movies following the initial verbal prompt, whereby the time delay was no longer necessary.

In addition to a constant time delay of 10 seconds, the least-to-most prompting strategy was implemented during intervention phases. This prompting strategy is a common prompting hierarchy used in AAC intervention studies as it is a relatively simple procedure to implement, and allows the learner a greater number of opportunities in which to respond

(Duker et al., 2004). Additionally, this procedure can result in an increased frequency of errors as the user is only aided once several levels of prompting strategies have been exhausted. In the present study, the strategy implemented when participants produced an incorrect response initially involved providing a verbal prompt, followed by a second verbal prompt which included the verbal labelling and pointing to the correct symbol/ DS response. Finally, the participant was physically aided to produce a correct response, both picking up and exchanging the correct TS, or PE picture, or pushing play on the iPad (DS response). In this way, the participants were given several opportunities for independent requesting prior to being physically prompted to produce the required response.

The participants within the present study were only taught to make simple requests where handing over the correct picture or TS of the corresponding cartoon character indicated the request for the continuation of the cartoon movie on offer. During the trials focusing on DS, the participant was required to correctly activate the ‘play’ icon on the iPad in order to continue the movie independently. Arguably, the simplicity of the procedures implemented within this study may have contributed to the successful teaching outcome. Another factor which may have influenced the positive result was the relation (rapport) formed between the participants and me as the trainer. Verbal and gestural (i.e., high-five) consequences were given after every trial and request made. Both participants appeared to enjoy these consequences, as well as watching the movies, and they also appeared satisfied and proud when reinforced on making a correct request. As a trainer who works closely with children diagnosed with ASD or developmental disabilities, you learn to understand and respond appropriately when they are frustrated, angry, sad, or excited. Once you can understand the signals indicating these emotions you can either achieve more within one session, or end a session early. Positive relationships are important factors in determining the outcome of an

AAC intervention as if a child does not enjoy the task or the person who is teaching them, it is unlikely they will be motivated or willing to learn.

Both participants were taught to request each of the three modes following these instructional strategies. Leroy learned to use PE, TS, and the DS method at a faster rate than Max. The reasons for the two differing acquisition rates may be explained in terms of reinforcement. That is, Leroy seemed to enjoy watching all six of the cartoon movies more so than Max. Still, acquisition for both boys was relatively rapid, suggesting that the movies were effective reinforcers for both boys and that the responses being taught were relatively easy for me to teach. For PE and TS, the rapid learning might have something to do with the use of the PE pictures, and TS symbols that seemed to be very concrete representations of the referents. A limitation is that the concreteness of the PE and TS symbols was not directly assessed nor controlled. Still, the possibility that concrete symbols may ease learning is consistent with previous research suggesting that children with ASD and related developmental disabilities perform better with highly concrete AAC symbols (Bruce, 2005; Koul et al., 2001; Schlosser, 2003).

Interestingly, Max reached acquisition more quickly with DS than PE or TS. This suggests that a directly effective response (DS) is easier for me to teach, or easier for Max to learn than the more indirect (listener mediated) communication responses that are inherent in using PE or TS. This possible explanation is consistent with Skinner's (1957) distinction between verbal behaviour, which is listener mediated, and non-verbal behaviour, which is directly effective on the environment. Arguably by independently reinstating the cartoon movies via the DS method, Max's response was directly and more immediately reinforced, which may have facilitated acquisition. Max might have also learned the DS response quicker because it did not require as much stimulus discrimination, that is, although there was some discrimination required in selecting the play icon from the other icons on the iPad® (e.g., fast forward and rewind), this might have been seen as easier than discriminating between six different PE pictures and six different TS to make a correct response. Of course, Max did eventually learn to use the PE and TS systems to make correct requests and so he did learn to make these seemingly more complex discriminations. Perhaps once Max had learned the association between the 3-D symbol and the cartoon character referent, the symbol might have became more realistic and concrete representations for the movies. It may also be possible that throughout the intervention, Max further developed his understanding of symbolism, and developed the association that both 2-D and 3-D symbols can represent the reinstating of cartoon movies by representing the unique main characters in the cartoon movies. This possibility is consistent with previous research suggesting symbolic understanding can be taught to children with ASD and developmental disabilities (Charman et al., 2003; Yoshinaga-Itano et al., 1999), and that a basic symbolic understanding is crucial for children to learn to functionally communicate with visual AAC systems (Dijk, 1986; Koul et al., 2001; Quill, 1997; Schlosser, 2003).

Additionally, previous findings suggest that the facilitation of symbol learning is positively influenced by the combination of verbal labelling and visual presentation of information (Koul et al., 2001; Mirenda & Brown, 2009; Quill, 1997; Schlosser & Sigafoos, 2006), a finding relevant to the results of this study as both verbal feedback and verbal labelling of each symbol was executed during the present study whenever a participant produced an incorrect response, no response, and immediately following a correct response. This may have assisted Max and Leroy to further develop a concrete association between the symbol and referent. Early research has also illustrated the importance of structure, consistency, and stability when designing and implementing AAC intervention for participants with ASD especially (Mirenda & Brown, 2009). Offering users the opportunity to be able to predict a future event may be a crucial component for an AAC intervention to be successful. In the present study, participants were aware of what would be expected of them during each session as it was verbally explained to them upon beginning a session and as the intervention was implemented. In this way, both participants became accustomed to the structured procedures and could predict what would occur during subsequent sessions. Thus the successful outcome indicated in the present study suggests that; (a) both participants responded well to the instructional strategies implemented during intervention, (b) both participants responded well to the visual symbol-based communication systems taught during intervention, and, (c) the setting where each phase of the study was conducted appeared to suit each participant and may have facilitated their learning.

Educational Implications

Results from the present study suggest that PE, DS, and TS are all comparably effective ways for children with ASD to request/access preferred stimuli. However, of the three, the children seemed to show a preference for using TS. It is not clear why the children seemed to prefer using TS, but the implication is that such systems might be considered as a possible alternative to PE or DS. The TS used in this study were handmade by the author of this thesis from a product called Fimeo® a type of plasticene which, once oven baked, shares similar qualities and texture to plastic, resulting in a durable and relatively in-expensive communication system. The play element in this communication method may be more appealing to a wider range of children and provide an effective system for teachers and parents to use with young children who require a functional substitute for speech. Previous research has also demonstrated that use of this system to a high level of proficiency can aide in extending some children's' symbolic understanding. Furthermore, this system may act as a bridge to the further development of more advanced symbolic communication, such as sign language or speech, for some users (Rowland & Schweigert, 2000).

Previous research indicates that preference assessments are important components of an effective AAC intervention and should be considered by practioners when designing and implementing AAC study. User preferences for different AAC systems might be seen as a priority type of assessment to help in deciding which system to develop for a child. Such assessments may be one way to promote self-determination in AAC intervention. In order to satisfy the need to be both competent and autonomous throughout daily living for individuals with developmental disabilities who require AAC, it has been suggested that providing choices throughout communication interventions for users may promote feelings of autonomy in their education decisions. In achieving this, users will effectively decide what system they will communicate with, and how they will communicate (Sigafoos, 1998; Sigafoos et al., 2005). One method of enabling users to make such choices and subsequently promoting self determination is to implement the choice making paradigm (preference assessments) throughout an AAC intervention study. Preference may be used as a term to describe something an individual enjoys and is interested in. Therefore when an individual is engaged with such an activity or system, they typically perform at a higher level of proficiency as they are intrinsically motivated to use the system (Sigafoos et al., 2005; van der Meer et al., 2011; van der Meer et al., 2012). In the present study, preference assessments indicated that both participants chose to request more frequently by using the TS, although the degree of preference was stronger for Leroy than Max. Preferences in the present study should be considered, as acquisition rates of PE and TS were comparable for both participants, thus preference data provided the only point of difference between the two communication systems. This research contributes to the growing body of literature which indicates that determining a user’s communication system preference may have a significant impact on their rate of learning and on the maintenance of system preferences and system use in the long term (Sigafoos et al., 2005; van der Meer et al., 2012b; 2012c).

Implications for Parents and Teachers

Findings from the present study may be helpful for parents/caregivers and teachers who seek new communication intervention ideas for children who struggle to master the more common picture-based AAC systems. In some cases, picture-based communication systems may be inappropriate for particular children. These systems often use 2-D symbols which some users may struggle to associate with certain referents, due to the lack of concreteness and un-realistic nature of the picture symbols. SGDs may also prove to be inappropriate for some children due to the fine motor control needed to successfully select the icons, and activate the synthesised speech. These systems (iPads or iPods) can also be costly to purchase and setting these up with the correct speech producing software adds further cost. In such cases, three dimensional TS may provide a cheaper, more concrete, and realistic solution for these children and their families. By providing additional research based information on AAC systems, parents and teachers have a wider range of options to try at home or in the classroom. Additionally, the findings from the present study indicate the importance of communication system preferences for users of AAC. As has been established through the literature, it is important to create conditions under which an AAC user will find success, and in order to create such conditions, parents, teachers, and any party interested in teaching AAC to users must attempt to match the specific learning styles and characteristics of their children or students to AAC systems when designing and implementing AAC intervention (Quill, 1997). Preference assessments adopting the choice-making paradigm may aide in selecting AAC systems which help create these conditions. As, if a child prefers one system over another after they have reached a high level of proficiency with a number of different systems, it is likely that this system will (a) be intrinsically motivating for that student to continue developing and expanding their communication skills and, (b) be maintained over a longer period of time (Sigafoos, 1998; Sigafoos et al., 2005; van der Meer et al., 2012c).

Study Limitations

Several methodological issues limit the findings from the present AAC intervention study. Specifically, the external validity of the present study is weak as only two boys diagnosed with ASD received intervention. For the results from this study to be generalised to the greater population of children with ASD, a larger sample size is required. The small sample size was due to a limited time period for recruitment and a limited area for researchers to recruit from, as travel was a restricting factor. Originally the study was planned to include an extra female participant, however this participant was withdrawn from the study due to unforeseen circumstances. Therefore the results acquired from the present study should be extrapolated with caution, as they are preliminary findings and add further support for TS as a viable AAC system for children with ASD whom have failed to develop speech.

The demand placed upon the participants within the present study focused purely on simple requesting behaviours. Both participants were taught to produce a simple two-step request with two symbol-based communication systems. By only teaching the participants to produce these simple requests, the findings from this study are limited as the communicative functions represented by these TS constitute the very basic communication skill of requesting. In order for this system to be deemed functional, the communicative function of the TS would need to be expanded such that more sophisticated communication exchanges could be produced. Teaching procedures followed systematic ABA strategies during all three phases of the study (baseline, intervention, and follow-up), and were implemented in small rooms associated with each participant's special education unit in their mainstream primary schools. These rooms were quiet and void of any distractions, having only a table and few chairs, and only ever, at the maximum, three researchers and the participant in the room. Under these conditions, the participants were given one-on-one training and the full attention of the trainer. This teaching system and teaching environment is difficult to generalise as it is very dissimilar from the participant's everyday school environment where they are expected to participate in group activities and learn alongside over a dozen peers.

Therefore, a major limitation of this study is the lack of generality of these results to the greater population of individuals with ASD, to other communication tasks or demands the participants may be faced with during daily interactions, and to other environments. In addition, the present study failed to complete a long term follow-up phase after the follow-up sessions had ceased. Long term follow-up may have provided important information regarding the participant's maintenance of learnt skills, their system preference consistency or alterations, and whether the learnt skills were useful for functional communication during their daily lives. Furthermore, during this study preference assessments during intervention were only carried out after every third session. It seems necessary to incorporate more preference assessments into the intervention phase to have allowed each participant to have increased opportunities to clearly establish a system preference. One further limitation was the fact that the two communication systems and the direct select method of gaining access to the preferred stimulus were not functionally equal. When implementing a comparison AAC intervention study, the lack of functional equivalence across the compared systems may negatively impact the study results (Schlosser, 2003).

Future Research

Given these limitations, the present study has demonstrated a successful experimentally designed communication intervention comparing TS with PE and a DS method of accessing preferred stimuli using well established replicable instructional strategies. Future research should address some of the limiting factors described for the present study. For instance, the generality of the findings would be greatly improved by future studies assessing larger sample sizes, and incorporating a generalisation phase, such as system generalisation (where participants request items which were not taught during intervention), or environmental generalisation (where sessions are implemented within novel environments to the intervention). The overall goal of AAC intervention is to provide a method by which children with no speech may communicate in a functional way. In order to accomplish this, future research might assess teaching two step requesting with TS to determine whether this system could provide a method for more complex communication. Expanding the repertoire of communication tasks using TS may further the functionality of the system.

It is interesting to note that although the iconicity, concreteness, and/or realism of the PE or TS symbols was not directly assessed in this study, the two symbol-based communication systems were created with a varying degree of iconicity. Visually, the 2-D symbols from the PE system shared a greater degree of iconicity with the cartoon character referents in the movies, in comparison to the TS. The 2-D symbols were exact pictures of the characters whereas the 3-D TS were hand crafted by the author, resulting in 3-D symbols that were non-identical to the characters. However, physically it could be argued that the TS were a more concrete and realistic representation of the cartoon characters as they shared a 3 dimensional association with the referents, could be personified by users, and were similar to toy figurines. Both symbols were learnt by each participant at a similar rate; however the TS were more preferred. It would be interesting to identify the particular features of symbols, for instance concreteness, realism, and iconicity, which have the greatest impact upon both acquisition rates and preferences for children who are taught to communicate with different symbol systems. In this study, it seems that the concreteness of a symbol may influence preference, but did not appear to influence acquisition.

Conclusion

Overall, the present study provides positive results in that both boys learned to use PE, TS, and the DS method to request/access preferred stimuli. The choice-making assessments also seemed to effectively reveal that both boys seemed to prefer using TS compared to PE and DS. Thus, TS seemed to be the more promising AAC system for these two boys. The effect of teaching a 2 dimensional based symbol system compared to teaching a 3 dimensional based symbol system did not appear to result in differing acquisition rates for each participant, although one participant acquired both systems at a faster rate. Well established instructional strategies used, which have proven to result in successful outcomes, were implemented in the present study. By adopting these principles, the study successfully taught two children to communicate with two different AAC modes and to directly select a preferred stimulus independently, in a manner that could be easily replicated by a parent, teacher, or researcher interested in testing the results themselves. Both participants were shown to prefer selecting the TS to request the continuation of the cartoon movies, however only one participant showed a preference during intervention sessions, while the second participant only established this system preference during follow-up sessions. Preferences as indicated by the data are identified to be the only point of difference between the two symbol-based systems for the two participants, as acquisition rates showed comparable rates of learning. Preference data from the present study add to the growing body of literature promoting the importance of these assessments for AAC users and for the suggestion that clinicians may be more successful when implementing AAC interventions when preference data, in addition to acquisition data, are considered when selecting which AAC systems are to be further developed. Arguably, if AAC was to continue for the two participants within the present study, the selection of expanding and developing the communicative function of the TS system would seem appropriate.

Although future research could improve on specific limitations highlighted within this study, overall this successful communication intervention has shown two young boys and their primary school teachers a further method of successfully requesting preferred items, and has provided two mute young boys with an intervention teaching them an effective and alternative communication method for speech. Future research could expand the communicative function of TS, analyse the specific features of symbols which aide in acquisition and preferences, and potentially illustrate specific characteristics of AAC users which may benefit from particular types of visual AAC systems, and how best to teach these such that they may be maintained as a functional substitute for speech.

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Appendix A

Ethical amendment form for the present study

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

FACULTY OF EDUCATION TE WHĀNAU O AKO PAI

DONALD STREET PO Box 17 310, Karori 6147, Wellington, New Zealand
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27 June 2011

Jeff Sigafoos
Victoria University of Wellington Faculty of Education
C/- School of Educational Psychology and Pedagogy
Donald Street
Wellington

Dear Jeff

RE: Ethics application SEPP/2011/48 Addendum(2) to: SEPP/2010/92

RM 18095

I am pleased to advise you that your ethics application **Addendum (2) to: 'Enhancing communication Intervention for Children with Autism'**, with the required changes, has been approved by the Victoria University of Wellington Faculty of Education Ethics Committee.

Best wishes for your research.

Yours Sincerely

J. A. Loveridge

Dr Judith Loveridge

Co-Convener
Victoria University of Wellington Faculty of Education Ethics Committee

Appendix B

Parental consent form

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

FACULTY OF EDUCATION

CONSENT FORM FOR PARENTS

Project Title: Enhancing Communication Intervention for Children with Autism

This research has been assessed and approved by Victoria University Faculty of Education Ethics Committee (Reference Number SEPP/2010/92 RM 18095).

Please tick each of the boxes and sign the form to indicate your agreement with the statements below and your consent for your child and yourself to participate in this research.

1 I have read and understood the Information Sheet for this study. ⑥

2 I understand the nature of my involvement and the nature of my child's involvement in this project. ⑥

3 I understand that the investigators do not foresee any potential physical, psychological, social, legal, or other risks to me or my child as a result of participating in this study. ⑥

4 I understand that all research data will be securely stored at Victoria University of Wellington and/or the University of Canterbury premises for at least five years, and will be destroyed when no longer required. ⑥

5 Any questions that I have asked have been answered to my satisfaction. ⑥

6 I agree that research data gathered for the study may be published provided that my own and my child's identity is not disclosed ⑥

7 I understand that my identity, and my child's identity, will not be disclosed in any publications stemming from this research. ⑥

8 I understand that I will receive feedback on my child's progress and that I can request additional feedback at any time. ⑥

9 I agree to allow my child to participate in this investigation and understand that I may withdraw my permission at any time without any negative effect. I can also withdraw any data that has been collected about my child at any time prior to the publication of that data. ⑥

10 I agree to participate in the questionnaire at the end of the study, which consists of questions related to my preferences and opinions relative to the three different modes of communication that were taught to my child. I understand that I may withdraw my consent for this at any time without any negative effect. I can also withdraw any data that has been collected on the questionnaire and any information that I have provided about my child at any time prior to the publication of that data. ⑥

11 It is possible that you might not want to participate in the questionnaire at the end of the study, but that you would still like your child to participate in the research. If this is the case, you can tick this box: ⑥

12 It is possible that you might not want to your child to participate in the research, but that you would still like to complete the questionnaire. If this is the case, you can tick this box: ⑥

Parent Names/Contact Details Name of Child

____

Parent Signatures Date

____

Appendix C

Principal consent form

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

FACULTY OF EDUCATION

CONSENT FORM FOR PRINCIPALS

Project Title: Enhancing Communication Intervention for Children with Autism

This research has been assessed and approved by Victoria University Faculty of Education Ethics Committee (Reference Number SEPP/2010/92 RM 18095).

To indicate your agreement with each statement below, please tick the corresponding box.

❑ I have read and understood the Information Sheet for this study.

❑ I understand the nature of my involvement and the nature of each student's involvement in this project.

❑ I understand that the investigators do not foresee any potential physical, psychological, social, legal, or other risks to me, the teacher, or the participating students as a result of participating in this study.

❑ I understand that all research data will be securely stored at Victoria University of Wellington and/or the University of Canterbury premises for at least five years, and will be destroyed when no longer required.

❑ Any questions that I have asked have been answered to my satisfaction.

❑ I agree that research data gathered for the study may be published provided that my identity and that of the teacher and the school, is not disclosed.

❑ I understand that the parents' and students' identity and the teachers' and the schools' identity, will not be disclosed in any publications stemming from this research.

❑ I understand that the school will receive feedback on each student's progress and that I can request additional feedback at any time.

❑ I agree to allow this investigation to occur in the school and understand that I may withdraw my permission at any time without any negative effect.

Principal's Name/Contact Details Name of School

Principal Signature Date

Please return this Consent Form in the envelope provided. Thank you.

Appendix D

Teacher consent form

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

FACULTY OF EDUCATION

CONSENT FORM FOR TEACHERS

Project Title: Enhancing Communication Intervention for Children with Autism

This research has been assessed and approved by Victoria University Faculty of Education Ethics Committee (Reference Number SEPP/2010/92 RM 18095).

To indicate your agreement with each statement below, please tick the corresponding box.

- ❑ I have read and understood the Information Sheet for this study.
- ❑ I understand the nature of my involvement and the nature of each student's involvement in this project.
- ❑ I understand that the investigators do not foresee any potential physical, psychological, social, legal, or other risks to me, the principal, or the participating students as a result of participating in this study.
- ❑ I understand that all research data will be securely stored at Victoria University of Wellington and/or the University of Canterbury premises for at least five years, and will be destroyed when no longer required.
- ❑ Any questions that I have asked have been answered to my satisfaction.
- ❑ I agree that research data gathered for the study may be published provided that my identity and that of the principal and the school, is not disclosed.

- ❑ I understand that the parents' and students' identity and the principals' and the schools' identity, will not be disclosed in any publications stemming from this research.

- ❑ I understand that the school will receive feedback on each student's progress and that I can request additional feedback at any time.

- ❑ I agree to allow this investigation to occur in my classroom and understand that I may withdraw my permission at any time without any negative effect.

Teacher's Name/Contact Details Name of School

Teacher Signature Date

Please return this Consent Form in the envelope provided. Thank you.

Appendix E

Example of the PE and TS systems

Figure 1. PE board and pictures that were used in the present study

Figure 2. TS used in the present study.

Appendix F

Data sheets for baseline, intervention, and follow-up phases of the present study

Baseline

Child_______________ Observer_____________ P/I Date________ Session_____

Order	Correct response	
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4

1. Sit down at the table with the child and watch 1minute of the first movie. After 1minute, say "Let me know if you would like to watch some more of (movie)".
2. Time for 10 seconds recording any action the child makes within the 10second period.
3. After 10 seconds, regardless of any correct requests from the child, play 1 minute of the movie.
4. End the movie, bring up the screen for the next movie and repeat above steps.

Child_______________ Observer______________ P/I Date_____ Session______

order	Correct response	
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4

1. Sit down at the table with the child and watch 1minute of the first movie. After 1minute say "Let me know if you would like to watch some more of (movie)".
2. Time for 10 seconds recording any action the child makes within the 10second period.
3. After 10 seconds, regardless of any correct requests from the child, play 1 minute of the movie.
4. End the movie, bring up the screen for the next movie and repeat above steps.

Intervention

Child_______________ Observer______________ P/I Date_____ Session______

Order	Response	Device	PI
Cars	+ / -		1 2 3 4 5
Shrek	+ / -		1 2 3 4 5
Bugs	+ / -		1 2 3 4 5
Dragon	+ / -		1 2 3 4 5
Nemo	+ / -		1 2 3 4 5
S'Bob	+ / -		1 2 3 4 5

1. Sit down at the table with the child, say "I have some movies to watch". Watch 1 min of first movie.
2. Pause movie after 1 min. Prompt child, "Let me know if you want to watch more_______". Time for 10 s.
3. Within the 10 s, if the child requests the movie correctly (giving the correct TS/ picture/ pushes play directly), immediately restart the movie and provide verbal reinforcement. If child makes an incorrect request (requests wrong movie), or makes no response, implement least-to-most prompting, in order for child to make correct request.
4. Play 1 min more of the cartoon movie, even if child was prompted. Record any behaviour from child.
5. Repeat all steps for all 6 cartoon movies.

Preference:

Request	PE	TS	DS	PI
+ / -	+ / -	+ / -	+ / -	1 2 3 4

1. At the end of every 3rd intervention session, lay all 3 devices out I front of child within arms reach.
2. Point to and label each of the devices, then say "What would you like to use? Choose one". Time for 10 s and record whether the child selects/touches one of the devices.
3. If child chooses a device, leave only this device on the table and say, "let me know if you would like to watch more of______"(Randomly selected movie). Time for 10 s. Use least-to-most prompting if child uses chosen device incorrectly, then play 1 min of movie.
4. If child does not choose a device, play 1 min of movie regardless, do not prompt a 'choice'.

Follow-up

Child_______________ Observer_____________ P/I Date________ Session_____

Order	Correct response	
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4

5. Sit down at the table with the child and watch 1minute of the first movie. After 1minute, say “Let me know if you would like to watch some more of (movie)”.
6. Time for 10 seconds recording any action the child makes within the 10second period.
7. After 10 seconds, regardless of any correct requests from the child, play 1 minute of the movie.
8. End the movie, bring up the screen for the next movie and repeat above steps.

Child_______________ Observer______________ P/I Date_____ Session______

order	Correct response	
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
	N P T I	1 2 3 4
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