

Case Study 1: An Evidence-Based Practice Review Report

***Theme: School Based interventions for Children and Young People with
Special Educational Needs (SEN)***

***How effective is the Picture Exchange Communication System (PECS) for
children of primary-school age or younger with autism?***

Summary

This systematic literature review examines the effectiveness of the Picture Exchange Communication System (PECS) in supporting children with autism in early years and primary school settings to develop their functional communication skills. PECS is a low-tech form of an Aided Augmentative and Alternative Communication system (AAC). AAC systems assist students who are unable to use conventional speech either compensating for a lack of or serving as a replacement. This review critically evaluates five studies. Each study was evaluated using a weight of evidence framework (Gough, 2007) and a coding protocol for experimental and quasi-experimental designs (Gersten et al., 2005). The studies examined the effectiveness of PECS on a range of measures including social and communication interactions, initiations, speech and joint attention. Each study found that PECS had a positive impact on one or more of the measures of children's functional communication skills. Implications are discussed along with future recommendations.

Introduction

Aided Augmentative and Alternative Communication (AAC)

Not all children will learn to or be able to use conventional speech (Ganz et al., 2012). For these individuals AAC systems compensate for their lack of speech or serve as a replacement for unintelligible speech. AAC has three different communication systems: unaided (gestures, sign language), low-tech aided (taking a picture from a board or book) and high-tech aided (speech-generating devices) (Communication Matters, 2013). This systematic literature review is examining the effectiveness of a low-tech aided communication system.

Picture Exchange Communication System (PECS)

PECS is an AAC system designed to teach functional communication skills to individuals who have limited speech through initiating communicative interactions in a social context (Bondy & Frost, 2001). It does so through the use of symbols or pictures, relying on behavioural principles to teach functional communicative behaviours allowing children to request objects (Howlin, Gordon, Pasco, Wade, & Charman, 2007). The behaviour is reinforced through obtaining the desired item. It is used with children on the autistic spectrum as tangible outcomes are initially more motivating than social ones (Bondy & Frost, 1994).

PECS is comprised of six instructional phases (Bondy & Frost, 1998). The first two phases teach children to exchange pictures for preferred items or activities. Phase II builds on Phase I through teaching generalisation across items and pictures, distance and communicative partners. In Phase III children are taught picture-to-object discriminations between their preferred and non-preferred items (exchanging

the right picture for an object) and corresponding object-to-picture relations (Bondy & Frost, 1994). Once students can request a range of desired items, across settings and from different people, they can then move onto Phase IV which focuses on commenting (Bondy & Frost, 2001). In Phase IV children construct and exchange sentences using a sentence strip with two symbols “I want” and the desired “item”. This then moves onto Phase V where children learn to respond to the question “What do you want?” using the sentence strip. In Phase VI children are taught to comment both spontaneously and to a question such as “What do you have?” or “What do you see?” (Bondy & Frost, 1994). Through the six PECS phases children learn to approach a communicative partner, develop a broad vocabulary, and develop sentence structure and communicative functions (Bondy & Frost, 2001).

Language and Communication

“Speech, language and communication is the most important thing in all our children...It’s their key to life” (Bercow, 2008, p.17).

Speaking, listening, reading and writing are core communication skills central to children’s intellectual, emotional and social development (Rose, 2006). The importance of these skills is stated in the Early Years Foundation Stage framework which sets the standards for development, learning and care of children from birth to five years (DfE, 2014). It identifies communication and language as one of three particularly vital areas that provides children with the opportunity to experience a language rich environment, develop confidence and skills when expressing themselves and learn to speak and listen. Children and young people who do not have the ability to communicate or understand language will face many difficulties,

academic and social (interacting with those around them and within society) (Bercow, 2008).

Autism and Communication

Autism is a neurodevelopmental disorder that is commonly known as autism spectrum disorder (ASD) (Geschwind, 2011). Children can be diagnosed with autism from as early as 18 months through the use of checklists or other observational tools, which allow observers to consider signs and symptoms systematically (Frederickson & Cline, 2015). One of the core diagnostic features of autism is an impairment in social communication (Charman, 2011). Other areas in which they may experience difficulties include imagination, language and communication which may impact relationships with others, along with other potential areas of special educational needs (SEN) including sensory needs (DfE, 2014).

Language and communication is a priority area for students with autism, as it has been estimated that around 25% live without functional speech (Volkmar, Lord, Bailey, Schultz, & Klin, 2004). Previous studies have shown that children with autism have particular social communicative difficulties; initiating communication (Potter & Whittaker, 2001), reciprocating interactions, motor imitation, understanding language, conventional use of gestures (Wetherby, Watt, Morgan, & Shumway, 2007) and joint attention skills (pointing or looking in the same direction as another person) (Bruinsma, Koegel, & Koegel, 2004). They are also not as motivated by the social effects of communication (praise) than they are by concrete effects (gaining a desired item) (Bondy & Frost, 1998).

Relevance to Educational Psychology Practice

The prevalence of autism has significantly increased over the last 30 years, not only in the United Kingdom (UK) but in other developed countries around the world (Fombonne, 2003). The accepted rate in the UK is currently around 1% (NICE, 2013). With prevalence increasing and a move towards a more inclusive educational system (DfES, 2004), more students with autism are being educated in mainstream schools (Keen & Ward, 2004). Teachers have reported that they have not received the required training or support to effectively provide for students (Robertson, Chamberlain, & Kasari, 2003). With each child having such diverse learning and language needs, schools must incorporate a joint approach working with external professionals and where appropriate commissioning specialist services (including Educational Psychologists) (DfE, 2015).

Educational Psychologists (EP) can be commissioned by schools to support students with autism develop language and communication skills. This can be achieved through early identification and intervention which can significantly reduce the long term impacts of social and communication deficits and the need for more costly interventions later on (DfE, 2015). Alongside early identification, EPs can recommend, train and consult with school staff on interventions, such as PECS. With recent reforms over the past few years there is now a push to adopt strategies and interventions that are evidence based (Simpson, 2005). Therefore if PECS, which is already extensively used (Howlin et al., 2007), is to be recommended by an EP an evaluation of its effectiveness must be undertaken. This systematic review will support EPs in evaluating its effectiveness.

Review Question

How effective is the Picture Exchange Communication System (PECS) for children of primary-school age or younger with autism?

Critical Review of the Evidence Base

Literature Search

On the 13th January 2018 a systematic literature search was conducted using the online databases PsycINFO and Education Resources Information Center (ERIC). The search terms used are presented in Table 1. Literature searching terminology ‘AND’ and ‘OR’ were used to combine terms.

Table 1 Search Terminology

Intervention (Title)	Participants (Title)	Participants (Abstract)
PECS OR Picture Exchange Communication System	Children	Special Educational Needs

The results from the two databases were combined giving 47 initial studies, 12 of which were duplicates. To ensure the remaining 35 studies were appropriate to the review question, the inclusion and exclusion criteria presented in Table 2 was applied.

Table 2 *Inclusion and Exclusion Criteria*

	Inclusion criteria	Exclusion criteria	Rationale
1. Participants	<p>a) Participants must be primary school aged or younger</p> <p>b) Participants must have a diagnosis of autism or autistic spectrum disorder (ASD)</p>	<p>Participants who are older than primary age</p> <p>Participants who do not have a diagnosis of autism or ASD</p>	<p>Review is looking specifically at the effectiveness of PECS on children of primary-school age or younger who have been diagnosed with autism</p>
2. Study design	<p>a) The study must be a primary empirical paper</p> <p>b) The study must be a between groups or within groups design</p> <p>c) The study must use pre and post measures</p> <p>d) The study must look at the effectiveness of PECS</p>	<p>Non-primary empirical data e.g. meta-analyses, literature review, descriptions about PECS</p> <p>The study must not be single case design</p> <p>Study does not use pre and post measures</p> <p>The study doesn't look at the effectiveness of PECS</p>	<p>The data needs to be original so that statistical calculations to compare studies, such as effect sizes can be calculated</p> <p>The review aims to collate findings to determine the effectiveness of the intervention</p> <p>The review is examining the effectiveness of PECS thus pre and post measures are needed</p> <p>The review is looking at the effectiveness of PECS</p>
3. Publication	Published in a peer reviewed journal	Not published in a peer reviewed journal	Studies that have been reviewed by an expert will be of higher quality

After the initial search and the removal of duplicates, the titles were read and 13 were excluded. For the remaining 22, abstracts were screened with 13 more excluded. On the nine remaining studies, an ancestral search was conducted which screened the titles for related terminology. Five studies were identified with four of these excluded after reading the abstract. One study from the ancestral search and nine database studies were then read. The five papers which did not meet the inclusion criteria were excluded with the remaining five included in the review presented in Table 3. Figure 1 is a summary of this process and the excluded studies are in Appendix A.

Figure 1 Flow Chart of the Literature Search

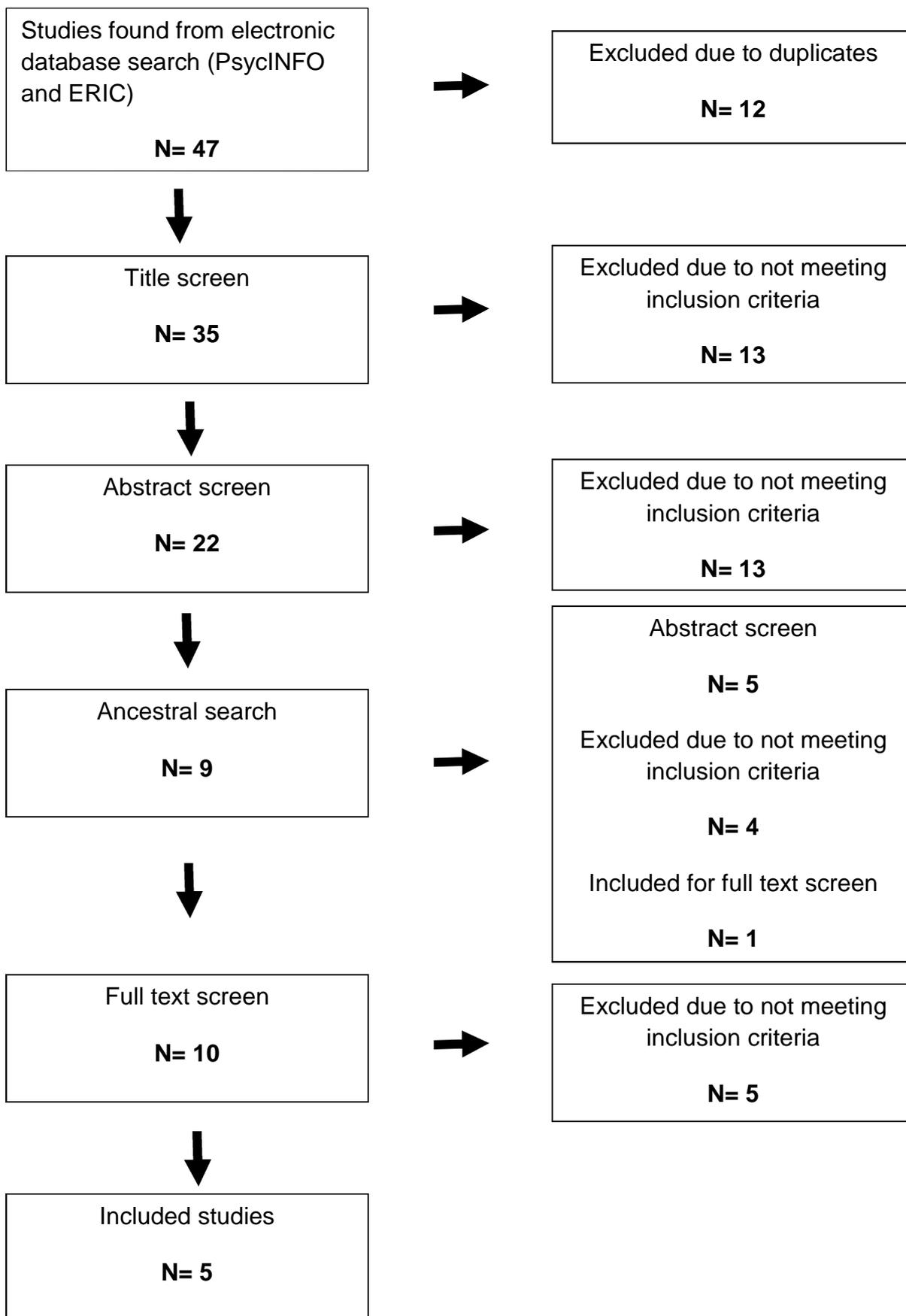


Table 3 *Included Studies*

Included studies
<p>Carr, D., & Felce, J. (2007). The Effects of PECS Teaching to Phase III on the Communicative Interactions between Children with Autism and their Teachers. <i>Journal of Autism and Developmental Disorders</i>, 37, 724-737.</p>
<p>Howlin, P., Gordon, R. K., Pasco, G., Wade, A., & Charman, T. (2007). The effectiveness of Picture Exchange Communication System (PECS) training for teachers of children with autism: a pragmatic, group randomised controlled trial. <i>Journal of Child Psychology and Psychiatry</i>, 48(5), 473-481.</p>
<p>Lerna, A., Esposito, D., Conson, M., & Massagli, A. (2014). Long-term effects of PECS on social-communicative skills of children with autism spectrum disorders: a follow-up study. <i>International Journal of Language and Communication Disorders</i>, 49(4), 478-485.</p>
<p>Lerna, A., Esposito, D., Conson, M., Russo, L., & Massagli, A. (2012). Social-communicative effects of the Picture Exchange System (PECS) in Autism Spectrum Disorders. <i>International Journal of Language & Communication Disorders</i>, 47(5), 609-617.</p>
<p>Yoder, P., & Stone, W. L. (2006). Randomized Comparison of Two Communication Interventions for Pre-schoolers with Autism Spectrum Disorders. <i>Journal of Consulting and Clinical Psychology</i>, 74(3), 426-435.</p>

Mapping the field

The five studies included in the review examined the effectiveness of PECS with children of primary school age or younger. The key features of each study have been described in Table 4.

Table 4 *Summary of Each Study*

Study	Objective	Country	Sample	Design	Intervention	Setting
Carr & Felce (2007)	The impact of obtaining PECS Phase III mastery on the communication skills of children with autism	Wales	41 participants aged between 3 and 7 years	Quasi-experimental design Students were allocated to either a PECS intervention group ($n=24$) or a non-intervention control group ($n=17$). All students who lived within 50 miles of the researcher's base were in the intervention group	Two researchers were trained to deliver PECS teaching at a two day workshop. PECS I and II adhered to the manual but III was modified. The intervention occurred in the participant's school environment over a five week period. Each child received 15 hours of PECS teaching in total	Specialist unit for students with autism or an SEN class
Howlin, Gordon, Pasco, Wade, & Charman (2007)	To examine the effectiveness of expert training and consultancy for teachers of children with ASD in the use of PECS	UK	84 participants aged between 4 and 11 years 73 males, 11 females	Group randomised control trial: Immediate treatment group, Delayed treatment group and No treatment group	Classes in the treatment group sent staff and parents to a two day PECS workshop Consultants visited each class for half a day, once a month for five months. Recommendations and demonstrations were carried out to advance PECS usage and encourage facilitation across the whole school day	Schools providing specialist education for children with ASD

Study	Objective	Country	Sample	Design	Intervention	Setting
Lerna, Esposito, Conson, & Massagli (2014)	A 12 month follow up study to examine the long term effects of PECS on the social communicative skills of children with autism	Italy	Participants were a subsample of children ($n=14$) from Lerna et al.'s (2012) study	Quasi-experimental design Participants were assigned to the experimental group (PECS, $n=7$) or the control group (Conventional Language Therapy, $n=7$)	In the original study (Lerna et al., 2012) the PECS trainer attended a two day workshop and followed the training manual. Children were offered 30 minute individual therapy sessions, three times a week for six months	Clinical setting
Lerna, Esposito, Conson, Russo, & Massagli (2012)	To test the effectiveness of PECS on the social communicative skills of children with ASD	Italy	18 participants 18-60 months 17 males, 1 female	Quasi-experimental design Participants were assigned to the experimental group (PECS, $n=9$) or the control group (Conventional Language Therapy, $n=9$)	The PECS trainer attended a two day workshop and followed the training manual. Children were offered 30 minute individual therapy sessions, three times a week for six months	Clinical setting
Yoder & Stone (2006)	To compare the effectiveness of PECS and Responsive Education and Prelinguistic Milieu Teaching (RPMT) on pre-schoolers with ASD	USA	36 pre-schoolers (18-60 months) with ASD 31 males, 5 females	Randomised experimental design Children were randomly assigned to either PECS ($n=19$) or RPMT ($n=17$)	PECS researchers completed a two day workshop conducted by two qualified PECS therapists. Each treatment was delivered three times a week, in 20 minute sessions for six months	University clinic

Weight of Evidence (WoE)

Gough's (2007) Weight of Evidence (WoE) framework was used to evaluate the selected studies.

Methodological quality (WoE A) evaluated the coherence and integrity of each study's evidence. It was judged using a protocol (Gersten et al., 2005) designed for group experimental or quasi-experimental designs. The completed protocols are included in Appendix C.

Methodological relevance (WoE B) examined the type of evidence and its appropriateness for answering the literature review question. To examine and rate the suitability of each study a 'hierarchy of evidence' was used (Pettricrew & Roberts, 2003).

WoE C evaluated each study on how relevant their focus was to answering the review question. Each study was rated on four areas: description, training, implementation and setting with descriptors in Appendix B. To calculate a WoE C, each area was totalled and averaged.

WoE D is an overall rating for each study. The scores from A, B and C were totalled and then averaged. A rating of 'high' was 2.4-3, 'medium' 1.7-2.3 and 'low' 1-1.6. An overview of each study's ratings can be found in Table 5.

Table 5 *Weight of Evidence (WoE) for Evaluated Studies*

Study	WoE A	WoE B	WoE C	WoE D
Carr & Felce (2007)	1	2	2.5	1.83
	(low)	(medium)	(high)	(medium)
Howlin, Gordon, Pasco, Wade, & Charman (2007)	1	3	2.5	2.17
	(low)	(high)	(high)	(medium)
Lerna, Esposito, Conson, & Massagli (2014)	1	2	2	1.67
	(low)	(medium)	(medium)	(low)
Lerna, Esposito, Conson, Russo, & Massagli (2012)	1	2	2.25	1.75
	(low)	(medium)	(medium)	(medium)
Yoder & Stone (2006)	1	3	2.25	2.08
	(low)	(high)	(medium)	(medium)

Participants

As the review is looking at the effectiveness of PECS, the results will only examine those who participated in the PECS intervention. Each study provided information on the participant's age with these ranging from 1 and a half to 11 years. Participants had a diagnosis of autism or ASD. As all students received a diagnosis prior to involvement, researchers used a range of methods to confirm this. Student characteristics across each condition were examined using baseline assessments and where differences were found, statistical tests were run with adjustments made prior to analysis.

Two studies occurred in the UK, two in Italy and one in America. The studies which occurred in the UK (Carr & Felce, 2007; Howlin et al., 2007) were both conducted

with students who attended SEN classes or specialist units for students with autism. As all studies used convenience sampling, the generalisability of their findings to all students with autism is reduced (Barker, Pistrang, & Elliott, 2002). Results may not be representative of the target population and minority populations may be underrepresented. Furthermore, it may not be representative of the female population, however, this cannot be accurately determined as not all studies identified gender differences (Carr & Felce, 2007; Lerna, Esposito, Conson, & Massagli, 2014).

Design

Studies which used experimental and quasi-experimental designs were included in this review. Two studies used a randomised experimental design: Howlin et al. (2007) compared an immediate treatment group, delayed treatment group and no treatment group and Yoder and Stone (2006) compared a treatment group and an alternative-intervention control. As randomised experimental designs are regarded as the “gold standard” for evaluating treatments or interventions (Barker et al., 2002) these two studies received a ‘high’ WoE B rating.

The remaining three studies (Carr & Felce, 2007; Lerna et al., 2014; Lerna, Esposito, Conson, Russo, & Massagli, 2012) all used quasi-experimental designs where there is no randomisation of participants (Barker et al., 2002). Without random assignment there is a threat to internal validity as each group may have a significant difference that is not due to the presence or absence of the PECS intervention. Therefore these studies received a lower rating on WoE B.

Intervention

Intervention characteristics link directly with WoE C which looks at the relevance of the intervention to the review question.

When examining each study the reviewer looked specifically at the detail and level of description. It is important that a researcher provides ample details so the nature and structure of the intervention is clear. By having a detailed description, future researchers can replicate the study and add to the literature base. Both Carr and Felce (2007) and Lerna et al. (2012) received 'high' WoE C ratings as they provided detailed descriptions of each phase with examples.

When considering whether an intervention is effective one must consider the fidelity of implementation. For an intervention to be most effective it needs to follow the strategies, content curriculum and original delivery design. If fidelity was not maintained then the effects may not be a result of the intervention. All studies received a 'high' for intervention-specific training as researchers completed a two day PECS workshop. However, only one study received a 'high' for examining the fidelity of treatment quality. Yoder and Stone (2006) coded therapist and child sessions each month using a rating scale and then examined these using inter-observer agreement reporting a high level of fidelity. All other studies received lower ratings in WoE C. A lack of fidelity in implementation could be a key factor in the effectiveness of PECS as Howlin et al. (2007) found that after 10 months the positive effects identified in the immediate treatment group had no longer been maintained. This may be due to teachers or support staff not having the required training to implement the intervention once consultation has finished.

Setting is the last criteria for WoE C. As some individuals with autism will never learn to verbally communicate it is vital that their communication system becomes their voice allowing them to interact with a range of individuals across different contexts. The reviewer rated an intervention delivered in a school setting as 'high', due to the range of activities students are exposed to and the different communicative partners they will interact with throughout the day. A clinical or university setting was rated as 'low' as children would only be practising communications with a limited number of partners in a short time frame. Two of the studies were conducted in a school setting and therefore received a 'high' rating for this descriptor (Carr & Felce, 2007; Howlin et al., 2007).

Data extraction

As part of the literature review process, each study's data was extracted and then analysed. The coherence and integrity of evidence was examined through WoE A. As Table 5 demonstrates all of the included studies received a 'low' WoE A. While including examples from audio recordings in the findings is good practice, only Yoder and Stone (2006) did so. The Gersten et al. (2005) protocol examined the coherence of the written study. Yoder and Stone (2006) were the only study that did not meet this descriptor. In the results section they combined the PECS and RPMT data, making it difficult to examine the effects of each intervention.

Measures

When examining an intervention it is important to look at the measures that have been utilised. The Gersten et al. (2005) coding protocol, evaluates studies on their use of measures, reliability and whether interventions were measured post treatment. Outcome measures were evaluated in WoE A (Table 5 and Appendix B).

Three of the five studies (Howlin et al., 2007; Lerna et al., 2014; Lerna et al., 2012) reported their findings using standard measures to examine the social communicative skills of children with autism pre and post intervention. While each study explained the reasoning behind the use of a measure no study included reliability or validity coefficients. Each study observed students looking for a range of behaviours such as initiation and joint attention. In three studies (Lerna et al., 2014; Lerna et al., 2012; Yoder & Stone, 2006) interrater reliability of outcomes were evaluated through coders who were blind to the intervention groups or treatment thus reducing observer bias (Barker et al., 2002). Only one study Lerna et al. (2014) looked at the effectiveness of a PECS intervention post treatment through a one year follow up. Howlin et al. (2007) conducted a 10 month follow up for the immediate treatment group but not for the delayed thus, it did not meet the descriptor. As no study reported the reliability or validity of the standardised measures all studies received lower weightings in WoE A.

Outcome measures and effect sizes

The effectiveness of PECS for children with autism was the focus of this literature review. The reviewer looked at the pre and post data for all studies and where possible calculated effect sizes using the standardised mean difference. The effect sizes were then interpreted according to the criteria in Table 6 (Cohen, 1988).

Table 6 *Effect Size Interpretation (Cohen, 1988)*

Type of effect size	Small	Medium	Large
Cohen's d	0.2	0.5	0.8

Two studies did report effect sizes (Howlin et al., 2007; Lerna et al., 2014) however these were recalculated to ensure consistency across studies. While this made data analysis easier, it may have increased one study's findings (Howlin et al., 2007) as they used ordinal data due to their highly skewed distribution. As Yoder and Stone (2006) pooled their data, the effect sizes were calculated using the information from the adjusted means and the standard error. The overall data for pre and post initiating joint attention was used to calculate Cohen's *d* (1988) and the confidence interval. Carr and Felce (2006) did not have enough statistical data to calculate effect sizes.

As the effectiveness of PECS on children with autism is the focus of this review only the outcome measures and effect sizes for the PECS intervention were included in Table 7.

Table 7 Outcome Measures and Effect Sizes for PECS

Study	Sample size	Design	Outcome measure	Post-test outcome			
				Cohen's d	p	Confidence Intervals	Weight of Evidence (WoE) D
Carr & Felce (2007)	N= 41	Quasi-experimental	Child to adult initiations	*	<0.001	*	1.83 (medium)
			Child to adult linguistic initiations	*	<0.001	*	
			Child to adult initiations with adult response	*	<0.005	*	
			Adult to child initiations with opportunity for child response plus response from child	*	<0.002	*	
			Adult initiations with no opportunity for child response	*	<0.005	*	

Study	Sample size	Design	Outcome measure	Post-test outcome			
				Cohen's d	p	Confidence Intervals	Weight of Evidence (WoE) D
Howlin, Gordon, Pasco, Wade, & Charman (2007)	N= 84	Randomised control trial	Classroom ratings:				2.17
			<i>Initiations</i>	0.04	0.91	-0.53 - 0.60	(medium)
			<i>Use of PECS</i>	0.25	0.48	-0.33 - 0.81	
			<i>Speech</i>	0.05	0.83	-0.52 - 0.61	
			Autism Diagnosis Observation Schedule-Generic model 1 (ADOS-G):				
			<i>Reciprocal Social Interaction</i>	-0.70	<0.05	-1.31 - 0.05	
Lerna, Esposito, Conson, & Massagli (2014)	N= 14	Quasi-experimental	Vineland Adaptive Behaviour Scales (VABS):				1.67
			<i>Social</i>	0.97	0.13	-0.52 – 2.15	(low)

Study	Sample size	Design	Outcome measure	Post-test outcome			
				Cohen's d	p	Confidence Intervals	Weight of Evidence (WoE) D
			Unstructured free play with examiner:				
			<i>Joint attention</i>	0.61	0.12	-0.68 – 1.71	
			<i>Verbal requests</i>	0.15	>0.05	-0.98 – 1.23	
			<i>Initiation</i>	0.77	0.16	-0.60 – 1.90	
			<i>Cooperative play</i>	1.76	0.001	-0.28- 3.24	
Lerna, Esposito, Conson, Russo, & Massagli (2012)	N= 18	Quasi-experimental	VABS:				1.75
			<i>Communication</i>	0.65	0.03	-0.57 - 1.69	(medium)
			<i>Social</i>	2.61	0.01	0.11 - 4.41	
			Unstructured free play with examiner:				

Study	Sample size	Design	Outcome measure	Post-test outcome			
				Cohen's d	p	Confidence Intervals	Weight of Evidence (WoE) D
			<i>Joint attention</i>	2.78	0.02	0.15 - 4.68	
			<i>Requests</i>	2.10	0.02	-0.01 - 3.66	
			<i>Initiation</i>	7.84	0.03	1.02 - 12.60	
			<i>Cooperative play</i>	5.63	0.004	0.67 - 9.11	
Yoder & Stone (2006)	N= 36	Randomised group experiment	Object exchange turns	0.20	*	-0.47 – 0.85	2.08 (medium)
			Joint attention: <i>Early Social Communication Scales</i>	0.57	*	-0.16 – 1.25	

Note: + or – Refers to the direction of the effect size or confidence interval

Note: * Refers to outcomes not calculated due to insufficient statistical data

Each study examined a range of communicative skills, to assist with data analysis these have been grouped: social and communicative interactions, initiations, joint attention and speech.

Social and communicative interactions- Howlin et al. (2007) used the Autism Diagnosis Observation Schedule- Generic Module 1 (ADOS-G) to examine whether children's reciprocal social interaction skills had changed over time. They found that there was no significant effect on the immediate treatment group following intervention, however, at the 10 month follow up there was a decrease in severity scores (medium effect). Lerna et al. (2014) and Lerna et al. (2012) employed the Vineland Adaptive Behaviour Scales, Second Edition (VABS II) which looks at parent reports of their child's communication and social abilities. Both studies reported large effect sizes on social scales and Lerna et al. (2012) found a medium effect on communication. Observations during unstructured free play found that PECS had a large effect on cooperative play (Lerna et al., 2014; Lerna et al., 2012). While Lerna et al. (2014) was a follow up of the 2012 study, on careful examination of the results, different means and standard deviations were recorded. This may account for some variability in effect sizes. As two of the three studies received a 'medium' overall rating, the findings will be considered relevant in answering the review question.

Initiations- Carr and Felce (2006) examined the initiations of children with adults pre and post PECS intervention. The study used a self-designed observational instrument and found a statistically significant effect on the communicative initiations of children after 15 hours of PECS instruction. Howlin et al. (2007) examined the rate of initiations in the classroom and found a significant effect immediately after treatment but this was not maintained at a 10 month follow up with a small effect size

found. Lerna et al. (2014) found a medium effect size after a one year follow up, while immediately post intervention Lerna et al. (2012) found a large effect size that was statistically significant. The results reported an increase in initiations immediately post treatment.

Joint attention- Lerna et al. (2012) used observations to examine the effectiveness of PECS on joint attention. A statistically significant effect and a large effect size was found immediately post treatment. At a one year follow up (Lerna et al., 2014), these findings were no longer statistically significant with a medium effect size. Yoder and Stone (2006) employed the Early Social Communication Scales (ESCS) – Abridged version which includes a list of activities and adult prompts designed to elicit communication. They found a medium effect size on student’s joint attention. With two of the three studies having an overall weighting of ‘medium’ these findings are considered relevant to the review question.

Speech- Howlin et al. (2007) examined the effect of PECS on children’s speech. They found it was non-significant with a very small effect size. Lerna et al. (2014) also examined student’s verbal requests and found it was statistically significant with a small effect size.

Conclusion

This literature review has examined the effectiveness of PECS for children with autism through an evaluation of five studies, using experimental or quasi-experimental designs. Two studies used randomised control trials (Howlin et al., 2007; Yoder & Stone, 2006) which are regarded as the “gold standard” for evaluating the effectiveness of interventions (Barker et al., 2002) while the others used quasi-experimental. All studies were evaluated using Gough’s (2007) weight of evidence framework. The reviewed studies have provided a promising evidence base for the effectiveness of PECS on functional communication skills of children with autism. However, these findings do need to be considered cautiously due to the variability in results.

The coherence and integrity of each study was examined in-depth using the Gersten et al. (2005) coding protocol, on which all studies received an overall rating of ‘low’. There were a number of descriptors that contributed to the lower rating including: fidelity of treatment, interrater reliability, validity of measures, excerpts from the study and a lack of descriptive statistics. When analysing the data there is some inconsistency in regards to effect sizes. One study (Lerna et al., 2012) has significantly large effect sizes which should be read with caution as in the follow up (Lerna et al., 2014) means and standard deviations were not consistent. While the overall weight of evidence for each study was either ‘medium’ or ‘low’, the effect sizes immediately post treatment were promising. The generalisability of results should be considered as all studies used convenience sampling and may not be representative of all students with autism.

Some children with autism or ASD will never develop functional speech (Volkmar et al., 2004). Thus a functional communication system such as PECS could provide a way to communicate with partners at both school and home. However, one must recognise the limitations of each study in terms of both methodology and outcome measures.

Recommendations

The positive effects of PECS on the functional communication skills of children with autism is evident through these five studies. Thus, it would be appropriate for EPs to recommend the use of PECS for children with autism. While the research offers promising results immediately after treatment, there remains a lack of studies on the longer term impacts. It is therefore recommended that longitudinal studies on the use of PECS are undertaken in a naturalistic setting, such as a preschool or primary school. When conducting future studies researchers need to carefully select their outcome measures. It has been suggested by Preston and Carter (2009) that when investigating the social communicative effects of PECS researchers should consider: standardised functional assessment of adaptive behaviour, standardised psychometric data and information on social-communicative variables scored in unstructured settings.

All of the PECS interventions were run by researchers or teachers (Howlin et al., 2007) who attended a two day PECS workshop. Howlin et al. (2007) found that once consultation ceased the positive effects were not maintained. This could be a result of fidelity, with less reliable or less frequent PECS implementation. None of the five studies rigorously evaluated fidelity. Thus in future studies the fidelity of the intervention needs to be examined.

With PECS used widely across both the UK and other developed countries (Howlin et al., 2007) more training needs to be undertaken. Both teachers and teaching assistants need to attend workshops from trained PECS consultants to ensure that the program is implemented with fidelity. Once trained, external specialists (EPs or speech and language therapists) could then consult with school staff providing guidance and maintenance of teaching skills.

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Yoder, P., & Stone, W. L. (2006). Randomized Comparison of Two Communication Interventions for Pre-schoolers with Autism Spectrum Disorders. *Journal of Consulting and Clinical Psychology*, 74(3), 426-435.

Appendix A- Excluded Studies

Excluded on title	Reason for exclusion
Battaglia, D., & McDonald, M.E. (2015). Effects of the Picture Exchange Communication System (PECS) on Maladaptive Behavior in Children with Autism Spectrum Disorders (ASD): a Review of the Literature. <i>Journal of the American Academy of Special Education Professionals</i> , 8-20.	2a
Bondy, A. (2012). The Unusual Suspects: Myths and Misconceptions Associated with PECS. <i>Psychological Record</i> , 62(4), 789-816.	2a
Conklin, C.G., & Mayer, R.G. (2011). Effects of Implementing the Picture Exchange Communication System (PECS) with Adults with Developmental Disabilities and Severe Communication Deficits. <i>Remedial and Special Education</i> , 32(2), 155-166.	1a
Flippin, M., Reszka, S., & Watson, L.R. (2010). Effectiveness of the Picture Exchange Communication System (PECS) on Communication and Speech for Children with Autism Spectrum Disorders: A Meta-Analysis. <i>American Journal of Speech-Language Pathology</i> , 19(2), 178-195.	2a
Ganz, J.B., Davis, J.L., Lund, E.E., 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. <i>Research in Developmental Disabilities: A Multidisciplinary Journal</i> , 33(2), 406-418.	2a
Green, D., Meroz, A., Margalit, A.E., & Ratzon, N.Z. (2012). A validation study of the Keyboard Personal Computer Style instrument (K-PeCS) for use with children. <i>Applied Ergonomics</i> , 43(6), 985-992.	2d
Koita, H., Sonoyama, S., & Takeuchi, K. (2003). Communication Training With the Picture Exchange Communication System (PECS) for Children with Autistic Disorder: The Training Program and Current and Future Research. <i>Japanese Journal of Behavior Analysis</i> , 18(2), 120-130.	2a

Excluded on title	Reason for exclusion
Malandraki, G.A., & Okalidou, A. (2007). The Application of PECS in a Deaf Child with Autism: A Case Study. <i>Focus on Autism and Other Developmental Disabilities</i> , 22(1), 23-32.	2b
Ostryn, C., Wolfe, P.S., & Rusch, F.R. (2008). A Review and Analysis of the Picture Exchange Communication System (PECS) for individuals With Autism Spectrum Disorders Using a Paradigm of Communication Competence. <i>Research and Practice for Persons with Severe Disabilities</i> , 33(1), 13-24.	2a
Savari, C. (2007). Experiences in the Integration of CAS into Engineering at the University of Pecs. <i>International Journal for Technology in Mathematics Education</i> , 14(3), 130-136.	2d
Sigafos, J. (2005). From Premack to PECS: 25 Years of Progress in Communication Intervention for Individuals with Developmental Disabilities. <i>Educational Psychology</i> , 25(6), 601-607.	2a
Spencer, T.D., Peterson, D.B., & Gillam, S.L. (2008). Picture Exchange Communication System (PECS) or Sign Language: An Evidence Based Decision-Making Example. <i>Teaching Exceptional Children</i> , 41(2), 40-47.	2a
Sulzer-Azaroff, B., Hoffman, A.O., Horton, C.B., Bondy, A., & Frost, L. (2009). The Picture Exchange Communication System (PECS): What do the Data say? <i>Focus on Autism and Other Developmental Disabilities</i> , 24(2), 89-103.	2a
Excluded on abstract	Reason for exclusion
Beck, A.R., Stoner, J.B., Bock, S.J., & Parton, T. (2008). Comparison of PECS and the Use of a VOCA: A Replication. <i>Education and Training in Developmental Disabilities</i> , 43(2), 198-216.	2b
Boesch, M.C., Wendt, O., Subramanian, A., & Hsu, N. (2013). Comparative Efficacy of the Picture Exchange Communication System (PECS) versus a Speech-Generating Device: Effects on Requesting Skills. <i>Research in Autism Spectrum Disorders</i> , 7(3), 480-493.	2b

Excluded on abstract	Reason for exclusion
Carson, L., Moosa, T., Theurer, J., & Oram, J. (2012). The collateral effects of PECS training on speech development in children with autism. <i>Canadian Journal of Speech-Language Pathology and Audiology</i> , 36(3), 182-195.	2b
Carre, A.J.M., Le Grice, B., Blampied, N.M., & Walker, D. (2009). Picture exchange communication (PECS) training for young children: Does training transfer at school and to home?. <i>Behaviour Change</i> , 26(1), 54-65.	2b
Chaabane, D.B., Alber-Morgan, S.R., & DeBar, R.M. (2009). The Effects of Parent-Implemented PECS training on Improvisation of Mands by Children with Autism. <i>Journal of Applied Behavior Analysis</i> , 42(3), 671-677.	2b
Charlop, M., Malmberg, D.B., & Berquist, K.L. (2008). An application of the Picture Exchange Communication System (PECS) with children with autism and a visually impaired therapist. <i>Journal of Developmental and Physical Disabilities</i> , 20(6), 509-525.	2b
Charlop-Christy, M.H., Carpenter, M., Le, L., LeBlanc, L.A., & Kellet, K. (2002). Using the picture exchange communication system (PECS) with children with autism: Assessment of PECS acquisition, speech, social communicative behavior, and problem behavior. <i>Journal of Applied Behavior Analysis</i> , 35(3), 213-231.	2b
Ganz, J.B., Simpson, R.L., & Lund, E.M. (2012). The Picture Exchange Communication System (PECS): A Promising Method for Improving Communication Skills of Learners with Autism Spectrum Disorders. <i>Education and Training in Autism and Developmental Disabilities</i> , 47(2), 176-186.	2a
Kuma, H., & Yamamoto, J. (2014). Effects of PECS and matrix training on the acquisition and extension of vocal requests by children with autism. <i>Japanese Journal of Special Education</i> , 51(5), 407-419.	2b
Miyazaki, M., Kato, H., & Inoue, M. (2014). Increase in eye contact and vocalisation: Combining the Picture Exchange Communication System (PECS) with imitation training for children with Autism. <i>Japanese Journal of Behavior Analysis</i> , 29(1), 19-31.	2b

Excluded on abstract	Reason for exclusion
Park, J.H., Alber-Morgan, S.R., & Cannella-Malone, H. (2011). Effects of Mother-Implemented Picture Exchange Communication System (PECS) Training on Independent Communicative Behaviours of Young Children with Autism Spectrum Disorders. <i>Topics in Early Childhood Special Education</i> , 31(1), 37-47.	2b
Travis, J., & Geiger, M. (2010). The Effectiveness of the picture exchange communication system (PECS) for children with autism spectrum disorder (ASD): A South African pilot study. <i>Child Language Teaching and Therapy</i> , 26 (3), 383-384.	2b
Yokoyama, K., Naoi, N., & Yamamoto, J. (2006). Teaching Verbal Behavior Using the Picture Exchange Communication System (PECS) With Children With Autistic Spectrum Disorders. <i>Japanese Journal of Special Education</i> , 43(6), 485-503.	2b
Excluded on ancestral search	Reason for exclusion
Ganz, J. B., & Simpson, R. L. (2004). Effects on communicative requesting and speech development of the Picture Exchange Communication System in children with characteristics of autism. <i>Journal of Autism and Developmental Disorders</i> , 34, 395–409.	2b
Ganz, J. B., Simpson, R. L., & Corbin-Newsome, J. (2008). The impact of the Picture Exchange Communication System on requesting and speech development in preschoolers with autism spectrum disorders and similar characteristics. <i>Research in Autism Spectrum Disorders</i> , 2, 157–169.	2b
Kravits, T.R., Kamps, D.M., Kemmerer, K., & Potucek, J. (2002). Brief report: Increasing communication skills for an elementary-aged student with autism using the picture exchange communication system. <i>Journal of Autism and Developmental Disorders</i> , 32, 225–230.	2b
Tincani, M., Crozier, S., & Alazetta, L. (2006). The Picture Exchange Communication System: effects on manding and speech development for school-aged children with autism. <i>Education and Training in Developmental Disabilities</i> , 41,177–184.	2b

Excluded on full text	Reason for exclusion
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. <i>Education and Training in Developmental Disabilities</i> , 40(3), 264-278.	2b
Cummings, A.R., Carr, J.E., & LeBlanc, L.A. (2012). Experimental Evaluation of the Training Structure of the Picture Exchange Communication System (PECS). <i>Research in Autism Spectrum Disorders</i> , 6(1), 32-45.	2b
Ganz, J.B., Goodwyn, F.D., Boles, M.M., Hong, E.R., Rispoli, M.J., Lund, E.M., & Kite, E. (2013). Impacts of a PECS instructional coaching intervention on practitioners and children with autism. <i>AAC: Augmentative and Alternative Communication</i> , 29(3), 210-221.	2b
Magiati, I., & Howlin, P. (2003). A Pilot Evaluation Study of the Picture Exchange Communication System (PECS) for Children with Autistic Spectrum Disorders. <i>Autism: The International Journal of Research and Practice</i> , 7(3), 297-320.	2b
Pasco, G., & Tohill, C. (2011). Predicting progress in Picture Exchange Communication System (PECS) use by children with autism. <i>International Journal of Language & Communication Disorders</i> , 46(1), 120-125.	2d

Appendix B- Weight of Evidence

Weight of Evidence A (WoE A): Methodological quality

The Gersten et al. (2005) coding protocol for studies with experimental and quasi-experimental designs was used in this systematic literature review. Each study was rated for both essential and desirable quality indicators.

A rating of 'high', 'medium' or 'low' was based on the criteria shown in the table below:

WoE A rating	Criteria	Rationale
High (3)	Meets ≥ 9 essential criteria and ≥ 4 desirable criteria	Derived from recommendations by Gersten et al. (2005)
Medium (2)	Meets ≥ 9 essential criteria and ≥ 2 desirable criteria	
Low (1)	Meets < 9 essential criteria and ≥ 2 desirable criteria	

Summary of Weight of Evidence (WoE A) Ratings

Study	Essential criteria	Desirable criteria	WoE A
Carr & Felce (2007)	7	2	1 (low)
Howlin, Gordon, Pasco, Wade, & Charman (2007)	8	3	1 (low)
Lerna, Esposito, Conson, & Massagli (2014)	8	3	1 (low)
Lerna, Esposito, Conson, Russo, & Massagli (2012)	7	2	1 (low)
Yoder & Stone (2006)	8	3	1 (low)

Weight of Evidence B (WoE B): Methodological relevance

Methodological relevance looks at the type of evidence and its appropriateness for answering the literature review question.

Criteria for WoE B was informed by Petticrew and Roberts (2003) who investigated studies most suited to questions about 'effectiveness'. In the table below are the ratings for 'high' (3), 'medium' (2) and 'low' (1).

High (3)	Medium (2)	Low (1)
Randomised control trial	Quasi- experimental designs	Non- experimental evaluations, other study designs
Randomised experimental design		

Summary of Weight of Evidence (WoE B) Ratings

Study	WoE B rating
Carr & Felce (2007)	2 (medium)
Howlin, Gordon, Pasco, Wade, & Charman (2007)	3 (high)
Lerna, Esposito, Conson, & Massagli (2014)	2 (medium)
Lerna, Esposito, Conson, Russo, & Massagli (2012)	2 (medium)
Yoder & Stone (2006)	3 (high)

Weight of Evidence C (WoE C): Relevance to question

Weight of evidence C criteria and rationale

Criteria	Ratings	Rationale
A. Description	3) PECS intervention is fully described with examples of each phase	An intervention is more likely to be replicable if all aspects of the intervention are described in detail
	2) PECS intervention is described in sufficient detail so that it can be replicated	
	1) PECS intervention is described in insufficient detail	
B. Training	3) Intervention is delivered by researchers or teachers who have attended a PECS workshop	A PECS intervention is more likely to be effective if it is delivered by trained individuals
	2) PECS intervention is delivered by teachers who have received PECS training	
	1) PECS intervention is delivered by teachers or teaching assistants with minimal training	
C. Implementation	3) The intervention follows the PECS training manual (Frost & Bondy, 2002) and the quality of its implementation was examined in the study	For an intervention to be most effective it needs to follow the strategies and content curriculum being delivered in the same way it was designed to be used
	2) The intervention follows the PECS training manual (Frost & Bondy, 2002)	
	1) The intervention modifies some aspects of the PECS training manual (Frost & Bondy, 2002)	
D. Setting	3) School setting	Students need to learn to communicate with different individuals using PECS. This is more likely to occur in a school context
	2) Home setting	
	1) University/clinical setting	

To calculate a total for WoE C the scores from each study for description, training, implementation and setting were averaged.

To receive an overall rating of 'high' a study must receive an average of 2.4-3.

To receive an overall rating of 'medium' a study must receive an average of 1.7-2.3.

To receive an overall rating of 'low' a study must receive an average of 1-1.6.

Summary of Weight of Evidence (WoE C) Ratings

Study	Criteria score				Average score
	A	B	C	D	
Carr & Felce (2007)	3	3	1	3	2.5 (high)
Howlin, Gordon, Pasco, Wade, & Charman (2007)	2	3	2	3	2.5 (high)
Lerna, Esposito, Conson, & Massagli (2014)	2	3	2	1	2 (medium)
Lerna, Esposito, Conson, Russo, & Massagli (2012)	3	3	2	1	2.25 (medium)
Yoder & Stone (2006)	2	3	3	1	2.25 (medium)

Weight of Evidence D (WoD): Overall weighting

To calculate an overall weight (WoE D) the scores for WoE A, B and C were averaged for each study.

To receive a rating of 'high' overall a study must receive an average of 2.4-3.

To receive a rating of 'medium' overall a study must receive an average of 1.7-2.3.

To receive a rating of 'low' overall a study must receive an average of 1-1.6.

Study	WoE A	WoE B	WoE C	WoE D
Carr & Felce (2007)	1	2	2.5	1.83
	(low)	(medium)	(high)	(medium)
Howlin, Gordon, Pasco, Wade, & Charman (2007)	1	3	2.5	2.17
	(low)	(high)	(high)	(medium)
Lerna, Esposito, Conson, & Massagli (2014)	1	2	2	1.67
	(low)	(medium)	(medium)	(low)
Lerna, Esposito, Conson, Russo, & Massagli (2012)	1	2	2.25	1.75
	(low)	(medium)	(medium)	(medium)
Yoder & Stone (2006)	1	3	2.25	2.08
	(low)	(high)	(medium)	(medium)

Appendix C- Coding Protocols

Coding Protocol 1

Gersten et al., (2005). Quality Indicators for Group Experimental and Quasi-Experimental Research in Special Education

Date: 27.01.2018

Full Study Reference:

Carr, D., & Felce, J. (2007). The Effects of PECS Teaching to Phase III on the Communicative Interactions between Children with Autism and their Teachers. *Journal of Autism and Developmental Disorders*, 37, 724-737.

Intervention Name (description of study): Two researchers were trained to deliver PECS after attending a two day workshop. They administered Phase I and II adhering to the training manual (Frost & Bondy, 2002) while Phase III was modified. The intervention occurred in the participant's school environment over a five week period. Each child received 15 hours of PECS teaching in total.

Research design: Quasi-experimental design

Type of Publication: Journal Article

Essential Quality Indicators

Describing Participants

Was sufficient information provided to determine/confirm whether the participants demonstrated the disability(ies) or difficulties presented?

Yes

No

N/A

Unknown/Unable to Code

Were appropriate procedures used to increase the likelihood that relevant characteristics of participants in the sample were comparable across conditions?

Yes

No

N/A

Unknown/Unable to Code

Was sufficient information given characterizing the interventionists or teachers provided? Did it indicate whether they were comparable across conditions?

Yes

No

N/A

Unknown/Unable to Code

Implementation of the Intervention and Description of Comparison Conditions

Was the intervention clearly described and specified?

Yes

No

N/A

Unknown/Unable to Code

Was the fidelity of implementation described and assessed?

Yes

No

N/A

Unknown/Unable to Code

Was the nature of services provided in comparison conditions described?

Yes

No

N/A

Unknown/Unable to Code

Outcome Measures

Were multiple measures used to provide an appropriate balance between measures closely aligned with the intervention and measures of generalised performance?

Yes

No

N/A

Unknown/Unable to Code

Were outcomes for capturing the intervention's effect measured at the appropriate times?

Yes

No

N/A

Unknown/Unable to Code

Data Analysis

Were the data analysis techniques appropriately linked to key research questions and hypotheses? Were they appropriately linked to the unit of analysis in the study?

Yes

No

N/A

Unknown/Unable to Code

Did the research report include not only inferential statistics but also effect size calculations?

Yes

No

N/A

Unknown/Unable to Code

Desirable Quality Indicators

Was data available on attrition rates among intervention samples? Was severe overall attrition documented? If so, is attrition comparable across samples? Is overall attrition less than 30%?

Yes

No

N/A

Unknown/Unable to Code

Did the study provide not only internal consistency reliability but also test-retest reliability and interrater reliability (when appropriate) for outcome measures? Were data collectors and/or scorers blind to study conditions and equally (un)familiar to examinees across study conditions?

Yes

No

N/A

Unknown/Unable to Code

Were outcomes for capturing the intervention's effect measured beyond an immediate post-test?

Yes

No

N/A

Unknown/Unable to Code

Was evidence of the criterion-related validity and construct validity of the measures provided?

Yes

No

N/A

Unknown/Unable to Code

Did the research team assess not only surface features of fidelity implementation (e.g. number of minutes allocated to the intervention or teacher/interventionist following procedures specified), but also examine quality of implementation?

Yes

No

N/A

Unknown/Unable to Code

Was any documentation of the nature of instruction or series provided in comparison conditions?

Yes

No

N/A

Unknown/Unable to Code

Did the research report include actual audio or videotape excerpts that capture the nature of the intervention?

Yes

No

N/A

Unknown/Unable to Code

Were results presented in a clear, coherent fashion?

Yes

No

N/A

Unknown/Unable to Code

Overall Rating of Evidence: 3 2 1