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Augmentative and alternative communication for children with autism spectrum disorder: An evidence-based evaluation of the Language Acquisition through Motor Planning (LAMP) programme

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Abstract: Children diagnosed with autism spectrum disorder often have restricted verbal communication. For children who do not use functional speech, augmentative and alternative communication (AAC) devices can be an important support. We evaluated the effectiveness of one AAC programme, the Language Acquisition through Motor Planning (LAMP) using a Vantage Lite™ device as the speech output in the home and school environments. Eight children with limited communication were assessed by a speech pathologist prior to the introduction of the programme, after five weeks of training and again after a further two weeks of use of the programme, but without the supported training. The pre-/post-assessment measures revealed that all eight children made gains in the development of spontaneous communication using the device during the implementation period. Parents and teachers also reported that the gains achieved during the five-week trial were

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Susan Bruck is the Aspect Practice Research Officer at Autism Spectrum Australia (Aspect). Susan's research focuses on improving client outcomes through evidence-based evaluations of interventions, support devices and programmes

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PUBLIC INTEREST STATEMENT

Children who have autism spectrum disorder often have difficulty communicating. Some children are unable to communicate in order to get their needs met. For these children, there are a range of methods to help them communicate. In this study, we looked at one of these methods, a computerised speech production device (Vantage Lite™) and the Language Acquisition through Motor Planning (LAMP) programme. Eight children were assessed by a speech pathologist at the beginning of the study and again at the end. During the study, the children were taught how to use the LAMP programme to communicate at home and at school. The results showed that children who used this programme for five weeks increased the number of words they used to communicate.

greater than those achieved in previous interventions. Two years after the completion of the study, a follow-up phone interview was completed which identified that children who received ongoing support from a LAMP-trained speech pathologist continued using the LAMP programme. As a result of this study, a specialised LAMP-specific classroom was established in one of the participating schools.

Subjects: Autism; Autism & Aspergers; Autism & Aspergers in Children & Adolescents; Inclusion and Special Educational Needs; Teaching Practice - Education; Technology in Education

Keywords: augmentative and alternative communication (AAC); autism spectrum disorder (ASD); evidence-based practice (EBP)

1. Introduction

Autism spectrum disorder (ASD) is characterised by persistent deficits in social communication, social interaction and restricted repetitive patterns of behaviour (American Psychiatric Association, 2013), and it is estimated that between 30 and 50% of individuals with ASD, do not use functional speech (Lord & Paul, 1997; Lord, Risi, & Pickles, 2004). There is evidence to suggest that augmentative and alternative communication (AAC) can improve the quality of life by supporting children who are diagnosed with ASD and are non-verbal, to increase their communication (Ennis-Cole, 2015; Ganz et al., 2012; Lubas, Mitchell, & De Leo, 2014; Sigafoos, O'Reilly, Lancioni, & Sutherland, 2014). Recent advances in AAC technology have provided options that are more portable, lightweight and produce speech output with the touch of a few keys. In this study, we investigate the longitudinal effectiveness of using an AAC device to advance the motivation and independence of eight children in communicating and socially interacting within their school and home environments.

2. Background

There are several effective AAC approaches available. Some methods do not need supplementary supports and these are known as natural communication methods. These include non-verbal communication such as pointing, gesturing, mime, body language and facial expressions. Auslan Sign Language or Key Word Sign (Goldstein, 2002) is an example of a formalised natural communication system that can support communication. Other forms of AAC use visual symbolic systems that require a hand or pointer device to be used with a communication board, book, photo or symbol chart (Bondy & Frost, 1994). Although these are useful for able-bodied individuals, they have an inherent accessibility problem for people who have limited mobility (Lord & McGee, 2001).

AAC technology, with built-in speech generating capacity, has the capacity to deliver independence for spontaneous expression (Topia & Hocking, 2012). Several technologies are available, including some communication devices that have specific keys that relate to set words whilst others use typing boards to spell out and "say" messages. These devices can, however, have a limited vocabulary and restricted accessibility due to the need to remember where particular words are on different screens and for people with restricted mobility it can be difficult to manoeuvre around the device.

Autism Spectrum Australia (Aspect) is the nation's largest multi-service provider for people with ASD. In addition to early intervention and diagnostic services, adolescent and adult programmes, and life support facilities, Aspect provides school education to more than 1,000 students through eight schools and satellite classes in mainstream schools. Aspect uses a variety of evidence-based classroom and teaching strategies to maintain a learning environment that minimises stress and encourages independence (Bennett, Reichow, & Wolery, 2011; Hume, Loftin, & Lantz, 2009).

Motivation and independence are fundamental to the progression of a child's communication ability (Koegel, Matos-Freden, Lang, & Koegel, 2012). Structured teaching is a systematic educational theory that incorporates environmental considerations into a child's education through making the learning

setting understandable and suitable for the student's needs (Mesibov, Shea, & Schopler, 2004). Structured teaching is a central component in the Aspect Comprehensive Approach for Education (Aspect, 2015) curriculum and teaching approach.

The Aspect Comprehensive Approach for Education (Aspect, 2015) is an evidence-based document that is continually being reviewed and updated. It is an educational manual that has been developed to support education providers by presenting the theoretical research that explains the practical classroom and teaching initiatives that are undertaken at Aspect. The manual contains templates and recommendations on how to implement programmes including the structured teaching methodology.

The objective of structured teaching is to support children with ASD by establishing a structured and predictable learning environment where expectations are well-defined (Mesibov, Shea, & McCaskill, 2012). Structured teaching incorporates both the educational approaches of the Treatment and Education of Autistic and related Communication-handicapped CHildren (TEACCH) programme (Mesibov & Howley, 2003; Mesibov et al., 2004) and the naturalistic behaviour-based pivotal response training intervention (Koegel, Koegel, Ashbaugh, & Bradshaw, 2014; Koegel, Koegel, Harrower, & Carter, 1999; Koegel, Koegel, Shoshan, & McNerney, 1999). The pivotal response training intervention complements the TEACCH programme by introducing a naturalistic, behaviour-based intervention that is designed to increase a student's motivation to respond to educational activities that are foundational, or pivotal, to the development of complex language, play and social interaction skills (Koegel, Koegel, & Brookman, 2003). The TEACCH programme emphasises the individualised person and family-centred education plan that incorporates visual and physical supports within a predictable structured environment.

In this study, we used the Language Acquisition through Motor Planning (LAMP) programme because it provides strategies for teaching communication using an AAC speech production device that are consistent with the structured teaching theory. The LAMP programme approach contains five teaching elements that provide students with the language skills necessary to teach effective communication. These are (1) readiness to learn; (2) joint attention and shared focus; (3) natural consequence; (4) auditory signals; (5) consistent and unique motor patterns (Halloran & Halloran, 2009).

In the LAMP programme, readiness to learn refers to an individual's level of alertness and ability to focus on a learning experience through being at an optimal arousal level and through having appropriate learning tasks (Corbett et al., 2014; Watters, 1999). This motivation is fundamental to establishing effective communication, and it both influences a person's readiness to learn and encourages joint attention between the individual and communicator. Joint attention is fundamental to communication development and a precursor to developing intentional communication (Lawton & Kasari, 2012; Wong, 2013; Wong & Kasari, 2012).

The LAMP programme approach provides the student with the opportunity to learn the meaning behind words and icons on the device by allowing them to make the connection through natural consequences of using a word and seeing the response of the person who they are communicating with (Kilham & Costley, 2012; Koegel et al., 2003; Kuhn, Bodkin, Devlin, & Doggett, 2008). When the child selects a word on the device, the speech output is immediate. The instantaneous linking of the device word icon with the auditory cue can improve the development of the communication associations necessary for learning and sustaining the meaning of a word (Brady, Thiemann-Bourque, & Fleming, 2013).

The most unique aspect of the LAMP programme is the importance of consistent motor patterns. A motor pattern can be described as a hand memory that is similar to typing or playing a piano; in other words, the keys stay in the same place and your fingers automatically know where to go after a period of practice (Keel, 1968). Motor planning can be categorised into three phases: cognitive, associative and automatic learning (Dijksterhuis, Aarts, Bargh, & van Knippenberg, 2000; Salmoni,

Schmidt, & Walter, 1984). The cognitive stage is the learning stage where behaviour (communication) is specifically taught with necessary supports in place, such as prompting from the speech pathologist (Koegel, Koegel, Harrower, et al., 1999; Koegel, Koegel, Shoshan, et al., 1999). The associative stage is the practice stage where an individual moves between active thinking and automatic implementation (Ganz, Boles, Goodwyn, & Flores, 2014; Ganz & Hong, 2014). In the automatic stage, the individual no longer needs to think about how the behaviour is made as it has been retained in their memory (Koegel et al., 2003).

The LAMP programme also focuses on teaching core words. Core words are words that are frequently used in communication and allow an individual to communicate more meaningful messages. They are defined as functional words commonly used in day-to-day communication such as go, stop, more, eat or drink (Banajee, Dicarlo, & Buras Stricklin, 2003). Fringe words are more specific labels of nouns, used to extend information provided (Banajee et al., 2003). Combining core and fringe vocabulary allows an individual to produce simple phrases such as, "eat apple" or "more banana" (Marvin, Beukelman, & Bilyeu, 1994).

The LAMP programme also supports the development of individual core words prior to progression to phrases, which is consistent with typical language development.

3. Literature review

Evidenced-based research on the effectiveness of AAC devices' studies have mainly focused on single-case studies or very small samples (Ganz et al., 2012; Waddington et al., 2014). Despite the small samples, the findings have suggested the AAC approaches have positive outcomes for the children with ASD (van der Meer & Rispoli, 2010).

In a meta-analysis report of 24 single-case research studies that trialled AAC systems with children aged between 3 and 18 years and adults aged up to 40 years, researchers found that AAC interventions had a large effect on targeted behavioural outcomes for people with ASD (Ganz et al., 2012). Similarly, Waddington et al. (2014) reported on three boys aged between 7 and 10 years who had ASD and severe communication impairment also demonstrated that systematic instruction in the use of a speech generating device was effective in improving their requesting and social communication responses in a multiple baseline across participants research design.

Much of the AAC research has, however, concentrated on personalised tablet computers using appropriate communication focused applications. One study that demonstrated that the effectiveness of the tablet computer as a speech-generating device in improving requesting and vocalised requesting was the research conducted by King et al. (2014). In this study, the researchers adapted and modified a picture-based communication system for use on the tablet computer. The three participants who were aged between three and five years, and were diagnosed with ASD all had significant speech delay. Using the tablet computer, each of the participating children established a requesting repertoire and the researchers reported that vocal requests were also observed in each of the children in between 50 and 70 sessions.

In another study that examined the effect of using personalised tablet computers for learning communication skills in three 10-year-old children with ASD who had little or no functional speech, researchers found that communication with teachers and peers increased after six weeks of training (Xin & Leonard, 2014). This study also showed that the students who had delayed speech at the baseline measurements were able to initiate requests, respond to questions and make social comments in class and during non-classroom settings after the six-week intervention.

Although, most of the literature presents the personalised tablet computer as a successful computerised AAC speech-generating devices that most children with ASD prefer to use when compared to natural and symbolic systems (Couper et al., 2014), the downside can be that the iPad can cause student distraction in the classroom (Karsenti & Fievez, 2013). In the study by Karsenti and Fievez (2013),

6,057 students and 302 teachers in Quebec, Canada, were surveyed about the benefits and challenges of using personalised tablet computers. Along with the finding that virtually 100% of the students reported having access to a tablet computer can lead to distraction in class, teachers also reported that the device was a major source of distraction from their classwork for students, particularly when it was connected to the internet and could be used as an entertainment console or social media platform. Lack of training and professional development in the pedagogical use of personalised tablet was also reported as a challenge to the success of implementation of the device in classrooms by teachers (Karsenti & Fievez, 2013).

4. Study purpose

To test whether AAC can improve functional communication in daily-life activities, we chose to use the Vantage Lite™ AAC device implemented through the LAMP programme as it is a designated communication-specific device, and does not provide any entertainment or social media options. The Vantage Lite™ device is an one-speech production tool that applies a structured physical environment using visual supports (buttons with pictures) to provide a constant location for each word symbol. The Vantage Lite™ device uses the Minspeak™ software to generate speech output. It uses word icons on a computerised screen that when pressed give a realistic sounding voice. The screen, voice and vocabulary can be customised and the device is suitable for children due to its durability and portability (1.5 kg). The benefit in using this device is that it can be individualised to the student's educational needs, communication and cognitive level, and the placement of the words is consistent and predictable. The Vantage Lite™ device offers a range of icon screen layouts to cater for the different cognitive levels (48, 60 and 84 icons). These features can encourage a student's motivation for self-initiated practice which can lead to an improved generalised communication (Ganz & Hong, 2014).

In the study, we investigated the impact AAC, specifically the LAMP programme, has on improving functional communication in daily living activities. The purpose of this study was to investigate whether children who are trained in the use of an AAC using the LAMP programme improve their functional communication consistently, spontaneously and independently, and whether any gains that are achieved are maintained over a short-term period and longer term period.

There were four specific aims of this study.

- The first was to evaluate the level of improvement of functional use of words in children with ASD who had limited functional communication, after five weeks of training in the student's natural environment (e.g. school, home) using the LAMP programme. The natural environment was chosen to support a generalisation of their communication development.
- The second aim was to identify whether the children could use this functional communication consistently, spontaneously and independently (without reliance on prompting).
- The third was to investigate the confidence of the parents and teachers who were supporting the students in using the LAMP programme. Being an individualised education and family-centred programme, where the student is supported by their family in their home environment and their teachers at school, it was important that the parents and teachers were confident in supporting the student to use the LAMP.
- The fourth aim was to evaluate the long-term use and generalisation of the LAMP programme, two years after the completion of the initial study. Under the structured teaching theory, the aim is to achieve a generalisation of the skills learnt in one setting to other scenarios. This fourth aim was designed to determine whether the LAMP was being used as an established communication tool in the student's natural environment after the speech pathologist's support was withdrawn.

In this study, we evaluated the developmental progression of pre-intentional, intentional and symbolic communication. Pre-intentional communication refers to communicative behaviour that relies on their communicative partner (e.g. adult) to understand them and interpret the meaning of their

message (Cress, 2014). For example, if a child is lying on the floor crying, they are communicating a state of upset or discomfort; however, the parent or adult needs to interpret the message that is being communicated.

Intentional communication is when an individual is deliberately communicating, intending to send a message to a communicator and they realise that their actions have an effect on others (Meadan, Halle, & Kelly, 2012). At the intentional stage, the communication is still not clear and their message still needs to be interpreted by the communicator, because it is not yet symbolic. One example would be when a child stands at a cupboard and points or vocalises.

Symbolic communication represents any system in which individuals need to understand the meaning of the symbols in that system, in order to be able to communicate effectively (Maljaars, Noens, Scholte, & van Berckelaer-Onnes, 2012). Speech, written word, sign, visuals and speech output devices are all examples of symbolic systems.

Ethics approval for this study was granted from the Autism Spectrum Australia (Aspect) Research Approval Committee which follows the NHMRC's Australian Code for the Responsible Conduct of Research (National Health and Medical Research Council, 2007, Updated March 2014), and other relevant legislation. The Autism Spectrum Australia (Aspect) Research Committee comprises staff members who are experienced human studies researchers and ethics application evaluators are not involved in the research project.

5. Method

A multiple-participant, single-case, within-subject experimental design methodology was used as it allows for each participant to act as their own control (Boslaugh & Watters, 2008). This method is considered a valid and reliable method of evaluating small sample trials in special education programmes (Horner et al., 2005).

5.1. Participants

Participants were recruited through the Aspect Early Intervention Programme and Aspect schools. All children enrolled at Aspect schools and intervention programmes had a diagnosis of ASD. Children who presented with inconsistent functional communication were invited to participate in the study. The families and teachers of these children were invited to participate in the study. Signed informed consent was obtained from all participating families and teachers.

Nine children aged between 4 and 12 years of age participated in the study. Eight out of nine family participants completed the intervention and two-week follow-up assessment. One family withdrew prior to completion of the study, and these results are not included in the findings. Data from seven boys and one girl were analysed and reported. Seven of the eight families participated in the two-year follow-up interview.

At the time of the study, all of the participating children were receiving speech therapy. All participating children were using some level of picture exchange to communicate, and many were using other communication systems concurrently. Despite the use of these communication methods, the children were not using any of the communication systems consistently, spontaneously or independently, as reported by their parents, teachers and therapists.

The parent–teacher survey was completed by seven parents and two teachers.

5.2. Procedure

Four speech pathologists conducted the research evaluation. Training and ongoing support was provided to the speech pathologists by the developers of the LAMP programme and Vantage Lite™ device. The parents and teachers received training in the use of the LAMP programme and Vantage Lite™ device from the speech pathologists who conducted the research evaluation.

The speech pathologists recorded the child's progress at each session. Only the baseline, post-programme assessment and maintenance sessions were video-taped. Taping of the sessions allowed for reviewing and accurate data collection. The speech pathologists met weekly to review their consistency of implementation and to ensure inter-rater reliability in their data collection.

Structured and non-structured speech pathology sessions were conducted using the LAMP programme and the Vantage Lite™ device (Halloran & Halloran, 2009; Liberator, 2014). The structured sessions involved teaching the child how to use the LAMP programme to produce focus words, prompting the child to respond using the speech output device and encouraging the child to progress to the next level of difficulty such as communicating with two or more word phrases.

The non-structured sessions were any other time the device was used to communicate in the child's natural settings (e.g. home). During these sessions, specific vocabulary and prompting were used to encourage generalised use of the device and practice of words taught in structured sessions, in the family's natural environment.

A child-led approach was exercised in all sessions to ensure that the language was functional and meaningful to the child. During these sessions, the students were taught to use core and fringe words.

In order to motivate the child to use the device to communicate, activities were designed around the child's interests and motivators with the aim of eliciting focused language (such as "more, go, drink"). There were three levels of prompting used during the programme implementation to support the students in acquiring and practising the skills needed to communicate with the AAC device. These were:

Full physical prompt—the speech pathologist, parent or teacher directs the child's hand over the AAC screen to demonstrate how to complete the whole motor pattern of a given word or phrase, on the speech output device.

Partial physical prompt—the speech pathologist, parent or teacher takes the child's hand to initiate and guide production of the motor pattern for the individual word or phrase on the device, and then removes their hand so that the child can independently complete the rest of the motor pattern.

Gesture—the speech pathologist, parent or teacher points to the key on the device to guide the child to initiate the motor pattern of the individual word or phrase.

5.3. Measures—data collection tools

5.3.1. Aspect Building Blocks communication checklists

Aspect Building Blocks is the largest early intervention service in Australian. Its centre-based and home-based interventions are identified as an "emerging or best practice evidence"-based model in early education, as rated according to internationally established scientific criteria for evidence on the treatment efficacy of ASD for children up to seven years of age (Prior & Roberts, 2012; Prior, Roberts, Rodger, Williams, & Sutherland, 2011). Aspect Building Blocks delivers family centred, evidence-based, transdisciplinary service that engages elements of behavioural, developmental and social learning therapies. The expressive and receptive communication language checklists used by Aspect Building Blocks (Ulliana & Mitchell, 1997) were used in this LAMP programme evaluation.

Expressive communication checklist evaluates the function and method of communication such as requesting, protesting, commenting and symbolic communication, and identified whether the child was communicating at the pre-intentional, intentional or symbolic stage.

Receptive communication checklist evaluates the participant's understanding of words, questions and comments as well as their ability to follow instructions of different complexities. This checklist provided information about what level of support the child needed to be able to respond:

(1) Physical support—the child is supported in following through with an instruction using physical prompts;

(2) Non-symbolic—the child is supported in following through with an instruction using a non-symbolic prompt such as a point or hand gesture;

(3) Symbolic—the child is supported in following through with an instruction using a symbolic prompt such as a sign or visual support;

(4) Verbal—the child is supported in following through with an instruction using a verbal prompt such as repeating the instruction or simplifying it verbally; and

(5) Environmental or natural context—the child is supported in following through with an instruction by independently observing others in their environment, or by relying on environmental cues, e.g. lights off indicating sleep time, tap on indicating wash hands, etc.

5.3.2. LAMP data log

The LAMP data log (Figure 1) is used to collect information about the specific vocabulary used on the Vantage Lite™ device, during each activity. It is designed to collect information about the type of vocabulary used on the device (words vs. phrases) and the level of physical prompting needed compared to their spontaneous use. It also records the particular activity and the amount of time spent on that activity as well as the date and participant details.

5.3.3. Building Blocks spoken language log

The spoken language log (Figure 2) was developed to keep track of the spoken language used by the child during implementation of the device.

5.3.4. Interests' inventory

This document was created by the LAMP programme developers (Halloran & Halloran, 2009). It collects information about the participant's interests, motivators, likes and dislikes. This information is then used to create opportunities to stimulate communication.

5.3.5. Parent–teacher questionnaire

The parent–teacher questionnaire rated the knowledge and confidence of the parents and teachers in implementing the LAMP programme, on a rating scale from 1 to 10 (not that confident to very confident). Three questions were asked: How confident do you feel implementing the device? How confident do you feel teaching another person? How confident do you feel that the device will help your child?

Figure 1. LAMP data log.

Date	Participant Name	Time Spent on Activity	Activity E.g. Blowing Bubbles	Core Vocabulary	Outcomes Full Physical Prompt, Partial Physical Prompt, Gesture, Spontaneous Communication

Figure 2. Spoken language log.

Function and Spoken Language Used				
Requesting	Commenting	Protesting	Greetings	Feelings

5.3.6. Two-year follow-up phone interview questions

A phone interview was developed to assess generalisation of use of the LAMP programme, using the Vantage Lite™ device, two years after the study. The parents were asked five questions after providing informed consent.

(1) Are you and your child still using the Vantage Lite™ device with the LAMP programme?

(2) In what context is the Vantage Lite™ device being used, how often and with whom?

(3) Why did you continue/discontinue to use the Vantage Lite™ device?

(4) Are you still seeing a LAMP-trained speech pathologist? Do you think a trained therapist would have made a difference to your continued use?

(5) Were there any difficulties in using the Vantage Lite™ device?

5.4. Data collection

The speech pathologist conducted the research with the children in their home and school environments over a period of 14 weeks.

Parents and teachers were surveyed before the programme started in Week 2 and again after the implementation of the programme in Week 9. Figure 3 shows the implementation timeline for the research project.

Speech pathologist, teachers and parents completed the data collection after each structured and informal non-structured session.

5.5. Training

In Week 1, the speech pathologist conducted a training session with the families, students and teachers. These sessions involved demonstrating how to use the LAMP programme and device.

5.6. Baseline assessments

During the baseline assessment stage in Weeks 2–3, the speech pathologist observed the child for one hour each week at the home and/or the school environment. During this time, the speech pathologist collected baseline data using the expressive and receptive communication checklists (Figure 4), interests inventory (Figure 5) and parent–teacher questionnaire. An example of the expressive and receptive communication checklists is provided.

5.7. Programme implementation

Programme implementation took place during Weeks 4–8 (five consecutive weeks), and consisted of structured and non-structured sessions where the students practiced using the speech output device.

The LAMP data log was completed by parents, teachers and therapists in structured and unstructured sessions, to show the development and progression of vocabulary used and levels of prompting needed.

The Building Block's spoken language log was also completed during programme implementation weeks.

Figure 3. Implementation timeline.

Week 1	Weeks 2 – 3	Weeks 4 – 8	Weeks 9 – 10	Week 11 – 12	Weeks 13 – 14
Training (Family/Teacher)	Baseline Data Collection	Program Implementation	Post–Program assessment	Maintenance Period	Generalisation Measure

5.8. Post-programme assessment

During the post-programme assessment stage in Weeks 9–10, the speech pathologist completed the expressive and receptive communication checklist again as a post-implementation measure. These sessions took place in both the child's home and school environments. No structured teaching took place at these sessions. The aim of this assessment stage was to collect data on the child's level of communication after five weeks of implementation.

5.9. Maintenance period

Week 11–12 were referred to as the maintenance period. During this fortnight, there were no meetings with, or support from the therapists. The families were asked to continue using the LAMP programme during their day-to-day routines. All the participating families and teachers completed the LAMP data logs during the maintenance period.

5.10. Maintenance assessment

In Weeks 13–14, the speech pathologist reassessed the child's progress using the expressive and receptive communication checklist and LAMP data log, once again, to see if any communication development had been maintained without the support of structured teaching from the speech pathologists.

Figure 4. Expressive and receptive communication checklists (a) Page 1, (b) Page 2, (c) Page 3.

autism spectrum AUSTRALIA

COMMUNICATION CHECKLIST

RECEPTIVE COMMUNICATION

Name: _____ D.O.B: _____

Staff Name: _____ Date Completed: _____

What level of commands or instructions does your child respond to and follow?

	Physical Support	Non-Symbolic pointing gesture, facial expressions	Symbolic Objects, photos, pictures, signs	Verbal repetition, rephrasing	Environmental Time of day, movement of others, peer modelling	Natural Context
1-part directions (routine)						
1-part direction (non-routine)						
2-part sequential (e.g. "shoes and socks")						
2-part unrelated (e.g. "shoes and pillow")						
3- part directions						
Prepositions (in/on/under/beside)						
Attributes (colours, shapes, sizes)						

Aspect Building Blocks® Early Intervention Service

(a) Page 1

Which question form does the child understand and respond to?

	Physical Support	Non-Symbolic pointing gesture, facial expressions	Symbolic Objects, photos, pictures, signs	Verbal repetition, rephrasing	Environmental Time of day, movement of others, peer modelling	Natural context
Yes/No Question						
'What?' question						
'Which one?' Question						
'Where?' Question						
'Who?' Question						
'When?' Question						
'How?' Question						
'Why?' Question						

Skill Level Achieved
A=Acquisition Learning a new skill
P=Practising Consolidating & working at improving accuracy & quality of skill
M=Maintenance Routinely uses the skill
G=Generalisations Uses the skill across a variety of settings and learning to adjust the skill dependant on the situation

Comments & Examples (e.g. *familiar/unfamiliar people, settings, sentence structure, intelligibility, topic maintenance, conversational turn taking, social use*)

_____
_____
_____

Aspect Building Blocks® Early Intervention Service

(b) Page 2

Does the child understand and respond to the following information? Comment using the key below on which method aids his/her response:

	Physical Support	Non-Symbolic Pointing gesture, facial expressions	Symbolic Objects, photos, pictures, signs	Verbal Repetition, rephrasing	Natural Context Time of day, movement of others, peer modelling
Their name or a greeting					
Names of preferred people/food/ items					
Names of non-preferred/ unfamiliar items					
Comments about child/surrounds/ events					
Comments re: change in routine					
Routine past and future events					
Non-routine past and future events					

Skill Level Achieved
A=Acquisition Learning a new skill
P=Practising Consolidating & working at improving accuracy & quality of skill
M=Maintenance Routinely uses the skill
G=Generalisations Uses the skill across a variety of settings and learning to adjust the skill dependant on the situation

General Comments

_____
_____

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(c) Page 3

Figure 5. Interests inventory (a) Page 1, (b) Page 2.

Source: The Center for ACC & Autism.

INTERESTS INVENTORY

In order to initiate a child-centered intervention, the clinician should make available items or activities, which will interest the child. Individuals with ASD often have very limited interests. Additionally, they may use common objects in unusual or ritualistic ways. Consequently, it is often helpful to obtain information about the child's preferences prior to intervention. This information can also be used to explain the child's interest and play skills. On the reverse side of this page you will find a blank form for you to fill in any additional items not included on this list.

	Very Motivating	Some Interest	No Interest	Aversive	Don't know
Manipulatives					
Stacking Block					
Beads					
Puzzles					
Marbles					
Light Bright					
Wikki Sticks					
String, yarn, etc					
Active Play					
Ball					
Beanbags					
Jump rope					
Hoppity Hop					
Swing					
Slide					
Sit and Spin					
Jumping					
Spinning					
Putting Together/Taking Apart					
Building Blocks					
Lego					
Bristle Blocks					
Pop-beads					
Exploring the Sense					
Sand Play					
Water Play					
Vibrating Toys					
Toys That Light Up					
Spinning Toys/Objects					
Bells					
Flash Light					
Plush Toys					
Rattle/Shaking Toy					
Technology					
Videos					
Listening to Music					
Playing Music with instrument (drum/whistle)					
Computer Games					
Literacy					
Books					
Magazines					
Letter Forms					
Letter Games					

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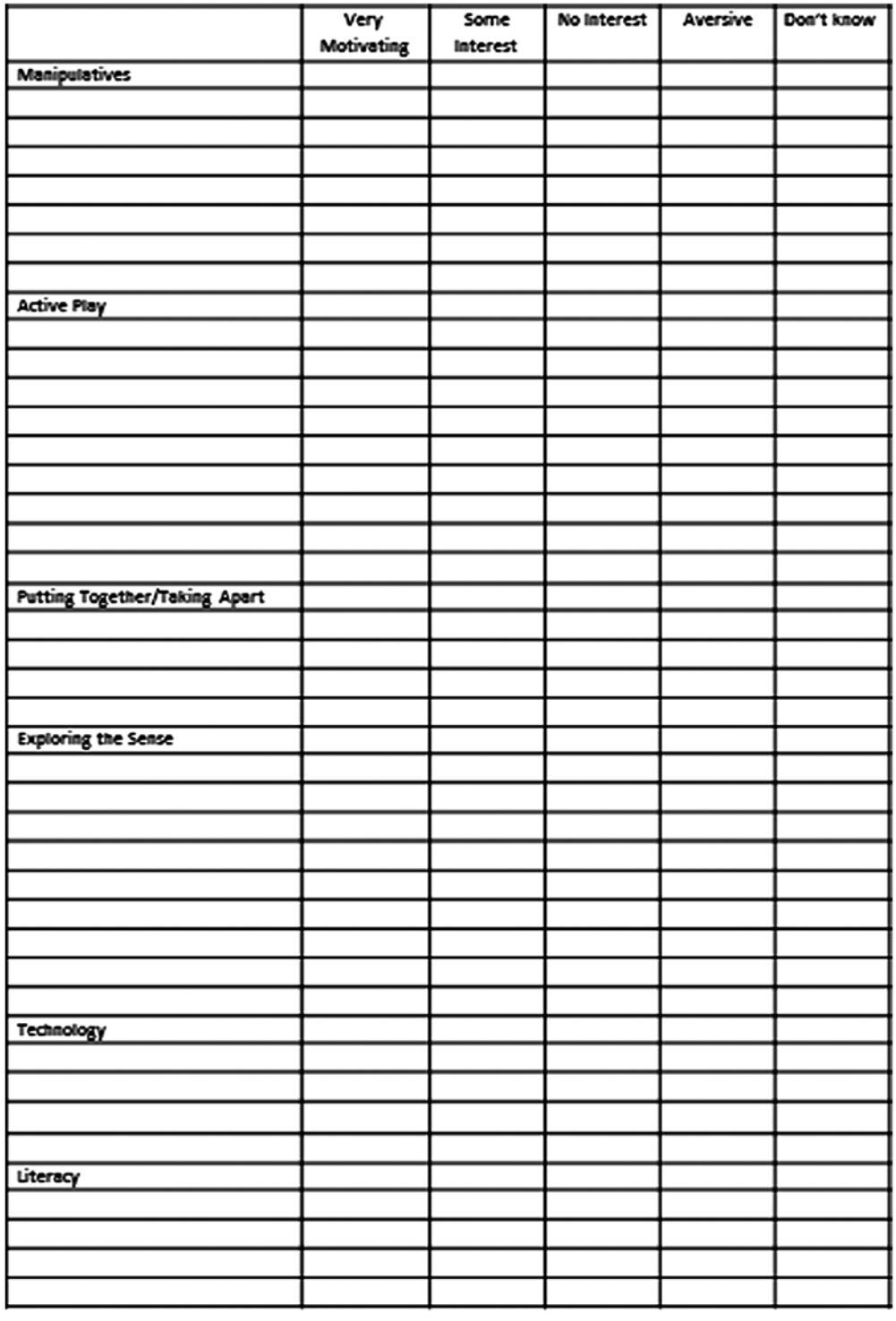
(a) Page 1



	Very Motivating	Some Interest	No Interest	Aversive	Don't know
Manipulatives					
Active Play					
Putting Together/Taking Apart					
Exploring the Sense					
Technology					
Literacy					

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(b) Page 2

5.11. Two-year follow-up—generalisation

Two years after the end of the primary study, the lead researcher speech pathologist (Mary-Ann Naguib Bedwani) conducted an informed-consent telephone interview with the parents of the participants who had been part of the original study.

6. Results

The finding from this evaluation of the LAMP programme using the Vantage Lite™ showed that the children's greatest improvements were in their expressive communication outcomes.

The results demonstrate that after five weeks of using the AAC device, all of the children who were in the pre-intentional or intentional stage of communication at the baseline assessment progressed to using symbolic communication at the post-programme assessment. For those children who were inconsistently using symbolic communication at the baseline assessment, the results of the post-programme assessment identified that they increased their use of consistent symbolic communication. Four out of the eight children progressed from using primarily pre-intentional or intentional communication to using intentional and symbolic communication. The other four children, who were already using intentional and symbolic communication at the baseline assessment, improved their symbolic communication and established a consistent method of communicating, after five weeks of programme implementation.

For children with ASD, requesting and protesting are usually the most effective function of communication they use. The DSM-5 criteria for diagnosis are based on a deficit in social communication which involves commenting, greetings and expressing feelings (American Psychiatric Association, 2013). To assess the participating children's social communication, we used the expressive and receptive communication checklists to compare the children's communication skills at the baseline assessment and at the post-programme assessments.

Table 1 shows the percentage of the children who were using pre-intentional, intentional, symbolic communication at the baseline and post-programme assessment. This table demonstrates that at the baseline assessment, all of the children were requesting their needs using pre-intentional behaviour, gesture (intentional) or symbolic communication. The baseline assessment also revealed that 87% of the children were protesting and 62% were using communication to gain attention, greet and farewell, or express feelings using some form of communication or physical behaviour (e.g. hugging another person). Only two of the children (25%) were commenting at the baseline assessment.

By the post-programme assessment and maintenance stages of the research, all of the children were requesting using a symbolic means of communication (on the device or using spoken language) and 100% of the children were developing social communication through commenting. Other social communication improvements were also observed in gaining attention (75%), expressing feelings (75%) and greetings (87%). This was a substantial change in that all of the children had received previous intervention prior to the study, (up to 9 years) yet only 25% of them were able to comment at the baseline assessment compared to 100% at the post-programme assessment.

Table 2 presents the percentage of children who were using spontaneous and symbolic communication at the baseline and post-programme assessment. This table illustrates the notable improvement that the children made in all functions of their spontaneous and symbolic communication over the five-week programme implementation. Symbolic communication included using the Vantage Lite™ speech output device, or spoken language. In the post-programme assessment,

Table 1. Pre-intentional, intentional and symbolic communication

	Requesting (%)	Commenting (%)	Protesting (%)	Gaining attention (%)	Greeting (%)	Expressing feelings (%)
Baseline assessment	100	25	87	62	62	62
Post-programme assessment	100	100	100	75	87	75

Table 2. Spontaneous symbolic communication

	Requesting (%)	Commenting (%)	Protesting (%)	Gaining attention (%)	Greeting (%)	Expressing feelings (%)
Baseline assessment	100	25	87	62	62	62
Post-programme assessment	100	100	100	75	87	75

100% of children were using symbolic communication to request and 62.5% for protesting. The greatest gains observed in post-programme assessment were in areas of social communication: commenting (62.5%), gaining attention (75%), greetings (62.5%) and expressing feelings (75%).

The findings from the data log also showed an increase in the range of vocabulary and the length of utterances used by the children. Vocabulary and length of utterances using symbolic communication increased with use of the Vantage Lite™ speech output device and spoken language. Again, although the rate and level of increase differed for each case, there was an increase in use of vocabulary for 100% of the children. At the post-programme assessment, the data showed that 50% of the children were using up to 10 words; while the other 50% had greater than 30 words. Three of the children had a vocabulary of between 40 and 65 words at the post-programme assessment. Seventy-five per cent of the children were also observed to be using phrases by the end of Week 5.

A Wilcoxon Signed-Rank Test was conducted to compare the number of spontaneous communication words used with the LAMP programme during the five weeks of programme implementation. The findings from the Wilcoxon Signed-Rank Test revealed that there was a statistically significant increase in the number of words used by the children between Week 4 and Week 8 during the implementation sessions, $z = -4.50$, $p < .01$. Using the Cohen criteria (Cohen, 1988), a large effect size ($r = .63$) is evident.

In order to further investigate these findings, the numbers of words used in each of the outcomes were graphed for each child (Case) in Figure 6. Although there is a significant difference in word

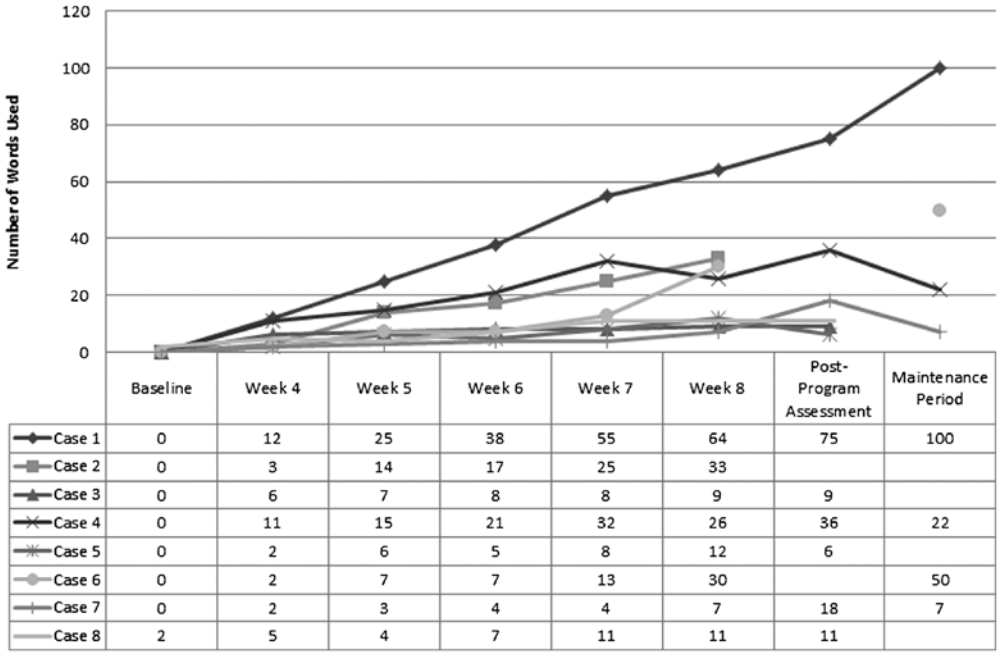


Figure 6. Individual case spontaneous communication.

usage between the beginning and the end of the implementation sessions across the sample, individual differences are worth noting.

The results shown in Figure 6 reveal a range of outcomes for the children. Case 1 demonstrated the most significant improvement, with the child using 11 words in Week 4 and 100 words in Week 8. Cases 2 and 6 made consistent gains throughout the implementation sessions, and Case 6 continued to improve when assessed at the maintenance assessment. No data were captured for Case 6 post-programme assessment.

Case 4 made good progress, but this child was unable to maintain this trajectory by the maintenance evaluation. Cases 3, 5, 7 and 8 all modestly improved their word count during the implementation sessions, with Case 7 continuing to improve by the post-programme assessment evaluation. These results, however, were not maintained by Week 14.

Participating parents and teachers were asked whether they were confident in implementing the LAMP programme with their child or student. Figure 7 shows that after training, the parent and teacher's confidence in implementing the LAMP programme had increased.

Parents and teachers were also asked if they were confident in teaching another person how to use the LAMP programme with the Vantage Lite™. Figure 8 shows that only confidence of Parent 6 did not improve—but the baseline assessment results from this parent indicate they were reasonably confident they could teach another person how to use the LAMP programme when they began the study.

Figure 7. How confident do you feel implementing the device?

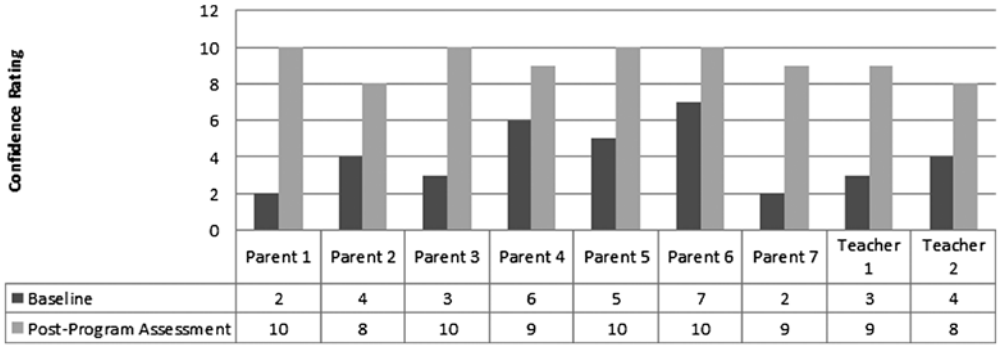


Figure 8. How confident do you feel teaching another person?

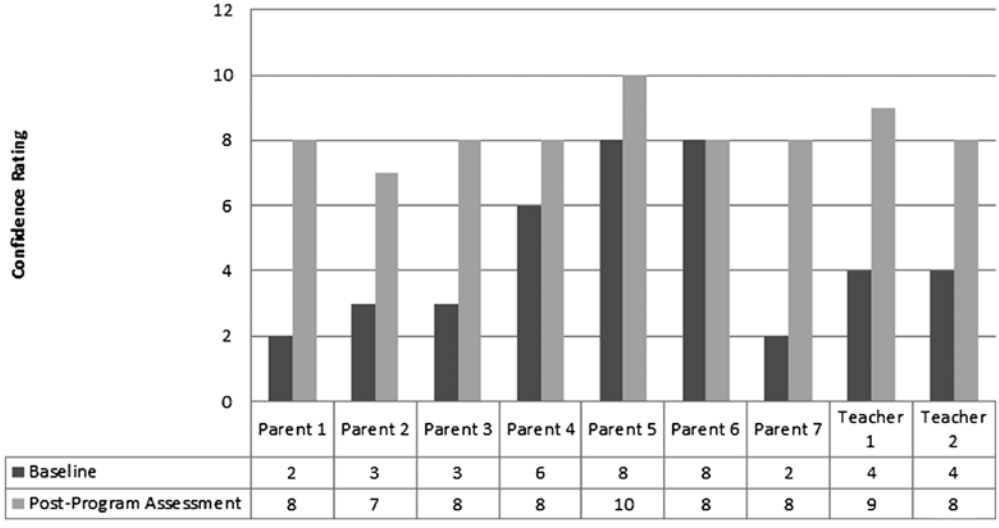
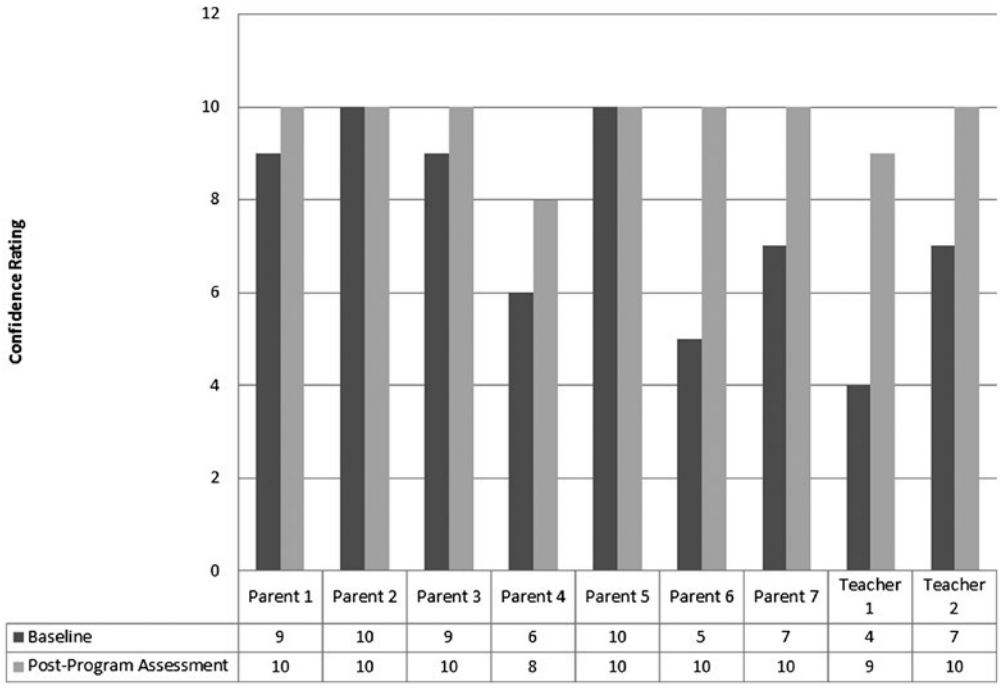


Figure 9. How confident do you feel that the device will help your child?



	Parent 1	Parent 2	Parent 3	Parent 4	Parent 5	Parent 6	Parent 7	Teacher 1	Teacher 2
Baseline	9	10	9	6	10	5	7	4	7
Post-Program Assessment	10	10	10	8	10	10	10	9	10

Figure 9 suggests that most of the parents were quite confident that the LAMP programme was going to help their child, and all provided responses that indicated that the LAMP programme either met or exceeded their expectations. Both the teachers increased their confidence about whether the LAMP programme helped the child improve their word count.

6.1. Follow-up survey

Two years after the original study was completed, a follow-up telephone questionnaire was undertaken. The lead research speech pathologist telephoned each of the parents to follow-up about their use of the LAMP programme using the Vantage Lite™ device.

Seven out of the eight parents consented to be surveyed. Five questions were asked and the responses are collated for reporting.

(1) Are you and your child still using the Vantage Lite™ device with the LAMP programme?

The results showed that two children were not using the Vantage Lite™ device for communication. Five parents reported that their child continued to use the LAMP programme with the device.

(2) In what context is the Vantage Lite™ device being used, how often with whom?

The two families who were not using the device had tried to use it after the programme but reported that they were not able to integrate the programme into their daily life. Of the five parents who reported their children continued to use the device, two stated that their children use the device in multiple environments. Two children use the device at home and one child uses it when needed to communicate with people who may not understand his spoken language.

(3) Why did you continue/discontinue to use the Vantage Lite™ device?

The main reason reported by the parents that the children stopped using the device was due to the lack of available technical support. The parents reported that they were not confident enough in problem solving if the device failed or updating information on the device. Parents were more likely to continue using the device if support was available when they needed it. Parents who required technical support when it was unavailable, were less likely to continue using the device.

The feedback from the families who continued to use the device indicated that they had received continued support from a speech pathologist. These families reported that their child actively requested to use the device as it enabled them to more successfully express themselves. One parent described the device as, "an extension of her [child's] body".

(4) Are you still seeing a LAMP trained speech pathologist? Do you think a trained therapist would have made a difference to your continued use?

Three out of the seven children continued to work with a LAMP-trained speech pathologist and these three all reported positive and ongoing usage of the device. Two of the children who continued to use the device were no longer seeing a speech pathologist, but they also reported that if they had a trained therapist it would have been beneficial. They had sought and received support from the distributor of the device.

Lack of availability of technical support was the main reason for not continuing to use the device. Parents reported that having a problem that was not able to be resolved quickly was the main reason for abandoning the device. The other issues reported by the parents were: (1) that only therapists trained in the LAMP programme were able to support the family; (2) when a child was working with a speech pathologist who was not trained in the LAMP programme, parents reported that their child lost interest in using the device because the support emphasis changed with the introduction of an alternative therapy.

(5) Were there any difficulties in using the Vantage Lite™ device?

All seven parents reported some level of difficulties using the device. Technical difficulties were the main issues reported by the parents for discontinued use. The families who continued to use the device reported technical difficulties including, progressing through settings, resetting the device and using the device to its fullest extent. However, when parents received efficient distributor support, they managed to overcome these technical difficulties.

7. Discussion

Improved communication through AAC has been identified as a means of enriching the quality of life of non-verbal or minimally verbal children with ASD (Ennis-Cole, 2015; Ganz et al., 2012; Lubas et al., 2014; Sigafoos et al., 2014). In this study one AAC programme, the LAMP programme using the Vantage Lite™ device has been demonstrated to improve communication in children between 4 and 12 years of age who have ASD and a communication disorder when family-centred, individualised student education plans are implemented. Using the LAMP programme supported by the structured teaching theory (Mesibov & Shea, 2011; Mesibov et al., 2004, 2012), this study assessed the effectiveness of one AAC device, the Vantage Lite™ device, to quantitatively research and evaluate the effectiveness of a speech output device, using the LAMP programme, for improving the number of spontaneous communications used, number of words used, level of communication intent, intentionality of use, function of communication, length of utterance and spoken language use.

The goal of this study was to examine whether children who use an AAC with the LAMP programme increase their spontaneous, independent and functional (core word) communication, and whether any gains that are achieved are maintained over a short-term period and longer term period. Results from this study suggest that the children who used the LAMP programme for three months demonstrated an improvement in communication, and that with ongoing support continued to use the programme for a range of communication needs even two years after the study was completed.

The findings from this research study of eight children demonstrated that there was an improvement in the use of functional core words after using the LAMP programme. The results showed that at the post-programme assessment, all of the children were independently communicating and were not restricted to vocabulary that had been taught to them.

The results from this study also showed that most of the children improved their functional communication and length of utterances, using either the Vantage Lite Device™ or spoken language and that all of the children made a significant increase in their expressive communication, that is, the number of words they used during the five weeks of the programme implementation. The speech pathologists noted that there were variations in the children's level of interest and motivation during a particular session may have influenced the vocabulary used in those sessions. Hence, a word that was previously taught in one session may not have been used at a subsequent session due to a lack of interest or motivation in a particular activity on the day of assessment.

Although the focus of the study was not the development of use of phrases until single core words were established, 75% of the children were observed to be using phrases on their device by Week 5 of the programme implementation. This effect was observed in children who were completely non-verbal, as well as minimally verbal, at the baseline assessment. One of the children, JB was a non-verbal 12-year-old participant, who after five weeks using the Vantage Lite™ device developed symbolic communication and began using a few phrases such as "I want x" and "go away". He was also able to repeat these phrases verbally after hearing the speech output on the device.

Understanding the varied meanings of words is essential in the development of language. Although not a focus of a research question, two of the children in the study were observed at the Week 9–10 post-programme assessment to be using words with multiple meanings in the right context. One child, AG—who at the baseline data collection had inconsistent use of verbal language and needed prompting to use verbal skills—was reported to use the word "drive" in three different contexts at the Week 9–10 post-programme assessment, thereby demonstrating an understanding of the meaning of this word and the ability to generalise its use.

As well as the expressive communication outcomes, there were a range of other outcomes that parents, teachers and speech pathologists observed and reported. These included an increase in joint attention, interest, motivation and engagement with others, and an overall increase in willingness to communicate. In addition, there was an overall increase in play and social communication reported by the parents and teachers. For some of the children, this was the first time they were able to communicate and participate in social situations. Behaviour was also reported to have improved with a corresponding decrease in frustration as a result of improved expressive communication.

At the beginning of the study, many children had a limited motor planning proficiency when using the LAMP™ device, and therefore fewer icons were made available on the screen layout. By the post-programme assessment, the speech pathologists reported that all of the children were able to identify, discriminate and use the complete 84 icon screen layout.

The results identified that the children who participated in this study improved their consistency and spontaneity of functional communication and also improved their independence in producing communication by reducing the level of prompting they needed to initiate communication. At the baseline assessment, physical prompting from the speech pathologist was needed to produce a word on the Vantage Lite™. By the post-programme assessment, all of the children were able to spontaneously produce a word on the device and had developed independent communication skills.

To further investigate the effectiveness of the LAMP programme, the research examined the confidence of the parents and the teachers who were supporting the children to learn how to use the AAC device. This was an important part of the research because the LAMP programme is a child- and family-centred programme that is designed to be used and supported in the child's natural environment specifically, the home and at school. The findings from this research suggest that training the child's school teacher and the parents in the use of the LAMP programme is vital to the child's improved communication. The results showed that teacher and parent training in using the LAMP programme improved their confidence in supporting the child to use the device for communication.

What was evident from the two-year follow-up was that when parents were unable to access technical support, the use of the device was decreased.

At the start of the study, all of the parents reported a confidence level of five or above out of 10, that the LAMP programme would help their child to improve their communication ability. The two teachers also had a comparable expectation about the effectiveness of the programme. After the study at the Week 9–10 post-programme assessment, the survey responses showed an increase in confidence that the programme would help the child's communication development.

At the Week 2–3 baseline data collection, most of the parents and the teachers reported that they were not confident that they would be able to teach another person how to implement the programme. By the end of the study, six of the seven parents and both the teachers reported an increase in their confidence in teaching another person how to implement the LAMP programme and Vantage Lite™. These results suggest that the training and support were effective in developing the confidence in supporting their child/student in using the LAMP programme.

Furthermore, in the pre-programme survey, the parents and teachers reported they were confident that the LAMP programme would improve their child's communication, suggesting that they had high expectations. In the post-programme survey, all of the parents and both of the teachers reported a continued confidence that the LAMP programme would help the child they were supporting, and it is suggested that parental and teacher confidence is an important factor in encouraging the child to continue to use the device (Prelock, Calhoun, Morris, & Platt, 2011).

The aim of the LAMP programme is for the children to generalise what they learn in their natural environment, and to be able to use those words and phrases, and later even sentences, spontaneously, independently and in varied situations. The results from this study showed that with continued speech therapy support for the child as well as ongoing and available technical support for the parents, generalised usage of the LAMP is possible, even two years after speech pathology support was discontinued.

In the two-year post-programme follow-up telephone calls to the parents, the most important factor in determining whether a child continued to use the Vantage Lite™ device and LAMP programme was reported as the ongoing support by a trained therapist. When support is readily available through a trained speech pathologist and the device distributor, families continue to encourage their child to use the LAMP programme. The flipside, however, is that when parents have technical issues that cannot be answered immediately, such as during weekends and evenings, the consequence is that the family loses interest in using the device, and the child's communication system is no longer available to them.

The findings from this study suggest that all eight children demonstrated an improvement in communication, albeit, with varying magnitudes of improvement. The primary aim of this study was to evaluate the level of improvement in children with ASD who have limited functional communication, after five weeks of training using the LAMP programme. Results from this research indicate that all the children demonstrated an improvement in the number of words they used during the study. These results provide further support the findings of previous smaller sample studies that AAC can support the development communication skills in children with language delay (Ganz et al., 2012; Waddington et al., 2014; Xin & Leonard, 2014)

This evidence-based study demonstrates that the LAMP programme using the AAC Vantage Lite™ device can provide sustained improved language development and is an effective method for improving functional language in non-verbal or minimally verbal children with ASD. The outcomes from this study support the findings from previous single-case and small sample studies that have evaluated AAC programmes and reported improved communication outcomes (Ganz et al., 2012; van der Meer & Rispoli, 2010).

Although promising, these results reveal that one of the most important factors contributing to the continued use of the device was the ongoing support of a speech pathologist and the continued technical support to parents and teachers. These findings are similar to previous research by Karsenti and Fievez (2013) who reported that technical and professional development support is crucial to the continued use of personalised tablets in the classroom. Further studies into AAC devices are needed to identify whether the communication improvements we found using the LAMP programme and Vantage Lite™ device are comparable in adults with ASD.

Feedback received from the parents reported that the improvements in communication they had observed over the duration of the study were the greatest gains they had seen their children make, even though they had previously participated in other communication intervention programmes. The mother of the oldest participant in the research, who was 12 years old at the time, quoted "it is the best thing JB has ever done for his communication".

As a result, a LAMP programme-specific classroom was established in one of the participating schools. Ongoing support is available for students, parents and teachers.

The findings of this study support the continued use of the LAMP programme as an AAC communication method for children with an ASD. It provides individuals with a consistent communication system that helps motivate children to learn and assists them in independently communicating meaningful messages.

The implications for the speech pathologists and teachers are that ongoing training, professional development and technical support in using technology are essential for effective and holistic support to families.

One of the limitations identified by the teachers who participated in the study was that the LAMP programme was introduced in Term 1 of the school year. On completion of the research, the feedback provided by the teachers was that at the beginning of the year, all of the children are still settling into the classroom routine. It was suggested that the programme implementation takes place in school Term 2 or Term 3 when the children are more settled in the classroom.

A second limitation to this study was the novelty factor of the Vantage Lite™ device in the classroom environment. The aim of the programme was to use the device in the child's natural environment, including the classroom. One issue that became apparent in the training stage was that the speech pathologists who implemented the LAMP programme in the classrooms often needed to create a one-to-one learning environment for the participant to reduce the distraction from the other students.

8. Conclusions

The evidence from this study suggests that children with ASD that were non-verbal or had limited communication showed an overall increase in independence and spontaneous communication as a result of using the LAMP programme. The LAMP programme also proved to be an effective approach for teaching children to communicate meaningful messages and developing functional vocabulary. Many other programmes used with children with ASD rely on an adult or external communicator to teach the child-specific vocabulary and this selection may not be meaningful or motivating to the child. In addition, based on the LAMP programme philosophy, teaching core vocabulary prior to the fringe words is an important consideration when choosing suitable vocabulary to teach a child.

The findings also identified that ongoing family support with a trained therapist and readily available technical support are the biggest contributors to continued use of the device. The implication of this finding indicates the importance of therapists keeping up to date with the development of new, effective communication programmes, to be able to support families with speech output devices.

One of the outcomes from the study was that LAMP specialist classrooms have been established at one Aspect school and the LAMP programme is continuing to be used by clients across the organisation. Further research is underway to investigate the use of the LAMP programme with adults with ASD.

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