Case Study 1: An Evidence-Based Practice Review Report

Theme: School Based Interventions for Learning

How effective are methods of aided AAC in improving the functional communication skills of pre-school children with additional needs?

Are these skills generalisable and maintained?

Summary

This systematic literature review aims to explore the effectiveness of aided methods of Alternative Augmentative Communication (AAC) in supporting pre-school children with additional needs in developing their functional communication skills. AAC describes a number of systems used by a range of individuals to act as an alternative, or a supplement to augment their speech. Specifically, this review will be exploring aided methods of AAC that require the use of an additional physical resource that is external to the person.

Six studies met the inclusion criteria and were reviewed using the Weight of Evidence Framework (Gough, 2007) and the 'Quality Indicators Within Single-Subject Research' by Horner et al. (2005).

The findings demonstrated that methods of aided AAC were effective in supporting pre-school children in developing their functional communication skills, and communicative behaviours, with medium and large effects occurring frequently. Differences between methods of AAC are discussed, in addition to implications for use and future directions for research.

Introduction

What is Alternative Augmentative Communication (AAC)?

AAC can involve the use of a range of systems and is used by a wide range of individuals to either; augment speech acting as a supplementary aide, or as an alternative to speech, acting as a primary method of communication.

There are two types of AAC, aided and unaided.

- Unaided communication does not require any equipment that is external to the body and involves the use of symbols such as manual signs and gestures.
- Aided communication incorporates devices that are external to the individuals who use them (for example, communication books) and can involve the use of symbols such as photographs, line drawings, letters, and words.

There are a number of forms of AAC including; the Picture Exchange Communication System (PECS), Speech Generating Devices (SGD), Makaton signing, Voice Output Communication Aids (VOCA). Aided communication involves systems including PECS, SGD and VOCA. Methods of unaided communication, such as signing, can require learners to use complex motor skills to create signs with their hands, which may prove difficult with very young children with additional needs (van der Meer et al., 2011).

Psychological Basis

Communication plays a critical role in development and behaviour. Competency in communication abilities can influence a number of factors in one's life. Severe language impairments in the early years can have lasting consequences in relation to long term development. In particular when a young child is unable to speak, due to

a developmental delay for example, their ability to express their needs and engage in social interactions is compromised and this subsequently impacts on their ability to access an educational environment (Romski, Sevcik, Hyatt, & Cheslock, 2002).

To support individuals with communication difficulties, a range of early interventions have been devised and implemented, and this includes the use of AAC. The principles of AAC are rooted in behaviourist psychology approaches. Skinner (1953) stated that language is learned behaviour that is under the functional control of environmental variables, and behaviourists regard all behaviour as a response to a stimulus. AAC stems from this approach, similar to learning spoken language, as it teaches individuals to carry out a particular communicative behaviour. For example, when using PECS a symbol needs to be selected in order to get a response. This behaviour is then reinforced by the response of the other in the interaction.

Although primarily designed to be used as alternatives or methods to augment speech, the use of AAC has also been stated to facilitate speech development. Mirenda (2003) stated that the behavioural theory of automatic reinforcement could act as a potential explanation for this. According to this theory, if AAC is used with the spoken word and then followed by reinforcement, the frequency of both the use of AAC and speech production should increase.

The Picture Exchange Communication System (PECS)

PECS is a communication training programme that involves the use of pictures or symbols as methods of communication (Bondy & Frost, 1994). PECS is being used nationally and internationally with children and young people with communication difficulties due to additional needs (Siegel, 2000). A number of factors have been

stated as to why PECS is appealing; it uses few motor skills, unlike methods of signing; it is portable and low cost to implement; and it is reported that learners of PECS can master the skills to use it rapidly (Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002).

Speech Generating Devices (SGDs) or Voice Output Communication Aids (VOCA)

The use of VOCAs, or SGDs result in synthesized speech that can be understood universally, and this can facilitate interactions with others (Schepis & Reid, 1995). Additional benefits of VOCAs were found in the work of Schlosser, Belfiore, Nigam, Blischak and Hetzroni (1995). Their research indicated that the addition of voice output facilitated their participants' learning of symbols.

Furthermore, Schepis, Reid, Behrmann and Sutton (1998) evaluated the effects of VOCA in relation to communicative behaviours in young children with autism. Their findings indicated that the use of a VOCA supported an increase in communicative interactions. SGDs can be personalised to specific user groups and are often programmed to contain and produce age-appropriate and contextually relevant content with minimal effort (Schlosser, Sigafoos & Koul, 2009). In addition to this, the speech-output provided by the SGD may also provide useful feedback to the users (Boesch, Wendt, Subramanian, & Hsu, 2013).

Rationale

"Speech, language and communication is the most important thing in all our children ... It's their key to life" (Bercow, 2008). Communication is fundamental in relation to education, and in particular for pre-school children as early experiences of

communication can impact their subsequent experiences (DfE, 2015). A method of AAC that allows an individual to communicate is invaluable. Having a functional communication method or system can positively influence an individual's ability to make choices and subsequently can improve their overall quality of life, and this relates to their fundamental human rights (Bush & Scott, 2009; Hamm & Mirenda, 2006). Furthermore, Pituch et al. (2011) found that in a survey of 90 parents, communication skills were selected as being in the top 10 educational priorities for children with additional needs.

In relation to pre-school children and the need for additional communication support, Binger & Light (2006) gathered the demographic information of pre-schoolers who were stated to require AAC. Their results indicated that approximately 12% of pre-schoolers in receipt of special educational services required AAC, and found these children came from a wide range of backgrounds relating to both race and disability, and used a range of AAC. They concluded that these results indicated that settings should ensure they are prepared and equipped to provide appropriate support to children who require AAC.

In light of this, settings may wish to identify which AAC systems are most effective for pre-school children with additional needs. There are a number of systems that could be implemented, each with its own benefits and limitations and this forms the basis for this review.

Relevance to Educational Psychology (EP) Practice

In the SEND Code of Practice (DfE, 2015), guidance is described in relation to assessing progress in the early years. It is advised that assessment should look at the seven areas of learning, of which 'communication and language' is one. The

SEND Code of Practice also states the importance of identifying and implementing any special educational provision, and failure to do so, may result in subsequent difficulties and frustration with learning and also possible loss of self-esteem.

AAC is referred to in the new Code of Practice (DfE, 2015), when carrying out an assessment, the local authority should seek the child or young person's views, and should do so using appropriate methods that may include a method of AAC. In addition to this, when describing a number of reasonable steps that can be taken to support children and young people, they stated; "providing the child with a channel of communication" is key (DfE, 2015).

In relation to EP practice, according to the Bercow Report (2008), around 7% of 5 year olds starting school in England have significant speech and/or language difficulties, and around 1% have severe and complex speech, language and communication needs. These children may have difficulties understanding what is said by others, and have little spoken language and are more likely to be incoherent when they start school. The children will often need methods of AAC in order to communicate, and are likely to need specialist help in the long term.

The Rose Review (2005) emphasised the importance of speaking and listening skills, not only for literacy, but for the entire curriculum. In addition to this, in the research conducted by Snowling, Bishop, Stothard, Chipchase and Kaplan (2006) it was found that children who had persistent and severe speech and language delays and difficulties and low non-verbal IQ at age 5.5 years, were at higher risk of psychiatric morbidity in adolescence, again highlighting the impact that difficulties with communication can have later in life. EPs therefore play a key role in helping to support those with communication needs to ensure access to appropriate learning opportunities to maximise potential outcomes. EPs may become involved with

children and young people experiencing communication difficulties, and through assessment they can provide information relating to particular aspects of communication they may be experiencing difficulties in, for example, expressive language skills. Based on the findings from their assessments, EPs will then provide recommendations on how the child can be best supported in relation to these needs, and in some instances, a communication aid may be recommended.

Review Question

Based on the research above, this review aims to explore;

- How effective are methods of aided AAC in improving the functional communication skills of pre-school children with additional needs?

Are these communication skills generalisable and maintained?

Critical Review of the Evidence Base

Literature Search

Systematic searches of electronic databases PsychINFO, Educational Resource Information Centre (ERIC) and Web of Science were carried out during December 2015 using the search terms presented in Table 1.

In order to ensure that the studies included in this review were suitable for the purpose of the question, inclusion and exclusion criteria were devised and applied to the identified studies. These criteria are presented in Table 2 with a rationale for each criterion. Studies that met the inclusion criteria and are included in this review are presented in Table 3. As illustrated in Figure 1 the study selection process involved a number of stages. Initially, duplicates were removed, and a further 58 studies were excluded following a screen of the title and abstract. Following this, the

35 studies that were remaining were screened at full text. When the inclusion and exclusion criteria were applied, 29 studies were excluded and the remaining 6 studies were included in this review.

Table 1: Search terms and results

Search terms	ERIC Results	PsychInfo Results	Web of Science Results
AAC AND preschool AND disabilities	5	10	51
PECS AND preschool AND disabilities	6	5	13
SGD AND preschool AND disabilities	1	1	9
speech generating devices AND preschool AND disabilities	3	1	16
VOCA AND preschool AND disabilities	2	2	8
alternative augmentative communication AND preschoolers AND disabilities	7	0	9

Figure 1: Study Selection Process

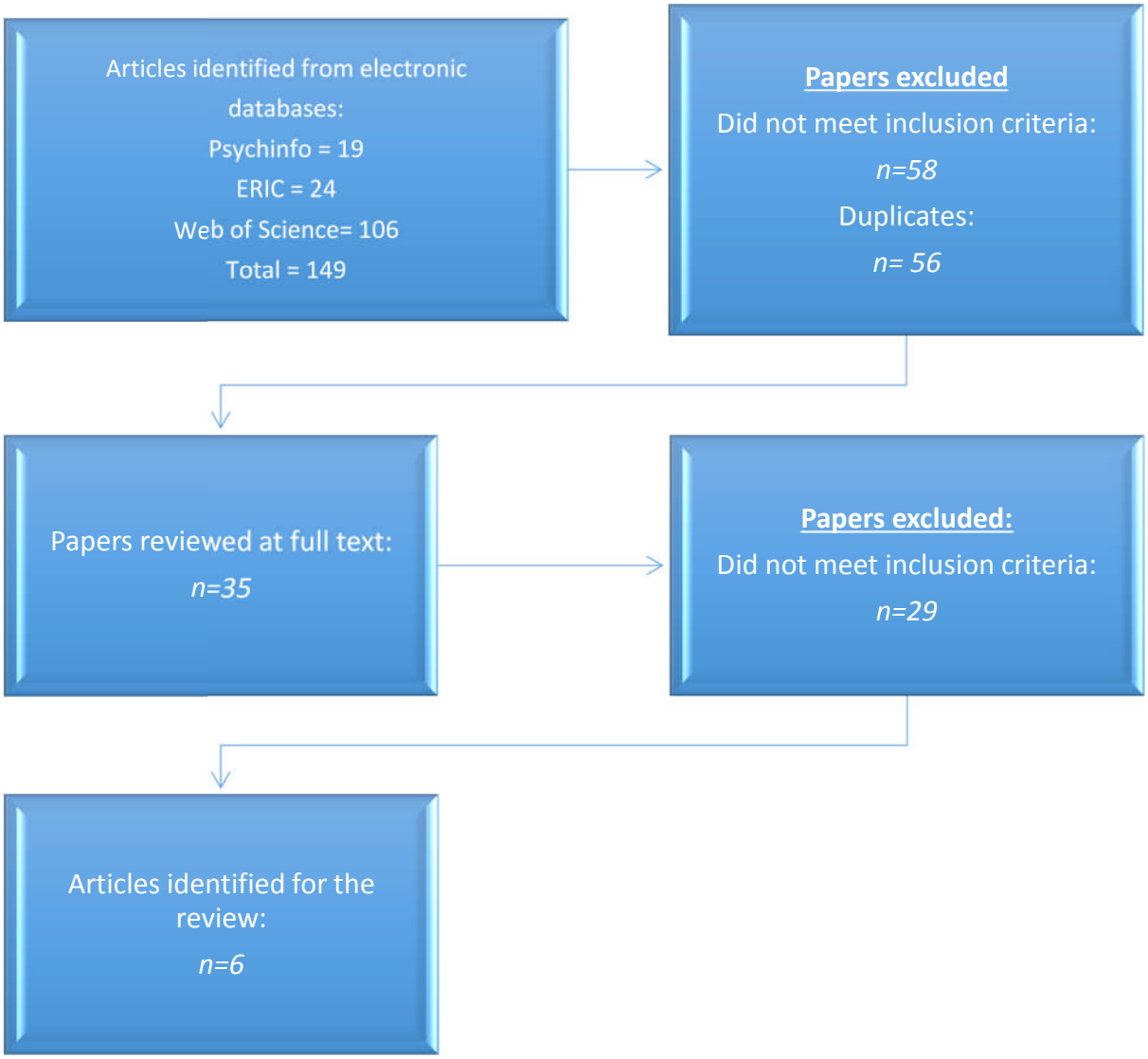

Table 2: Inclusion and exclusion criteria

	Inclusion	Exclusion	Rationale
1. Type of publication	a) Must be in a peer reviewed-journal or have been submitted for peer-review	a) Is not or has not been submitted for peer review i.e. Books, chapters.	Peer reviewers assess the quality of a study and therefore the study in these journals is likely to meet the required standards.
2. Design	a) Uses primary empirical quantitative data	a) Meta-analyses b) Research reviews c) Qualitative design	This review is exploring primary empirical data.
3. Intervention	a) Use of aided AAC including; SGD, PECS & VOCA. b) Targeting communication skills	a) No use of AAC b) Use of unaided AAC without equipment, e.g. Makaton, signing	The review question is based on exploring the effectiveness of aided AAC using equipment that is external to the individual. The review is aiming to explore school based interventions, therefore all

	Inclusion	Exclusion	Rationale
Intervention		c) Targeting non-communicative skills d) Carried out at home	participants need to be attending a setting and the intervention must be carried out in the setting.
4. Participants	a) Pre-schoolers b) Additional needs c) Attending provision e.g. nursery/pre-school	a) Above 5 years old b) Not attending provision c) No additional needs	The review question is based on a specific age group, pre-schoolers, with additional needs. In particular to explore the effectiveness of early intervention using aided AAC.
5. Language and setting	a) Must be written in English. b) No restrictions on country the research has taken place.	a) Study is not written in English	Reviewer does not have the resources to access other languages.
6. Date of publication	a) Studies published after 2000	a) Studies published before 2000	In order to ensure the review has the most up to date information, studies published in the past 15 years are to be included.

Table 3: Final list of included studies

Included studies
Beck, A.R., Stoner, J.B, Bock, S.J & Parton,T. (2008). Comparison of PECS and the use of a VOCA: A replication. *Education and Training in Developmental Disabilities*, *43*(2), 198-216.
Binger, C., & Light, J. (2007). The effect of aided AAC modeling on the expression of multi-symbol messages by preschoolers who use AAC. *Augmentative and Alternative Communication*, *23*(1), 30-43.
Bock, S. J., Stoner, J. B., Beck, A. R., Hanley, L., & Prochnow, J. (2005). Increasing functional communication in non-speaking preschool children: Comparison of PECS and VOCA. *Education and Training in Developmental Disabilities*, 264-278.
Cihak, D.F., Smith, C.C., Cornett, A., & Coleman, M.B. (2012). The use of video modeling with the picture exchange communication system to increase independent communicative initiations in preschoolers with autism and developmental delays. *Focus on Autism and Other Developmental Disabilities, 27*, 3-11.
Johnston, S.S., McDonnell, A.P., Nelson, C., & Magnavito, A. (2003). Teaching functional communication skills using augmentative and alternative communication in inclusive settings. *Journal of Early Intervention, 25*, 263-280.
Trembath, D., Balandin, S., Togher, L., & Stancliffe, R. J. (2009). Peer-mediated teaching and augmentative and alternative communication for preschool-aged children with autism. *Journal of Intellectual and Developmental Disability, 34*(2), 173-186.

Weight of Evidence (WoE)

The WoE framework (Gough, 2007) was used to appraise the quality and relevance of the studies included in the review.

WoE A involved generic judgements about the coherence and integrity of the evidence being made. For this purpose the 'Quality Indicators Within Single-Subject Research' checklist by Horner et al. (2005) was used to code different features of the study systematically. Through using the Horner coding protocols, it was possible to award each study a numerical rating for each key feature outlined in Appendix 3. This rating system then allowed a mean rating to be calculated for each study. WoE B involved specific judgements about the suitability of the research designs in relation to the review question. WoE C required specific judgements about the relevance of the focus of the evidence for the review question, to be made.

This framework then allowed the three sets of ratings (WoE A, B & C) to be averaged to give an overall assessment of the extent to which each study contributes to the review question, WoE D. Table 4 summarises the overall WoE.

Table 4: Critical appraisal for quality and relevance

Studies	WoE A Quality of methodology	WoE B Relevance of Methodology	WoE C Relevance of evidence to the review question	WoE D Overall weight of evidence
Beck, Stoner, Bock & Parton (2008)	Medium (1.8)	Medium (2)	Medium (2)	Medium (1.9)
Binger & Light (2007)	High (2.7)	Medium (2)	High (3)	High (2.6)
Bock, Stoner, Beck, Hanley & Prochnow (2005)	High (2.5)	Medium (2)	Medium (2)	Medium (2.2)
Cihak, Smith, Cornett, & Coleman (2012)	Medium (2.3)	Medium (2)	Medium (2)	Medium (2.1)
Johnston, McDonell, Nelson & Magnavito (2003)	Medium (2.1)	Medium (2)	High (3)	Medium (2.4)
Trembath, Balandin, Togher, Stancliffe (2009)	Medium (2.1)	Medium (2)	High (3)	Medium (2.4)

Low: Below 1.5; Medium: 1.6-2.4; High 2.5 or above

Participants

The number of participants in the included studies ranged from 3-6 and they were recruited from the USA (*n=5*) and Australia (*n=1*). When included studies were collated there were 25 children in total. All participants were pre-school children under 5 years old and were attending pre-school settings. The collated sample consisted of 18 males and 5 females. All participants were described as having additional needs; autism (*n=7*), developmental delay (*n=11*), Cerebral Palsy (*n=1*),

severe multiple disabilities (*n=1*), Pervasive Developmental Disorder-Not Otherwise Specified (*n=1*), Speech & Language impairment/apraxia (*n=1*), Prader-Willi Syndrome (*n=1*), Downs Syndrome (*n=1*) and DiGeorge Syndrome (*n=1*). The overall sample was primarily dominated by individuals with developmental disabilities, although did include participants with physical difficulties (e.g. Cerebral Palsy). In addition to this, there was also a gender imbalance within the sample, as the majority of the sample were male.

Design

All studies in this review used single case experimental designs. More specifically, the designs used in the studies included an alternating treatments design; (Beck et al., 2008; Bock et al., 2005; Cihak et al., 2012); a multiple baseline design (Johnston et al., 2003; Trembath et al., 2009); and a single subject, multiple probe research design (Binger & Light, 2007).

Research using a single case design enables investigation using small sample sizes. Single case designs can be used to establish causal implications and as they clearly document experimental control, they can be used to establish evidence based practices, similar to randomised control trials (Horner et al., 2005). In relation to research within education, single case designs can be beneficial. As the data collected focuses on individuals, these designs are suitable for heterogeneous populations, which can be particularly useful when carrying out research within special education. However as small samples are used in these designs, the results they generate must be generalised with caution, and this is reflected in none of the included studies receiving a high rating for WoE B.

Each study in the review was rated for methodological quality (WoE A) using a coding protocol relevant to the study design (Horner et al., 2005). Within single case design studies, the baseline condition acts as a within-participant control, similar to how a control group is used within a group design study (Horner et al., 2005). All studies established a baseline of the participants' use of the identified method of aided AAC to be used within their study.

Due to the nature of this review, aiming to explore the effectiveness of methods of aided AAC in developing the functional communication skills, it is important to assess if the effects of implementing this intervention are generalised or maintained. The overall aim of this intervention is to generalise the use of aided AAC to communicate functionally with others across a range of setting. Four out of the six reviewed studies did investigate generalisation and maintenance of the dependent variable within participants.

All designs provided a clearly operationalized definition of the target behaviours to be measured and each dependent variable was quantifiable. All six studies used more than one observer to record observations to minimise bias and increase reliability, and reported inter-observer agreement rates of at least 80% (Horner et al., 2005), all of which positively contributed to WoE A ratings.

Intervention

All studies included in this review used a method of aided AAC during the intervention phases. These included; PECS, VOCA, SGD, PECS and visual modelling and communication boards/symbols.

In the Johnston et al. (2003) study, each of the participants were provided with an AAC device that was designed to address their specified communication goals.

These devices were individualised for the participants in order to maximise their abilities and address their communication needs therefore was rated highly on WoE C, as the significance of the use of AAC was established. Two of the participants used a single-switch voice output device (VOCA), and the third participant used symbols in the form of coloured laminated line drawings from the Picture Communication Symbols Collection (Johnson, 1994).

In the studies by Beck et al. (2008) & Bock et al. (2005) VOCA and PECS were used. VOCA interventions used a 'GoTalk,' a lightweight digitised AAC device with a built in handle and nine static locations separated by a keyguard. PECS included the use of a 3 ring binder with a Velcro strip attached to the front. Both used symbols that were laminated coloured pictures with the name of the picture printed above it.

Two of the participants in the Binger & Light (2007) study used specific VOCAs (Mercury ™; EasyTalk ™) and the final participant used a communication board, with printed symbols and placed in protective laminated sheets.

Participants in the Cihak et al. (2012) study used PECS, and the picture icons were attached, with Velcro, to a notebook. This study also included a video modelling aspect. During the VM and PECS intervention participants were shown a video of a peer using PECS to request a desired item on a laptop computer, and the video was chosen based on the setting of the upcoming activity the participant was to engage in. Immediately following VM procedures, PECS instruction began as described in the PECS-only intervention. This descriptive account provided by Cihak et al. (2012) positively contributed to the medium rating for WoE A in relation to clearly describing conditions that can be easily replicated.

All participants in the Trembath et al. (2009) study used a SGD during the intervention phase. Specifically, a Talara-32™ SGD was used with spoken words and messages in a digitised speech format that were represented using colour Boardmaker ™ symbols.

Although a number of the studies utilised a VOCA/SGD, the device used in the Binger & Light (2007) study, differed from those used in the other studies as it used a single switch output device. In contrast to this, the other devices had a number of symbols on corresponding buttons that participants could choose to select. This is important to consider as participants using the single switch output device could have been more limited in their communicative behaviours, as the other VOCAs/SGDs had a number of options to select, that resulted in varying outputs and corresponded to different objects or items. However, the use of the single output devices could be simpler for the participants to use as no demands are placed on them in relation to choice making and representation of information, and therefore these single switch devices could be more appropriate for individuals with complex needs who could have difficulties with a multiple option VOCA/SGD.

Measures

Data was recorded and measured in various ways across the studies. The following descriptors were used to record the use of AAC; percentage of accuracy using AAC; (Bock et al., 2005; Beck et al., 2008); percentage of independent exchanges (Cihak et al., 2012); percentage correct use of symbolic communication (Johnston et al., 2003); communicative behaviours per minute (Trembath et al., 2009); and number of multi-symbol messages within 15-min play sessions (Binger & Light, 2007).

In relation to the recording and measurement of data, the studies did vary. The majority of studies were focused on the accuracy and use of the method of AAC, whereas one study, (Trembath et al., 2009) measured all communicative behaviours.

Findings

Percentage of all non-overlapping data (PAND) was used to calculate the effect sizes for each case in the studies included for this review.

Table 5: Percentage of all non-overlapping Data (PAND) for interventions using VOCA & SGD

Participant	Study	Baseline vs intervention	Baseline vs Maintenance & Generalisation	Intervention vs Maintenance & Generalisation
V1	Binger & Light	100%	88%	62%
T1	Binger & Light	100%	100%	91%
R1	Binger & Light	97%	N/A	N/A
J1	Johnston et al.,	92%	100%	86%
M1	Johnston et al.,	60%	N/A	N/A
D2	Beck et al.,	71%	N/A	N/A
S2	Beck et al.,	75%	N/A	N/A
M2	Beck et al.,	0%	N/A	N/A
B2	Beck et al.,	0%	N/A	N/A
D2	Bock et al.,	78%	100%	92%
J3	Bock et al.,	80%	80%	92%
R2	Bock et al.,	78%	83%	85%
C2	Bock et al.,	83%	100%	81%
A3	Bock et al.,	91%	100%	81%
N3	Bock et al.,	100%	100%	81%
J2	Trembath et al.,	76%	100%	91%
A2	Trembath et al.,	93%	81%	100%
S1	Trembath et al.,	100%	66%	100%

Table 6: Percentage of all non-overlapping Data (PAND) for interventions using PECS & VM

Participant	Study	Baseline vs intervention	Baseline vs Maintenance & Generalisation	Intervention vs Maintenance & Generalisation
A1	Cihak et al.,	100%	100%	54%
B1	Cihak et al.,	100%	100%	33%
D1	Cihak et al.,	100%	100%	64%
C1	Cihak et al.,	100%	100%	75%

Table 7: Percentage of all non-overlapping Data (PAND) for interventions using – PECS only

Participant	Study	Baseline vs intervention	Baseline vs Maintenance & Generalisation	Intervention vs Maintenance & Generalisation
A1	Cihak et al.,	100%	N/A	N/A
B1	Cihak et al.,	100%	N/A	N/A
D1	Cihak et al.,	100%	N/A	N/A
C1	Cihak et al.,	100%	N/A	N/A
D2	Beck et al.,	86%	N/A	N/A
S2	Beck et al.,	87%	N/A	N/A
M2	Beck et al.,	78%	N/A	N/A
B2	Beck et al.,	73%	N/A	N/A
D2	Bock et al.,	86%	100%	86%
J3	Bock et al.,	85%	100%	78%
R2	Bock et al.,	92%	83%	85%
C2	Bock et al.,	100%	100%	81%
A3	Bock et al.,	100%	100%	90%
N2	Bock et al.,	100%	100%	81%

Table 8: Percentage of all non-overlapping Data (PAND) for interventions using Communication Board/Symbols

Participant	Study	Baseline vs intervention	Baseline vs Maintenance & Generalisation	Intervention vs Maintenance & Generalisation
N1	Binger & Light	100%	92%	80%
R1	Binger & Light	94%	91%	80%
S1	Johnston et al.,	100%	100%	80%

Overall, the results provided from the included studies indicate that aided AAC was effective in improving functional communication skills in pre-school children with additional needs with high, medium and moderate effects frequently demonstrated in 'baseline & intervention' scores for all methods of aided AAC. In relation to the methodological relevance of the included studies, they were all given low or medium ratings. This is important to note as results should be interpreted with caution, particularly in relation to generalisability of the findings. Studies that utilised an active comparison group, for example, randomised control trials, would have received a high rating for methodological relevance and could have provided more reliable data. As seen in Table 5, for 2 participants there was no effect found for the use of VOCA. This is important to note, as this demonstrates that although positive outcomes have been found, it is not possible to assume that AAC will be accessible for all individuals. The Beck et al. (2008) study that provided these results received a low rating for methodological relevance, and this should be considered in relation to trustworthiness of the data.

Effects for PECS, and PECS & VM showed the highest effects in 'baseline & intervention' scores, with effects ranging from 73% (moderate) to 100% (high).
The Beck et al. (2008) research showed the most within study variance, with intervention effectiveness ranging from no effect to very effective.
The research carried out by Bock et al. (2005) showed the strongest results for PECS with all of these participants demonstrating large effects (100%) in 'baseline & intervention' and 'baseline & maintenance/generalisation'. Table 10 shows overall effect sizes split by intervention. Both of the studies that used communication boards/symbols (Binger & Light; Johnston et al.,) rated highly on WoE C and high

and medium effects were found across conditions. As they received these high ratings, this is promising in relation to the trustworthiness of the data and its positive results.

Table 9: Percentile distributions & descriptors for PAND (Parker et al., 2011)

Percentile Rank	**10th**	**25th**	**50th**	**75th**	**90th**
PAND	.20	.38	.64	.86	1.00
Effect Size	No effect	Small	Moderate	Medium	Large

Table 10: Overall mean effect sizes split by intervention

Effect size	**VOCA & SGD**	**PECS**	**PECS & VM**	**Communication Board/Symbols**
Baseline vs intervention	76.66% **(Medium)**	91.92% **(Large)**	100% **(Large)**	98% **(Large)**
Baseline vs maintenance/generalisation	91.5% **(Large)**	97.16% **(Large)**	100% **(Large)**	94.33% **(Large)**
Intervention vs maintenance/generalisation	86.83% **(Large)**	83.5% **(Medium)**	56.5% **(Moderate)**	80% **(Medium)**

Maintenance & Generalisation

Four of the six included studies recorded maintenance and generalisation data for the communicative behaviour rationalised as their dependent variable and this was reflected in ratings for WoE A & B. Upon exploration of the data, a number of studies showed high effects (91-100%) between ‘baseline & maintenance/generalisation’

phases. To explore this further, PAND was also calculated between 'intervention & maintenance/generalisation' phases. The results were more varied when comparing these phases, with effects ranging from large (VOCA/SGD), to moderate (PECS & VM) and medium (PECS; Communication Board/Symbols).

This was important to explore as anticipated, the majority of participants made positive gains from baseline to intervention and maintenance/generalisation phases. Comparing intervention phases was also necessary as during intervention participants are supported in developing the skill, and it was important to explore if this skill is maintained over time, particularly following the implementation and subsequent removal of the support with the intervention.

Comparing these phases on individual cases also offered more variability within the findings. Excluding the 2 participants for which no effect of intervention was found, in the Cihak et al. (2012) study, the lowest effects of the review were demonstrated in 'intervention & maintenance/generalisation', at 33 & 54% respectively, however, as with the Beck et al. (2008) study, this study also received a low rating for methodological relevance. In contrast, to the high (100%) effects found for participants when comparing other phases. It is therefore important to consider individual differences which exist regarding preference and success with the different methods of AAC. Only one of the included studies received an overall WoE D rating of high (Binger & Light, 2007). The remaining 5 included studies received medium ratings for WoE D.

Conclusions

This review examined six studies, all of which utilised a single case design to explore the effectiveness of aided AAC in increasing functional communication skills in pre-

school children with additional needs. Overall, the reviewed studies provided promising evidence to support the effectiveness of aided AAC for increasing the child's functional communication skills. However, the presence of slight variability in data does raise questions regarding accessibility of these methods of AAC for all children, as for some participants, there was no effect of intervention in increasing functional communication skills.

From the combined results, PECS appeared to be the most effective form of aided AAC in improving functional communication skills. However, the generalisability of the results from the studies must be considered. Although all of the studies in this review showed medium or large effects for increases in functional communication skills, the small number of participants used in these studies can make it difficult to establish if other participants would experience the same results. This is particularly pertinent when within the same study there are participants who have achieved small or no effect from the intervention.

Children with developmental disabilities can sometimes fail to develop the ability to speak (National Research Council, 2001), therefore a method of AAC that can provide them with a means of functional communication can result in significant benefits to a child or young person's education. Due to this, the development of these skills in the early years appears to be promising intervention for pre-school children presenting with difficulties in relation to their expressive communication skills. In relation to exploring if aided or unaided methods of AAC are more appropriate, van der Meer et al. (2012) stated that it may be more difficult to learn methods of signing as they require recall memory whereas graphic symbols may be less demanding on children's working memory (Iacono & Duncum, 1995). In relation

to pre-school children in particular, these findings could also be supportive of the use of aided AAC rather than unaided AAC, due to greater demands placed on individuals when using unaided methods of AAC.

Limitations

Although the use of single case research has a number of benefits, and recording at various intervals support their robustness, there are limitations of research utilising the designs. Generalisability of findings should be approached with caution as the samples used in these studies are often heterogeneous. Although a range of additional needs/diagnoses were included in this review, the overall sample was dominated by individuals without specific physical disabilities. The use of aided AAC requires the use of fine (PECS/symbols) and gross (VOCA/SGD) motor skills. Although these aided methods of AAC are deemed to be easier to use, and more accessible than unaided methods of AAC (e.g. Makaton signing) some degree of motor skill proficiency is necessary (van der Meer et al., 2012).

Recommendations

This systematic literature review aimed to explore if methods of aided AAC supported pre-school children with additional needs in improving their functional communication skills. The positive increases in functional communication skills for the participants in this study are promising, as the majority of participants showed an increase in functional communication skills using methods of aided AAC. Results did vary depending on which method of AAC participants were using, and variables relating to the reasons for this could also be explored. In light of the findings from this

review, EPs may wish to tentatively recommend the use of aided AAC for young pre-school children having difficulties with communication as the results from the collated studies have demonstrated positive results, and they place less demand on motor skills than unaided methods of AAC.

In relation to the practical use of AAC with pre-school children, it is important to consider a number of factors. The varying needs of the children should be carefully considered before implementation of an AAC system to ensure that it is appropriate for both their communication need and also cognitive functioning. For example, very young children may have difficulties understanding the external representation of pictures or symbols in relation to objects, and in such cases, some AAC systems may not be effective. Due to this, it is important to ensure that the AAC system is both accessible and meaningful for the individual child to maximise possible success.

To conclude, whilst the current evidence suggests aided AAC can be effective in increasing functional communication skills for pre-school children with additional needs, further research in this area would be beneficial. Firstly, due to small sample sizes, more evidence would be needed to explore if these results could be generalised to a wider range of pre-school children with additional needs. In addition to this, research in relation to maintenance of the taught communication skills, and generalisation across a number of contexts would be beneficial. Research of this nature would further strengthen the evidence base for the use of aided AAC for children with additional needs.

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Appendices

Appendix 1: Excluded studies screened at full text

Study Reference	Excluded based on:
Barker, R. M., Akaba, S., Brady, N. C., & Thiemann-Bourque, K. (2013). Support for AAC use in preschool, and growth in language skills, for young children with developmental disabilities. *Augmentative and Alternative Communication*, *29*(4), 334-346.	Inclusion criteria: 2A
Binger, C., & Light, J. (2006). Demographics of preschoolers who require AAC. Language, Speech, and Hearing Services in Schools, 37, 200-208.	Inclusion criteria: 2A
Brady, N.C., Thiemann-Bourque, K., Fleming, K.,& Matthews, K. (2013). Predicting language outcomes for children learning augmentative and alternative communication: Child and environmental factors. Journal of Speech, Language, and Hearing Research, 56, 1595-1612.	Exclusion criteria: 3B
Charman, Tony [Ed]. (2004). Editorial Preface. Journal of Autism and Developmental Disorders, 34, 365-366.	Exclusion Criteria: 1A
Cosbey, J. E., & Johnston, S. (2006). Using a single-switch voice output communication aid to increase social access for children with severe disabilities in inclusive classrooms. Research and Practice for Persons with Severe Disabilities, 31(2), 144-156.	Exclusion Criteria: 4A
Dropik, P. L., & Reichle, J. (2008). Comparison of accuracy and efficiency of directed scanning and group-item scanning for augmentative communication selection techniques with typically developing preschoolers. American Journal of Speech-Language Pathology, 17(1), 35-47.	Exclusion Criteria: 4C
Fallon, K.A., Light, J.C., & Paige, T.K. (2001). Enhancing vocabulary selection for preschoolers who require augmentative and alternative communication (AAC). American Journal of Speech-Language Pathology, 10, 81-94.	Inclusion Criteria: 4C
Ganz, J.B., Earles-Vollrath, T.L., Mason, R.A., Rispoli, M.J., Heath, A.K & Parker, R.I. (2011). An aggregate study of single-case research involving aided aac: Participant characteristics of individuals with autism spectrum disorders. Research in Autism Spectrum Disorders, 5, 1500-1509.	Exclusion Criteria: 2A
Ganz, J.B., Davis, J.L., Lund, E.M., Goodwyn, F.D., & Simpson, R.L. (2012). Meta-analysis of PECS with individuals with ASD: Investigation of targeted versus non-targeted outcomes, participant characteristics, and implementation phase. Research in Developmental Disabilities, 33, 406-418.	Exclusion Criteria: 2A
Ganz, J. B., Mason, R. A., Goodwyn, F. D., Boles, M. B., Heath, A. K., & Davis, J. L. (2014). Interaction of participant characteristics and type of AAC with individuals with ASD: A meta-analysis. *American journal on intellectual and developmental disabilities*, *119*(6), 516-535.	Exclusion Criteria: 2A
Gevarter, C., O'Reilly, M. F., Rojeski, L., Sammarco, N., Sigafoos, J., Lancioni, G. E., & Lang, R. (2014). Comparing Acquisition of AAC-Based Mands in Three Young Children with Autism Spectrum Disorder Using iPad® Applications with Different Display and Design Elements. Journal of autism and developmental disorders, 44(10), 2464-2474.	Exclusion Criteria: 3D
Hochstein, D. D., McDaniel, M. A., Nettleton, S., & Neufeld, K. H. (2003). The Fruitfulness of a Nomothetic Approach to Investigating AACComparing	Exclusion Criteria: 4A

Study Reference	Excluded based on:
Two Speech Encoding Schemes Across Cerebral Palsied and Nondisabled Children. American Journal of Speech-Language Pathology, 12(1), 110-120.	
Johnston, S. S., Davenport, L., Kanarowski, B., Rhodehouse, S., & McDonnell, A. P. (2009). Teaching sound letter correspondence and consonant-vowel-consonant combinations to young children who use augmentative and alternative communication. Augmentative and Alternative Communication, 25(2), 123-135.	Exclusion Criteria: 4A
Kouri, T. (1988). Effects of simultaneous communication in a child-directed treatment approach with preschoolers with severe disabilities. *Augmentative and Alternative Communication*, *4*(4), 222-232.	Exclusion Criteria: 6A
Lee, Y., Jeong, S. W., & Kim, L. S. (2013). AAC intervention using a VOCA for deaf children with multiple disabilities who received cochlear implantation. International journal of pediatric otorhinolaryngology, 77(12), 2008-2013.	Exclusion Criteria: 4A
Lorah, E. R., Parnell, A., & Speight, D. R. (2014). Acquisition of sentence frame discrimination using the iPad™ as a speech generating device in young children with developmental disabilities. *Research in Autism Spectrum Disorders*, *8*(12), 1734-1740.	Exclusion Criteria: 4A
McNaughton, S. (1993). Graphic representational systems and literacy learning. *Topics in Language Disorders*, *13*(2), 58-75.	Exclusion Criteria: 6A
Olin, A. R., Reichle, J., Johnson, L., & Monn, E. (2010). Examining dynamic visual scene displays: Implications for arranging and teaching symbol selection. American Journal of Speech-Language Pathology, 19(4), 284-297.	Exclusion Criteria: 4C
Roberts, Joanne E [Ed], Chapman, Robin S [Ed] & Warren, Steven F [Ed]. (2008). Speech and language development and intervention in Down syndrome and fragile X syndrome. Speech and language development and intervention in Down syndrome and fragile X syndrome. Baltimore, MD, US: Paul H Brookes Publishing, US.	Exclusion Criteria: 1A
Roche, L., Sigafoos, J., Lancioni, G. E., O'Reilly, M. F., Schlosser, R. W., Stevens, M., ... & Carnett, A. (2014). An evaluation of speech production in two boys with neurodevelopmental disorders who received communication intervention with a speech-generating device. International Journal of Developmental Neuroscience, 38, 10-16.	Exclusion Criteria: 4A
Schwartz, I. S., Garfinkle, A. N., & Bauer, J. (1998). The picture exchange communication system communicative outcomes for young children with disabilities. *Topics in Early Childhood Special Education*, *18*(3), 144-159.	Exclusion Criteria: 6A
Sutton, A., Trudeau, N., Morford, J., Rios, M., & Poirier, M. A. (2010). Preschool-aged children have difficulty constructing and interpreting simple utterances composed of graphic symbols. *Journal of Child Language*, *37*(01), 1-26.	Exclusion Criteria: 4C
Thistle, J. J., & Wilkinson, K. (2009). The effects of color cues on typically developing preschoolers' speed of locating a target line drawing: Implications for augmentative and alternative communication display design. *American Journal of Speech-Language Pathology*, *18*(3), 231-240.	Inclusion Criteria: 3B
Trembath, D., Balandin, S., & Togher, L. (2007). Vocabulary selection for	Inclusion

Study Reference	Excluded based on:
Australian children who use augmentative and alternative communication. Journal of Intellectual and Developmental Disability, 32(4), 291-301.	Criteria: 2A
Trudeau, N., Cleave, P. L., & Woelk, E. J. (2003). Using augmentative and alternative communication approaches to promote participation of preschoolers during book reading: a pilot study. *Child Language Teaching and Therapy*, *19*(2), 181-210.	Exclusion Criteria: 4C
Wilkinson, K. M., Carlin, M., & Jagaroo, V. (2006). Preschoolers' speed of locating a target symbol under different color conditions. *Augmentative and Alternative Communication*, *22*(2), 123-133.	Exclusion Criteria: 4C
Wilkinson, K. M., & McIlvane, W. J. (2013). Perceptual factors influence visual search for meaningful symbols in individuals with intellectual disabilities and Down syndrome or autism spectrum disorders. American journal on intellectual and developmental disabilities, 118(5), 353-364.	Exclusion Criteria: 3C

Appendix 2: Coding Protocol (WoE A)

Horner et al., 2005: The Use of Single-Subject Research to Identify Evidence-Based Practice in Special Education

Quality Indicators Within Single-Subject Research

Article Reference: Binger, C., & Light, J. (2006). Demographics of preschoolers who require AAC. *Language, Speech, and Hearing Services in Schools*, *37*(3), 200-208.

Description of Participants and Setting

Participants are described with sufficient detail to allow others to select individuals with similar characteristics; (e.g., age, gender, disability, diagnosis).

☐ **Yes** Age, gender, diagnosis and also descriptive information relating to the presentation of the participants was given.

☐ **No**

☐ **N/A**

☐ **Unknown/Unable to Code**

The process for selecting participants is described with operational precision.

☐ **Yes** Criteria for participation was clearly described with 9 key points.

☐ **No**

☐ **N/A**

☐ **Unknown/Unable to Code**

Critical features of the physical setting are described with sufficient precision to allow replication.

☐ **Yes** 7 pretend play scenarios were set up including washing a baby, having a tea party, playing with vehicles, playing with a farm, eating fast food, going to a birthday party, and cleaning the kitchen. The toys used in the scenarios were also described.

☐ **No**

☐ **N/A**

☐ **Unknown/Unable to Code**

Overall Rating of Evidence: ☐ 3 ☐ 2 ☐ 1 ☐ 0

Dependent Variable

Dependent variables are described with operational precision.

☐ **Yes** Frequency of multi-symbol combination productions during 15-min play sessions.

☐ **No**

☐ **N/A**

☐ **Unknown/Unable to Code**

Each dependent variable is measured with a procedure that generates a quantifiable index.

☐ **Yes**

☐ **No**

☐ **N/A**
☐ **Unknown/Unable to Code**

Measurement of the dependent variable is valid and described with replicable precision.
☐ **Yes**
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Dependent variables are measured repeatedly over time.

☐ **Yes**
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Data are collected on the reliability or inter-observer agreement associated with each dependent variable, and IOA levels meet minimal standards
☐ **Yes** 95%
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Overall Rating of Evidence**:** ☐ 3 ☐ 2 ☐ 1 ☐ 0

Independent Variable
Independent variable is described with replicable precision.
☐ **Yes** Aided AAC models during play scenarios
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Independent variable is systematically manipulated and under the control of the experimenter.
☐ **Yes**
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Overt measurement of the fidelity of implementation for the independent variable is highly desirable.
☐ **Yes**
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Overall Rating of Evidence: ☐ 3 ☐ 2 ☐ 1 ☐ 0

Baseline

The majority of single-subject research studies will include a baseline phase that provides repealed measurement of a dependent variable and establishes a pattern of responding that can be used to predict the pattern of future performance, if introduction or manipulation of the independent variable did not occur.

☐ **Yes**
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Baseline conditions are described with replicable precision.

☐ **Yes**
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Overall Rating of Evidence: ☐ 3 ☐ 2 ☐ 1 ☐ 0

Experimental Control/internal Validity

The design provides at least three demonstrations of experimental effect at three different points in time.

☐ **Yes** Baseline, intervention, generalisation & maintenance phases.
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

The design controls for common threats to internal validity (e.g., permits elimination of rival hypotheses).

☐ **Yes**
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

The results document a pattern that demonstrates experimental control.

☐ **Yes** Data was collected over a range of sessions, and data was recorded on at least 3 different points in time.
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Overall Rating of Evidence: ☐ 3 ☐ 2 ☐ 1 ☐ 0

Social Validity

Experimental effects are replicated across participants, settings, or materials to establish external validity.

☐ **Yes** Generalisation & maintenance phases.
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

The dependent variable is socially important.

☐ **Yes**
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

The magnitude of change in the dependent variable resulting from the intervention is socially important.

☐ **Yes** Increases in functional communication skills are very important, particularly for pre-school children in early stages of development and learning.
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Implementation of the independent variable is practical and cost effective.

☐ **Yes** AAC systems can be relatively simple to implement.
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Social validity is enhanced by implementation of the independent variable over extended time periods, by typical intervention agents, in typical physical and social contexts.

☐ **Yes** Maintenance phases took place at 2, 4 and 8 weeks following generalisation phase.
☐ **No**
☐ **N/A**
☐ **Unknown/Unable to Code**

Overall Rating of Evidence: ☐ 3 ☐ 2 ☐ 1 ☐ 0

<u>Average WoE A across the 6 judgement areas:</u>

Sum of X / N = 16/6 = 2.7

X = individual quality rating for each judgement area

N = number of judgement areas

Overall Rating of Evidence: ☐ 3 ☐ 2 ☐ 1 ☐ 0

Appendix 3

WoE B: Methodological Relevance

This weighting considers whether the methodological design was suitable for evaluating the effectiveness of aided AAC on the functional communication skills of pre-school children with additional needs. To decide the ratings given for WoE B, an evidence hierarchy was employed (Evans, 2003) to influence descriptors. Evidence hierarchies typically place studies with high threats to validity at the bottom (e.g. studies with no control group) and those less prone to threats to validity at the top (e.g. randomised control trials (RCTs)).

In order to receive a *'High'* weighting an 'active' comparison group needs to be employed as this allows the effectiveness of the intervention to be examined. Pre, post and follow up measures are necessary to receive a 'high' weighting as it not only provides a baseline of participants and the impact of the intervention but also information as to whether the effects of the intervention are maintained when the intervention ceases.

In order to receive a '*Medium*' weighting for methodological relevance a between group study needs to have used a comparison group (e.g. waitlist control/no intervention), although the groups will not have not been accurately matched. Single case experimental designs may have also been used, in which case the levels of experimental control must be demonstrated (e.g. collecting data at various time-points during the intervention phase).

In order to receive a '*Low*' weighting for methodological relevance the study needs to have taken pre and post intervention measures, but used no comparison group. Non-experimental designs (e.g. observations, case reports) may also have been used. Single case designs may have also been used, but would have not demonstrated levels of experimental control (e.g. collecting data at various points during the intervention phase).

WoE C: Study Focus Relevance

In order to receive a '*High*' weighting for relevance the study sample must be comprised of pre-school children with a diagnosis of an additional need. The significance of the use of AAC for the child must have been established, (they must have limited communication skills). The functional communication skill operationalized as the dependent variable must have been identified as relevant by a child's teacher, parent or other caregiver.

In order to receive a '*Medium*' weighting for relevance the study sample must be comprised of pre-school children with a diagnosis of an additional need. Either the significance of the intervention or the relevance of the dependent variable for the child must have been established.

In order to receive a '*Low*' weighting for relevance, the study sample must be comprised of pre-school children with a diagnosis of an additional needs. The significance of the use of AAC for the child may have been established.

Appendix 4: Mapping the field

Author & Aims	N	Participants	Location	Design	Type of AAC	Setting
1. Beck, Stoner, Bock, & Parton (2008) This study compares use of the Picture Exchange Communication System (PECS) and a Voice Output Communication Aide (VOCA) with four preschool children who were either non-speaking or limited in their ability to speak and did not use an AAC system to communicate functionally.	4	3 males:1 female Autism (n=2), S&L impairment/ apraxia, (n=1) impairment, PDD-NOS (n=1) Ages not specified (pre-school >5 years)	USA	Alternating treatments design	VOCA & PECS	All attending pre-school settings
2. Binger & Light (2007) To evaluate the impact of using aided AAC modelling to support multi-symbol message production.	5	2 Males:3 females 3:05 – 4:06 years Prader-Wili (n=1), Downs Syndrome (n=1), DiGeorge Syndrome (n=1), Dev delay (n=2)	USA	Single subject, multiple probe research design	Communication boards	Pre-school
3. Bock, Stoner, Beck, Hanley, & Prochnow (2005) The purposes of this study were to build on the base of support for, and to compare the relative effectiveness of two types of AAC (PECS & VOCA) with preschool children who have complex communication needs.	6	Males 4 years old Developmental delay (n=6)	USA	Alternating treatments design	VOCA & PECS	Attending pre-school settings
4. Cihak, Smith, Cornett, & Coleman (2012) To evaluate if the use of VM and PECS would increase independent communicative initiations in preschool-age students	4	3 males:1 female 3 years old Autism (n=2) & Developmental delay (n=2)	USA	Alternating treatments design	PECS	All attending a developmental preschool classroom.

Author & Aims	N	Participants	Location	Design	Type of AAC	Setting
5. Johnston, McDonnell, Nelson & Magnavito (2003) To assess functional communication using AAC devices in pre-school children in autism.	3	1 male: 2 females Pre-school: 3-4 years Developmental delay, (n=1) Athetoid Cerebral palsy (n=1), severe multiple disabilities (n=1)	USA	Multiple baseline	Symbols/switch	Inclusive pre-school classrooms
6. Trembath, Balandin, Togher, & Stancliffe (2009) To assess the effectiveness of two communication interventions for preschool-aged children with autism.	3	Males Autism (n=3) 3,4 & 5 years	Australia	Multiple-baseline	Naturalistic teaching vs Naturalistic teaching with SGD vs generalisation	Pre-school