Case Study 1: An Evidence-Based Practice Review Report

Theme: School (setting) based interventions for children with special educational needs (SEN)

How effective is Proloquo2Go for improving communication for primary school aged children with ASD?

Summary

It is commonly recognised that children and young people (CYP) with Autism Spectrum Disorder (ASD) have difficulties with their Social Communication (American Psychiatric Association, 2013).This has the potential to impact their ability to meet their own daily needs, and may also have implications on a child's ability to access content and to learn within the classroom (Anderson et al., 2007; Case-Smith & O-Brien, 2015). Earlier interventions typically lead to better outcomes (Trembath & Vivanti, 2014) and therefore providing primary age children with an opportunity to learn skills for alternative communication, may support their communication and lead to improved outcomes (van der Meer et al., 2010).

This review aims to investigate the effectiveness of Proloquo2Go, a type of augmentative and alternative communication (AAC), to support primary school aged children with ASD. This intervention acts an alternative form of communication and provides speech-output to aid communication (Sennott & Bowker, 2009). A systematic literature search yielded seven studies which met the inclusion criteria for this review. These studies were then reviewed using a Weight of Evidence Framework (Gough, 2007) which found four studies to have medium weighting and the remaining three studies to have a low weighting score.

The current evidence available suggests that Proloquo2Go is a promising intervention for supporting communication in primary aged children with ASD, with medium effect sizes being primarily found across the significant study results. The review of these studies highlighted some methodological flaws and therefore this evidence needs to be interpreted with caution. A greater depth of research is required into use of Proloquo2Go and the need for more robust research methods is discussed within this review.

Introduction

Intervention

There is a growing quantity of research into the use of tablet-mediated speech generating devices (SGD) (Hong et al., 2017), with a wide range of different applications becoming more readily available, that are used to facilitate communication (Ganz et al., 2017). SGD are electronic devices that allow the activation of pre-recorded or computer generated speech output (Schlosser, 2003) to aid communication. One of the benefits of these devices is that they are often considered to be more practical than other types of AAC, such as the Picture Exchange Communication System (PECS), with the ability to add new communication buttons easily and quickly, as well as being easily portable (Hong et at 2017). Devices such as iPads have been considered transformative for aiding communication (Knight et al., 2013) as they are more affordable than previously created SGD and are also considered to be more socially acceptable for use (Hong et al., 2017). Similarly, it has been found that through using an iPad as a means of communication, there is a greater use of this type of AAC and therefore an increase in communication (Flores et al., 2012).

Proloquo2Go is a programme that can be used to produce verbal output for those with communication difficulties (Collette et al., 2018). This programme allows for high-quality vocal output and can be highly customised with the application having over 8000 default symbols and opportunities for further customisation (Sennott & Bowker, 2009). Proloquo2Go offers a range of vocabulary terms that can be sorted into pages or categories and when a new vocabulary item is added to the app, the text of the word can be accompanied by a matching symbol or photograph (Sennott & Bowker, 2009). The application has a variety of different 'voices' that can be used to output speech and, through selecting the relevant icon, the individual is able to produce voice output. This can facilitate communication and offer an alternative form of communication for those who are unable to produce speech or who may have difficulties with the level of speech they are able to produce (Sennott & Bowker, 2009).

Basis in Psychological Theory

Autism Spectrum Disorder (ASD) can be conceptualised as difficulties with understanding others' minds (Baron-Cohen et al, 1985), also referred to as Theory of Mind. Impairment of Theory of Mind can be considered closely linked to the difficulties with social interaction and communication often seen within children with ASD (Senju, 2011). ASD is characterised by impairments with social communication and restrictive or repetitive behaviour patterns (American Psychiatric Association, 2013) with studies finding approximately 25-30% of children who are diagnosed with ASD being unable to use verbal communication to the extent that allows them to meet their own daily needs

(Anderson et al., 2007; Rose et al., 2016), it is therefore important to consider how communication can be supported for these children.

Outcomes for children and young people with ASD can be varied, with Norrelgen et al. (2014) highlighting that there is generally a lack of empirical data looking at communication outcomes for children with ASD. It is, however, recognised that the earlier intervention is provided, the more positive the outcomes (Trembath & Vivanti, 2014) and therefore it is reasonable to consider that by introducing children to Proloquo2Go from a young age, it could be expected to potentially have greater impact. It has also been recognised that children and young people who do not develop a functional level of speech, can show poorer long-term outcomes in life, these can include difficulties with relationships, as well as communicating their needs and expressing their views (Thurm et al., 2015). This can lead to increased frustration and present itself in the form of challenging behaviours or self-injurious behaviours (Matson & LoVullo, 2008). Through allowing alternative methods to communicate these needs, it could be considered that these levels of frustration may decrease.

Rationale and Relevance

For children and young people in school, it has been shown that a lack of participation in academic context can result in hinderance for later opportunities (Case-Smith & O-Brien, 2015). It should therefore be considered that by having difficulties with communication, a child may struggle to actively participate in school and therefore may not gain as many academic benefits. By supporting their communication, it may lead to not only better communication outcomes, but also for academic outcomes to be raised.

A wide range of AAC devices have been used to support individuals with ASD with their functional communication (Beukelman & Mirenda, 2013; Light & McNaughton, 2012; van der Meer et al., 2010) and these can be used as an addition to speech or a replacement for those who are non-verbal. Meta analyses, such as Hong et al. (2017), have focused on the use of a range of different AACs and showed the benefits of their use generally. Within EP practice, it is important to ensure all children are able to access education and supporting a child's communication can aid with this. There has not been a systematic review of research looking into the specific use of Proloquo2Go, despite its use within school settings (Sennott & Bowker, 2009). This therefore should be considered an area of interest for EPs looking to recommend an intervention to support children's language.

A recent wider government strategy is focused on improving the access to education for children and young people with ASD (Department of Education, 2021). Given this, there needs to be consideration of the importance of a child's ability to communicate on their academic attainment (Case-Smith & O-Brien, 2015). Sennott and Bowker (2009) highlight how Proloquo2Go can be used to offer support for language and the practicality of this as a support within classrooms.

Therefore this review will answer the question of:

How effective is Proloquo2Go for improving communication for primary school aged children with ASD?

Critical Review of the Evidence

A systematic literature review was conducted using PsycINFO (OVID), ERIC (EBSCO) and Web of Science on 29th December 2021. The search terms used across all three databases are outlined below in Table 1. Due to the expansive number of articles yielded, these were confined to peer reviewed journal articles, to ensure academic integrity, and published between 2013 and 2022, in line with the release of the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-V) (American Psychological Association, 2013).

Table 1: *Search terms used within this Systematic Literature Review*

Databases Searched	**Search Term**
PsycINFO (OVID) ERIC (EBSCO) Web of Science	primar* age* OR "school age" OR "school-age" OR "elementary pupil" OR "4 - 11" OR "child*" OR student* OR pupil* AND "Autism Spectrum Disorder" OR ASD OR ASC or "Autism Spectrum Condition" or autis* AND proloquo2go or P2G or P2Go or "proloquo 2 go" or "proloquo to go" or proloquo or "speech generat*" or "speech-generat*"

Figure 1 highlights how the full literature search was conducted. 252 studies were yielded, 91 of these studies were duplicates and removed. The reviewer screened through the titles and abstracts for all 161 studies in line with the inclusion and exclusion criteria (Table 2). These titles and abstracts were reviewed at the same time to ensure studies were not excluded for simply not mentioning 'Proloquo2Go' in the title. 91 studies were removed based upon this screening leaving 70 remaining. A screening of the full text was conducted for the remaining 70 studies and 63 studies were excluded for not meeting the inclusion criteria (See Appendix A for full rationale), leaving seven studies remaining (See Table 3 for full references). Full mapping of the remaining seven studies can be found within Appendix B.

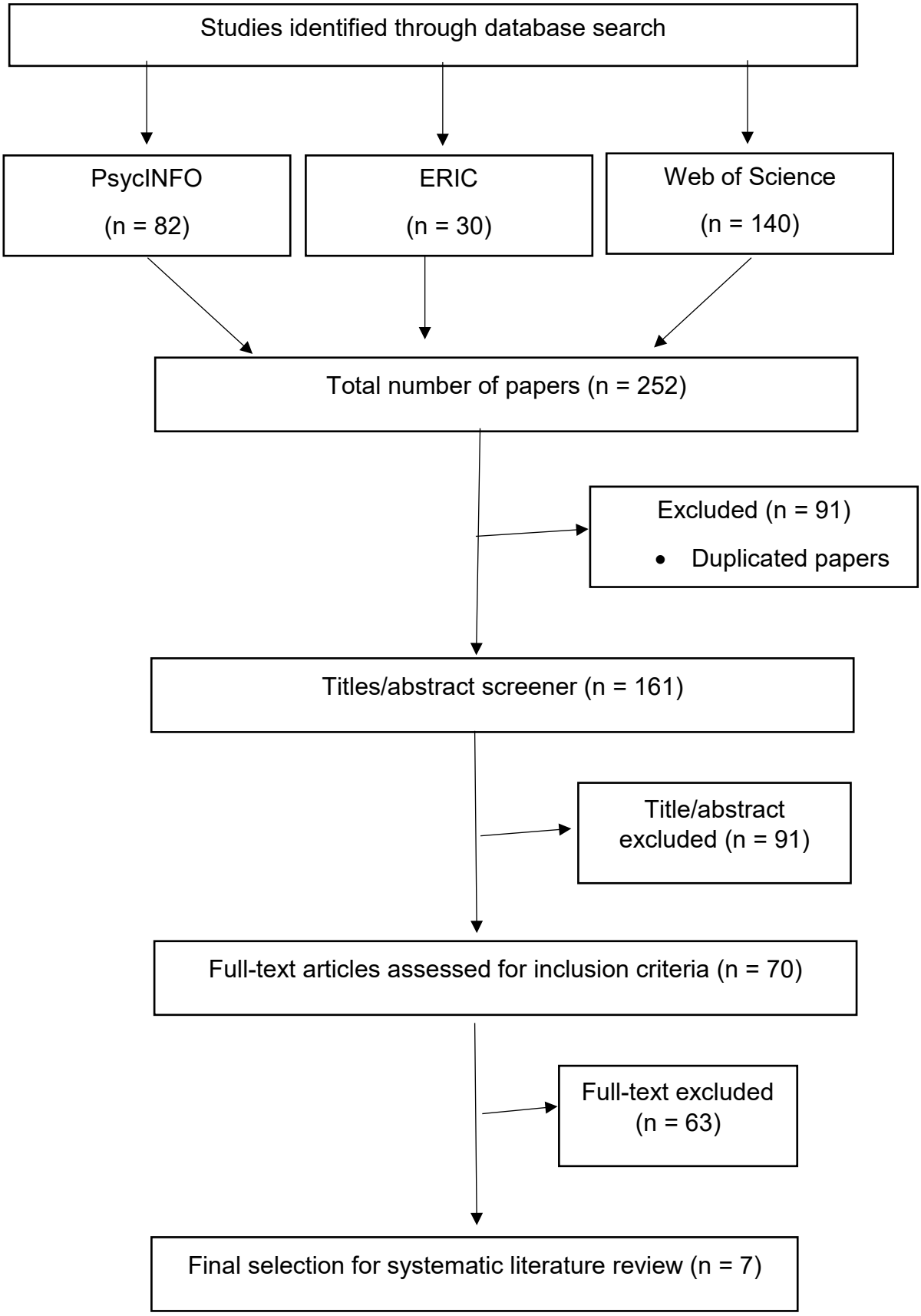

Figure 1. Literature search process

Table 2

Inclusion and Exclusion Criteria

	Criterion	Inclusion Criteria	Exclusion Criteria	Justification
1	Language of Publication	Studies published in English.	Studies not published in English	To ensure the reviewer is able to critically review studies in their first language.
2	Type of Publication	Published within a peer reviewed journal	Studies not published in a peer-reviewed journal.	Peer-reviewed studies are likely to be carried out using a higher quality research design.
3	Date of Publication	Published during or after May 2013	Studies published prior to May 2013.	The DSM-V (APA, 2013) was released in May 2013 with the latest criterion for a diagnosis of ASD.

4	Type of Intervention	Study must have use of Proloquo2Go as a speech generating device for all participants.	Study did not use Proloquo2Go for all participants.	To be able to critically evaluate the effectiveness of Proloquo2Go as an intervention for individuals with ASD.
5	Research design and methodology	Study must use empirical data, collected on at least two occasions including baseline data.	Empirical data was not gathered on at least two occasions or there was no baseline data..	To be able to review original data and to identify any change as a result of intervention.
6	Participants	Participants all aged between the age of four and 11 years (primary school age). Participants to have a diagnosis of ASD with no	Participants are outside of the age range four to 11 years. Diagnosis of any condition other than ASD, including a comorbid	This study is evaluating the use for primary school aged pupils with a diagnosis of ASD.

comorbid diagnoses.	diagnosis with ASD.

Table 3

Studies included in this Systematic Literature Review

Number	Reference
1	Carnett, A., & Ingvarsson, E. T. (2016). Teaching a Child with Autism to Mand for Answers to Questions Using a Speech-Generating Device. *The Analysis of Verbal Behavior*, *32* (2), 233–241.
2	McLay, L., Schäfer, M. C. M., van der Meer, L., Couper, L., McKenzie, E., O'Reilly, M. F., Lancioni, G. E., Marschik, P. B., Sigafoos, J., & Sutherland, D. (2017). Acquisition, Preference and Follow-up Comparison Across Three AAC Modalities Taught to Two Children with Autism Spectrum Disorder. *International Journal of Disability, Development and Education*, *64*(2), 117–130.
3	McLay, L., van der Meer, L., Schäfer, M. C. M., Couper, L., McKenzie, E., O'Reilly, M. F., Lancioni, G. E., Marschik, P. B., Green, V. A., Sigafoos, J., & Sutherland, D. (2015). Comparing Acquisition, Generalization, Maintenance, and Preference Across Three AAC Options in Four Children with Autism Spectrum Disorder. *Journal of Developmental and Physical Disabilities*, *27*(3), 323–339.

4 Sigafoos, J., Roche, L., Stevens, M., Waddington, H., Carnett, A., van der Meer, L., O'Reilly, M. F., Lancioni, G. E., Schlosser, R. W., & Marschik, P. B. (2018). Teaching two children with autism spectrum disorder to use a speech-generating device. *Research and Practice in Intellectual and Developmental Disabilities*, *5* (1), 75–86.

5 van der Meer, L., Achmadi, D., Cooijmans, M., Didden, R., Lancioni, G. E., O'Reilly, M. F., Roche, L., Stevens, M., Carnett, A., Hodis, F., Green, V. A., Sutherland, D., Lang, R., Rispoli, M., Marschik, P. B., & Sigafoos, J. (2015). An iPad-Based Intervention for Teaching Picture and Word Matching to a Student with ASD and Severe Communication Impairment. *Journal of Developmental and Physical Disabilities*, *27* (1), 67–78.

6 Waddington, H., Carnett, A., van der Meer, L., & Sigafoos, J. (2021). Teaching Two Autistic Children to Request Continuation of Social Routines with Their Parents Using an iPad®-Based Speech-Generating Device. *Advances in Neurodevelopmental Disorders*. https://doi.org/10.1007/s41252-021-00215-9

7 Waddington, H., van der Meer, L., Carnett, A., & Sigafoos, J. (2017). Teaching a Child With ASD to Approach Communication Partners and Use a Speech-Generating Device Across Settings: Clinic, School, and Home. *Canadian Journal of School Psychology*, *32*(3–4), 228–243.

Weight of Evidence (WoE)

Gough's (2007) Weight of Evidence (WoE) framework was used to critically appraise each of the seven included studies, with consideration over their relevance and their quality. The WoE evaluation was broken down into WoE A, WoE B and WoE C. The average of these was then taken to produce an overall value for WoE D.

WoE A considers the methodological quality of a study when compared to other studies of a similar type and used a coding protocol derived from Horner et al.'s (2005) which was viewed appropriate for use with Single Case Experimental Design Studies. WoE B judgments consider the methodological relevance of the evidence provided within the studies and considers the appropriateness of this to answer the review question. WoE C provides a judgement of the appropriateness of the studies for the review question and considers their relevance and suitability. Both WoE B and WoE C were judged using a coding protocol developed by the researcher (Appendix C).

WoE D was calculated from the average of the ratings for WoE A, WoE B and WoE C. This provided an overall rating for each study in regards to their quality and relevance to review question. The summary of WoE ratings is presented within Table 4 for each of the seven included studies.

Further information of how WoE A, WoE B and WoE C are calculated can be found within Appendix C and completed coding protocols can be found within Appendix E.

Table 4

Summary of Weight of Evidence (WoE) ratings

Studies	WoE A	WoE B	WoE C	WoE D
Carnett et al. (2016).	2.43	0.5	1.5	1.48 (low)
McLay et al. (2017).	2.29	0.5	2.5	1.76 (medium)
McLay et al. (2015).	2.71	0.5	2.75	1.99 (medium)
Sigafoos et al. (2018).	2.29	0.5	1.75	1.51 (low)
van der Meer et al. (2015).	2.14	1	2.25	1.80 (medium)
Waddington et al. (2021).	2.43	0.5	1.5	1.48 (low)
Waddington et al. (2017).	2.71	0.5	2	1.74 (medium)

Note. < 1.7 (low), 1.7-2.4 (medium) and > 2.4 (high)

Participants

The studies reviewed included between one and four participants per study, with 13 participants in total being included across the seven studies. All studies provided the age in years for their participants, with ages ranging from five to eleven years, therefore covering the majority of ages typically found within a UK primary school. Eleven of the participants were male and only two studies (McLay et al., 2015; Waddington et al., 2021) included female participants. All

participants within these studies had a formal diagnosis of ASD, with one study (Carnett & Ingvarsson, 2016) additionally completing the Childhood Autism Rating Scale (Schlopler et al., 1980) prior to the study, therefore receiving a higher WoE C score for this criterion. All apart from one study (Sigafoos et al., 2018), provided adequate details on the participants that would allow for the selection of other individuals with similar characteristics. Sigafoos et al. (2018) provided some participant details however these were not sufficient enough to allow for others to select individuals with similar characteristics, which was reflected within its WoE A score.

Sampling details were not given for the majority of studies, with only two studies provided enough detail on the process of selecting participants in order to replicate the study with precision (Carnett et al., 2016; McLay et al., 2015), resulting in lower WoE A scores for the remaining studies.

Settings

Waddington et al. (2017) explored use of Proloquo2Go across multiple settings, including home, clinic and school. This study received a higher WoE C weighting as it included school-based intervention that was administered by a member of the school staff and therefore the findings are more likely to be generalisable to use within a classroom. Three of the remaining studies occurred within schools and three studies occurred within a university clinic room. As this review focused around use of intervention within a school setting, studies conducted within a school setting (Carnett et al., 2016; McLay et al., 2015; McLay et al., 2017) gained a higher rating for WoE C. The clinic based settings (Sigafoos et al., 2018; van der Meer et al., 2015; Waddington et al.,

2021) received lower WoE C scores as they are less likely to generalise within a school setting.

Study design

All studies within this review utilised a Single Case Experimental Design (SCED) with the participants acting as their own baseline controls (Horner et al., 2005). Given the nature of this research, this design allows for a focus on individuals and, with the small population of individuals using Proloquo2Go, use of SCED allows for research to be carried out within low-incidence populations and allows assessment of these interventions within a typical educational setting (Horner et al., 2005). By staggering the interventions across time, the studies had increased internal validity, reflected within their WoE A scores. These studies did, however, all received lower scores for WoE B, given there are more robust methods that can be used to gather data on the effectiveness of interventions (Petticrew & Roberts, 2003).

Intervention Analysis

Each of the studies displayed variation in the use of Proloquo2Go, however all selected studies used Proloquo2Go as an intervention to aid communication and strategies were implemented to teach the children how to use the programme. The studies varied in regards to the number of sessions, both during the baseline and intervention stage, with some studies opting to gather follow up or post intervention data (McLay et al., 2016; McLay et al., 2017; Siagfoos et al., 2018; van der Meer et al., 2015), which reflected in a higher WoE C score. Table 5 highlights the outcome measure used for each study, including details of post-intervention or follow up information. As this review

looked into effectiveness of Proloquo2Go, studies that looked at longer term outcomes had this reflected with their WoE C rating, with higher scores being given when a larger gap was left between the intervention and follow up stages.

All studies apart from one (Carnett et al., 2016) provided a high level of detail around the use of Proloquo2Go and how this was utilised within their study, allowing clear understanding of the way these studies used Proloquo2Go as a method to support communication outcomes. Carnett et al.'s (2016) limited detail over the use of Proloquo2Go impacted its WoE C rating as it was less clear of the relevance for this study.

Researcher Bias

All studies bar one (van der Meer et al., 2015) received lower WoE B ratings due to the nature of the researchers. The authors of the remaining six studies had all completed previous research using Proloquo2Go. Researchers who have previously carried out research in this area may be more likely to support the intervention's use (Luborsky et al., 1999) and therefore this was reflected within the WoE B rating. Van der Meer et al. (2015) received a low WoE B score as the majority of its researchers had completed similar research, however there were novel researchers who had not looked into this area previously and therefore this study was scored higher than the remaining studies in that area.

Findings and Effect Sizes

Table 5 highlights the effect sizes and probabilities for each study. These were calculated from graphs provided within the research papers, using a web-plot digitaliser to gain the values from the graphs. Tau U calculations were

conducted and, where appropriate, the effect size was corrected for a baseline trend (Parker et al., 2011). Values were calculated for individual participants for the use of intervention and, where included, post intervention data/follow up data compared to the original baseline data. Boundaries for qualitative descriptions of Tau U are presented within Table 6.

The majority of these studies looked at the use of Proloquo2Go for making requests (Carnett et al., 2016; McLay et al., 2015; McLay et al., 2017; Sigafoos et al., 2018; Waddington et al., 2017; Waddington et al., 2021) with the specific nature of the request varying dependent on the study. Requests for a continuation of play were looked at by Waddington et al. (2021) and McLay et al. (2017). Waddington et al. (2021) found children can be taught using Systematic Instruction to use Proloquo2Go and this use leads to a greater increase in requesting continuation of play. The findings were all significant, with there being three medium and one large effect size found within this study. This highlights a larger effect of use of Proloquo2Go and, as this study received a medium WoE D rating, the findings should be considered relevant. However, this study did not provide any follow up data and therefore there cannot be reliable predictions about the long-term benefits of the use of Proloquo2Go to increase communication. McLay et al. (2017) had a medium WoE D score, meaning these results hold equal weight. This study looked at intervention and long term follow up for two participants. Only one of these participants showed significant improvements from baseline when using Proloquo2Go to make requests, this participant had a medium effect size, and neither participant showed sustained use at follow up, which combined may suggest the long term

effects of use of Proloquo2Go for requesting continuation of play are not sustained without practice.

Another way that requests were considered, were through the requesting of items, as seen within Waddington et al. (2017) and McLay et al. (2015). McLay et al. (2015) had a medium WoE D score and found a large effect size for increased use of Proloquo2Go to make requests for two participants and a medium effect for two participants. This study considered the effects at post-intervention, follow up and long term follow up, which contributed to its higher WoE C rating. These findings showed mostly significant results with two participants showing positive effects (Participant B displayed significant changes, with consistently large effect sizes, whilst Participant D consistently has significant improvement with medium effect sizes) suggesting the use of Proloquo2Go for requesting items was maintained following the study. Participant A did not show a significant effect at long term follow up, with medium to large effect sizes found at the other time points. Participant C had significant effects with a medium effect size at all time points apart from the long term follow up suggesting the effects remained after the intervention, but not after several months of non-use. Both this study and Waddington et al. (2017) should be considered with equal weight as both received equal WoE D ratings. Waddington et al. (2017) looked at the frequency of use of Proloquo2Go for requesting items across three different settings. Medium effect sizes were found across a clinic, home and school setting, with the largest effect size being found within the school and smallest being within a school. Both of these studies indicated that Proloquo2Go can be used to support communication requests when compared to baseline and Waddington et al. (2017) offers some evidence

that these skills may be transferable across settings, though studies with stronger methodology should be completed to explore this further.

Sigafoos et al. (2018) recognised a gap within the research of looking into participants requesting discontinuation of an un-preferred activity or refusal or an un-preferred item. This study demonstrated some significant effects for teaching rejecting skills using Proloquo2Go, with these having medium effect sizes. This study didn't look at long term follow up, reflected in its low WoE D score and therefore these findings should be considered with lower weight as to the long-term effectiveness of Proloquo2Go, however did show some tentative evidence that these skills could be taught.

Carnett et al. (2016) and van der Meer et al. (2015) explored how communication benefits from using Proloquo2Go can also have implications on their academic outcomes. Carnett et al. (2016) explored the use of prompts to teach a child to mand answers to unknown questions using Proloquo2Go. A mand is a verbal act or request that is typically followed by a reinforcing consequence (Skinner, 1957). For example, in this case, the reinforcing consequence would be the child being provided with the answer the unknown question. This study overall had a low WoE D score and therefore the results need to be considered with caution. There was little evidence within this study to suggest pupils could learn to mand for responses, with one participant not showing any significant improvements and the remaining participant showing a significant improvement but with a low effect size, suggesting the increase in use was small. This study did however show medium effect sizes for both participants when considering their learning of new academic knowledge from these manding trials. This suggests the process led to the participants learning

greater information, however it cannot be determined as to whether these same effects would have been found if taught without the use of Proloquo2Go. Van der Meer et al, (2015) study should be considered with greater weight due to its medium WoE D score. This study found medium effect sizes for increased learning when using Proloquo2Go to match text and pictures. This was maintained at both intervention stages and the follow up, which indicates the use of Proloquo2Go as a method to support communication can also have academic benefits for primary aged children with ASD.

Table 5 - *Summary of Effect Sizes and Key Findings*

Study	**Outcome Measure**	**Effect Size**	**Qualitative Descriptor**	**p**	**Main Findings**	**WoE D**
Carnett et al. (2016).	Unknown Items 1 – *Intervention:*	Tau = 0.160	N/A	*p* = 0.304	Some evidence of pupil learning to mand for answers. Evidence pupils learnt from the mands.	1.48 (low)
	Correct Responses:	Tau = 0.418	Medium	*p* = 0.004		
	Unknown Items 2 – *Intervention:*	Baseline	Small	*p* = 0.142		
	Correct Responses:	Corrected Tau = 0.221				
		Baseline	Medium	*p* = 0.000		
		Corrected Tau = 0.718				
McLay et al. (2017).	Participant A – *Intervention:*	Tau = 0.631	Medium	*p* = 0.003	Participants taught to request continuation of	1.76 (medium)
	Long-Term Follow Up:	Tau = -0.577	N/A	*p* = 0.181		
	Participant B –					

	Intervention:	Tau = 0.269	N/A	*p* = 0.161	play using	
	Long Term Follow Up:	Tau = 0.240	N/A	*p* = 0.439	Proloquo2Go. Poor Long term follow up.	
McLay et al. (2015).	Participant 1- *Intervention:*	Tau = 0.918	Large	*p* = 0.018	Participants learnt to request using Proloquo2Go with some effects remaining at both follow up and long term follow up.	1.99 (medium)
	Post-Intervention:	Tau = 0.762	Medium	*p* = 0.005		
	Follow Up:	Tau = 0.696	N/A	*p* = 0.123		
	Long-Term Follow Up:	Tau = 0.913	Large	*p* = 0.011		
	Participant 2 – *Intervention:*	Tau = 0.866	Large	*p* = 0.008		
	Post-Intervention:	Tau = 0.875	Large	*p* = 0.002		
	Follow Up:	Tau = 0.894	Large	*p* = 0.036		
	Long-Term Follow Up:	Tau = 0.918	Large	*p* = 0.018		
	Participant 3 – *Intervention:*	Tau = 0.620	Medium	*p* = 0.029		

	Post-Intervention:	Tau = 0.824	Medium	*p* = 0.003		
	Follow Up:	Tau = 0.840	Medium	*p* = 0.042		
	Long-Term Follow Up:	Tau = 0.750	N/A	*p* = 0.102		
	Participant 4 -					
	Intervention:	Tau = 0.678	Medium	*p* = 0.006		
	Post-Intervention:	Tau = 0.799	Medium	*p* = 0.001		
	Follow Up:	Tau = 0.685	Medium	*p* = 0.011		
	Long-Term Follow Up:	Tau = 0.657	Medium	*p* = 0.014		
Sigafoos et al.	Participant A –				Participants learnt	1.51
(2018).	*Request Intervention:*	Tau = 0.488	N/A	*p* = 0.302	to request/reject	(low)
	Request Post	Tau = 0.545	Medium	*p* = 0.002	using	
	Intervention:	Tau = 0.672	Medium	*p* = 0.000	Proloquo2Go.	
	Reject Intervention:					
	Participant B –	Tau = 0.516	Medium	*p* = 0.007		
	Request Intervention:	Tau = 0.438	Medium	*p* = 0.003		
	Break Intervention:					

van der Meer et al. (2015).	Picture-Picture – *Intervention:*	Tau = 0.561	Medium	*p* = 0.088	Increased use of Proloquo2Go when matching text and pictures.	1.80 (medium)
	Follow Up:	Tau = 0.791	Medium	*p* = 0.031		
	Word-Picture – *Intervention:*	Tau = 0.448	Medium	*p* = 0.013		
	Follow Up:	Tau = 0.762	Medium	*p* = 0.024		
Waddington et al. (2021).	Participant A – *Routine Teaching:*	Tau = 0.670	*Medium*	*p* = 0.005	Children learnt to request continuation during preferred social routines using Proloquo2Go.	1.48 (low)
	Choice of Routine:	Tau = 0.853	*Large*	*p* = 0.021		
	Participant B - *Routine Teaching:*	Tau = 0.625	*Medium*	*p* = 0.003		
	Choice of Routine:	Tau = 0.795	*Medium*	*p* = 0.011		
Waddington et al. (2017).	Clinic:	Tau = 0.409	*Medium*	*p* = 0.009	Participants learnt to approach partners to communicate	**1.74 (medium)**
	School:	Tau = 0.696	*Medium*	*p* = 0.000		
	Home:	Tau = 0.647	*Medium*	*p* = 0.000		

					using Proloquo2Go across all settings

Note: Qualitative descriptor not provided for non-significant effect sizes

Table 6

Tau U Qualitative Descriptors

Tau U Value	Qualitative Descriptor
0-0.31	Small
0.32-0.84	Medium
0.85-1	Large

Conclusions and Recommendations

This review evaluated the effectiveness of Proloquo2Go as an intervention to support communication for primary aged children with ASD. Seven studies met the inclusion criteria for this study, with four of these (McLay et al., 2015; McLay et al., 2017; van der Meer et al., 2015; Waddington et al., 2017) receiving a medium WoE D rating and three (Carnett et al., 2016; Sigafoos et al., 2018; Waddington et al., 2021) receiving a low WoE D rating.

The findings from this research have important social implications for children and young people with ASD and offer an alternative method of communication that can be practical to use (Knight et al., 2013). These findings begin to explore the use of Proloquo2Go within the educational settings, and results could be seen to tentatively promote its use for supporting communication within the classroom. The findings have provided some promising evidence of Proloquo2Go supporting an increase in the child's communication, however the overall quality of these studies needs to be considered and therefore these findings should be interpreted with caution. The majority of the studies found there to be significant effects when considering use of Proloquo2Go to increase communication, either through making requests or through sharing information,

with the majority of these significant findings having a Medium effect size. In terms of their methodological quality, none of the studies in this review were viewed as high, with the majority receiving a medium score.

Some of these studies provided tentative evidence towards a longer-term impact of the use of Proloquo2Go and looked into whether the children were able to sustain their use of Proloquo2Go after varying periods of time. It should be recognised that McLay et al. (2017) and Waddington et al. (2021) both failed to find long-term follow up effects, but it is important to recognise that Proloquo2Go is ideally used regularly and therefore it should be considered that research is needed to look at long term effects when the programme is continually used.

Not only did these studies explore communication directly, they also looked at how an increase in communication can impact academic achievement, with van der Meer et al. (2015) and Carnett et al. (2016) providing some evidence of the use of Proloquo2Go to support academic learning. This could be explored further to see whether there are significant academic benefits from use of Proloquo2Go. This indicates further potential benefits of use of Proloquo2Go within an educational environment and could be appropriate as an alternative form of communication for non-verbal students within a specialist provision. It could also be considered to be potentially beneficial for students with Speech, Language and Communication Needs who have difficulties with their speech as a way to aid their communication, both in and out of the classroom.

A further exploration of this intervention should explore the effectiveness of use when carried out by non-researchers. The majority of these studies were conducted by the researchers and therefore further research could benefit from

looking at the implications if interventions are implemented by non-researchers, such as school staff, which would make findings more generalisable to a school setting. This research would allow further assessment of the practicality of use and whether the significant findings are extended.

Another area to explore could be around other functional uses of Proloquo2Go. Primarily the studies included within this review looked at its use for increasing requesting. It could be considered helpful to explore further forms of communication such as asking and answering questions or providing information. Research into these areas could lead to greater understanding of how Proloquo2Go can be used to support those individuals with communication difficulties.

In summary, a review of the studies did provide some promising evidence that Proloquo2Go can support communication effectively for primary school age children with ASD, and in two studies, this was tentatively explored further with consideration over academic benefits that can come with this. It does need to be recognised that, given the methodological limitations discussed, these results need to be considered with caution and should not be considered conclusive. There is a need for further research with more methodically sound methods and ideally this should be conducted by independent researchers who may show less bias whilst completing the research.

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Appendices

Appendix A – Excluded Studies

Table 7

Articles excluded following full text review, with relevant exclusion criteria

Number	Article Excluded	Criteria Not Met
1.	Almirall et al. (2016)	4
2.	Alzrayer & Banda (2017)	2
3.	Alzrayer (2020)	4
4.	Alzrayer et al. (2017)	6
5.	Alzrayer et al. (2019)	6
6.	Asha & Nichols (2016)	4, 6
7.	Baker et al. (2021)	4
8.	Barker et al. (2013)	4
9.	Boesch et al. (2013)	4
10.	Boesch et al. (2013)	4
11.	Bourque et al. (2019)	4
12.	Boyd et al. (2015)	2
13.	Brady et al. (2013)	6
14.	Carnett et al. (2020)	6
15.	Carnett et al. (2021)	4
16.	Chang et al. (2018)	4

17.	Chung & Douglas (2015)	6
18.	Collette et al. (2019)	4
19.	Couper et al. (2014)	6
20.	DiStefano et al. (2016)	4
21.	Esposito et al. (2017)	4
22.	Frampton et al. (2020)	6
23.	Genc-Tosun & Kurt (2017)	4
24.	Gevarter & Horan (2019)	4
25.	Gevarter et al. (2020)	4
26.	Gevarter et al. (2021)	4
27.	Gevarter et al. (2016)	4
28.	Gevarter et al. (2018)	4
29.	Gevarter (2020)	4
30.	Gilroy et al. (2018)	4
31.	Kasari et al. (2014)	4, 6
32.	Krägeloh et al. (2016)	2
33.	Lee et al. (2015)	4
34.	Lorah (2016)	6
35.	Lorah (2018)	6
36.	Lorah & Miller (2018)	6

37.	Lorah et al. (2015)	6
38.	Lorah et al. (2019)	6
39.	Lorah et al. (2021)	6
40.	Lorah et al. (2014)	6
41.	Lorah et al. (2018)	2
42.	Martínez-Santiago et al. (2018)	4
43.	Medeiros & Cress (2016)	4
44.	Muharib et al. (2021)	4
45.	Pellegrino et al. (2020)	4
46.	Roche et al. (2014)	6
47.	Romano & Chun (2018).	1
48.	Senner & Baud (2017)	4
49.	Shillingsburg et al. (2019)	4
50.	Shillingsburg et al. (2019)	4
51.	Strasberger & Ferreri (2014)	6
52.	Suberman & Cividini-Motta (2020)	6
53.	Tan & Alant (2018)	4
54.	Thiemann-Bourque et al. (2019)	4
55.	Thiemann-Bourque et al. (2017)	4

56.	Thiemann-Bourque et al. (2018)	4
57.	Thirumanickam et al. (2018)	6
58.	Tullis et al. (2019)	4
59.	Van der Meer et al. (2013)	6
60.	Van der Meer et al. (2014)	2
61.	Waddington et al. (2014)	6
62.	Xin & Leonard (2014)	4
63.	Young et al. (2021)	4

Full Reference for Excluded Studies

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Appendix B - Mapping the Field:

Table 8

Overview of the Seven Included Studies

Study	Participant Number	Participant Characteristics	Setting	Research Design	Study Design	Outcome Measure
Carnett et al. (2016)	• n = 1	• Diagnosis of ASD • 11 year old male	School	Multiple Baseline across stimulus sets.	Single Case Experimental Design	Use of Proloquo2Go to say "I don't know please tell me" or to provide the correct answer to a question.
McLay et al. (2017)	• n = 2	• Diagnosis of ASD • 10 year old male • 5 year old male	School	Non-concurrent multiple probe design	Single Case Experimental Design	Indication of 'More' either using manual sign, PECS or use of Proloquo2Go,
McLay et al. (2015)	• n = 4	• Diagnosis of ASD • 7 year old male • 8 year old female • 10 year old male	School	Alternating treatment design in line with requirement of a	Single Case Experimental Design	Comparison of performance across three AACs (manual signing, PECS and Proloquo2Go) in terms of

		• 5 year old mal		delayed multiple probe across participants design		acquisition and maintenance, recording the frequency of use for each model.
Sigafoos et al. (2018)	• n = 2	• Diagnosis of ASD • 9 year old male • 7 year old male	Clinic	Modified/adapted multiple baseline across responses design	Single Case Experimental Design	Appropriate rejection of item using Proloquo2Go. Use of Proloquo2Go to request breaks from non-preferred activity.
van der Meer et al. (2015)	• n = 1	• Diagnosis of ASD • 10 year old male	Clinic	Multiple probe across matching targets design	Single Case Experimental Design	Frequency of independent use of iPad to accurately match pictures and words.
Waddington et al. (2021)	• n = 2	• ASD Diagnosis • 9 year old male • 5 year sold female	Clinic	Multiple baseline across participant design	Single Case Experimental Design	Percentage of correct, independent requests for continuation of positive social routine.

Waddington et al. (2017)	• n = 1	• Diagnosis of ASD • 8 year old male	Multiple settings – clinic, home, school	Multiple baseline across settings (clinic, school, home)	Single Case Experimental Design	Independent approaching communication partner and making a request.

Appendix C - Criteria for Weight of Evidence ratings with relevant rationale.

WoE A

The coding protocol used to appraise the quality of the execution these studies for WoE A was derived from Horner et al.'s (2005) Coding Protocol. This coding protocol evaluates the description of the participants and the settings, precision of the dependent variable and the independent variable, the quality of the baseline, the experimental control/internal validity, measures of control for external validity and social validity (Table 9). This protocol was selected as it is considered appropriate for use with Single Case Experimental Design studies that are typically used for studies of this nature. WoE A scores are presented within Table 10.

Table 9

Criteria for WoE A (Horner et al., 2005).

Section	Criteria (derived from Horner et al., 2005)	Scoring Criteria
A – Description of Participants and Setting	• Participants are described in detail to allow others to select similar individuals. • Process for participant selection is described with replicable prevision. • Physical description of setting is described in enough detail to allow for replication.	3 = all criteria are fulfilled 2 = two criteria are fulfilled 1 = one criterion is fulfilled 0 = none of the criteria are fulfilled
B – Dependent Variable (DV)	• DVs are provided with clear detail and operational precision. • DVs are each measured with procedure which generates a quantifiable index.	3 = all criteria are fulfilled 2 = three/four criteria are fulfilled 1 = one/two criteria are fulfilled 0 = none of the criteria are fulfilled

	• Measurement of the DV is valid and described accurately with replicable precision. • DVs are measured over time. • Reliability of interobserver agreement for each DV meets minimum standards of IOA = 80% or Kappa = 60%.	
C – Independent Variable (IV)	• IV is measured with replicable precision and detail. • Each IV is under the control of the experimenter and systematically manipulated with this. • Fidelity of implementation is overtly measured.	3 = all criteria are fulfilled 2 = two criteria are fulfilled 1 = one criterion is fulfilled 0 = none of the criteria are fulfilled
D - Baseline	• A baseline phase is used. • Baseline data provides repeated measurement of the DV and establishes pattern of responding which can be used for future predictions.	3 = all criteria are fulfilled 2 = two criteria are fulfilled 1 = one criterion is fulfilled 0 = none of the criteria are fulfilled

	• Detail of the baseline condition is sufficient enough to be reproduced with precision. • Three demonstrations of the experimental effect are provided at three different time points. • Common threats to internal validity are controlled for. • Results documented indicate a pattern highlighting experimental control.	3 = all criteria are fulfilled 2 = two criteria are fulfilled 1 = one criterion is fulfilled 0 = none of the criteria are fulfilled
E – Experimental control/Internal Validity.		
F – External Validity	See scoring criteria.	3 = experimental effects are replicated across 3+ participants or across 3 or more settings/materials and each generalised to a novel setting. 2 = Experimental effects are replicated across 3+ participants or across 3 or more settings/materials 1 = Experimental effects are replicated across 2 participants or across 2 settings/materials

		0 = Experimental effects are replicated with 1 or no participants, or across 1 settings/materials
G – Social Validity	• The DV is of social importance. • The magnitude of DV change is of social importance. • It is practical and cost effect to implement the IV. • Implementation of the IV over extended time periods has been used to enhance social validity.	3 = all criteria are fulfilled 2 = three criteria are fulfilled 1 = one/two criterion is fulfilled 0 = none of the criteria are fulfilled

Note. WoE A Rating Sum of A-G scores divided by 7 (average)

Table 10

WoE A results

Study	Criteria A	Criteria B	Criteria C	Criteria D	Criteria E	Criteria F	Criteria G	WoE A
Carnett et al. (2016)	3	3	3	3	2	1	2	2.43
McLay et al. (2017)	1	3	3	3	3	1	2	2.29
McLay et al. (2015)	3	2	3	3	3	3	2	2.71
Sigafoos et al. (2018)	1	3	3	3	3	1	2	2.29
van der Meer et al. (2015)	2	2	3	3	2	1	2	2.14
Waddington et al. (2021)	2	3	3	3	3	1	2	2.43

Waddington et al. (2017)	2	3	3	3	3	3	2	2.71

WoE B

The WoE B scores looked at the methodological relevance of the evidence provided. Petticrew and Roberts (2003) viewed systematic reviews and meta-analyses to be the highest quality of evidence when considering effectiveness of an intervention, followed by Randomised Control Trials (RCTs). The criteria in Table 11 have been used to provide each study a rating of their methodological relevance. These ratings were given in line with Petticrew and Roberts' (2003) review of evidence quality, with greater quality of evidence receiving a higher rating.

This was combined with a rating of 0-3 score which considered the impact of conflicts of interest. This involves the author appearing on multiple papers focused on the intervention and therefore may potentially be at risk of bias (Lubirsky et al., 1999). The results of this are displayed within Table 12.

Table 11

WoE B Criteria

Criteria	Scoring	Rationale
A – Study Type	3 = Randomised Control Trials 2 = Quasi-experimental designs with a control group 1 = Quasi-experimental designs without a control group, Cohort	It is important to consider the most appropriate method for data collection when considering studies looking at effectiveness.

	studies, Single Case Experimental Designs 0 = Qualitative Research, Survey, Case-control Studies, Non-experimental Evaluation	
B – Conflict of Interest	3 = None of the researchers have previously contributed to similar research looking at this intervention. 2 = One of the authors of the paper have contributed to similar research, looking at this intervention. 1 = Multiple authors of the paper have contributed to similar research looking at this intervention. 0 = All researchers have contributed to similar research looking at this intervention.	Conflicts of interest in this review are considerations over whether the research has a primary interest in the topic and is involved in several pieces of research into the area. This can be considered a potential bias over the methods and consequently the findings of the study (Luborskyn et al., 1999).

WoE B = sum of Criteria A and Criteria B, divided by 2.

Table 12

WoE B Ratings

Studies	Criteria A	Criteria B	WoE B

Carnett et al. (2016)	1	0	0.5
McLay et al. (2017)	1	0	0.5
McLay et al. (2015)	1	0	0.5
Sigafoos et al. (2018)	1	0	0.5
van der Meer et al. (2015)	1	1	1
Waddington et al. (2021)	1	0	0.5
Waddington et al. (2017)	1	0	0.5

WoE C

WoE C looked at the appropriateness of the studies, using criteria created by the reviewer (see Table 13 for full criteria). This included consideration over the relevance of the studies and their ability to answer the research question. This involved consideration over the type of participants, the intervention use, the outcome measures and the setting in which the intervention was used. Table 14 displays the relevant scores for WoE C.

Table 13

WoE C Criteria

Criteria	Scoring	Rationale
A - Participants	3 = Participants have a formal diagnosis of ASD which was independently confirmed prior to the	This review is looking into the role of Proloquo2Go to support

	intervention and completed the Vineland Adaptive Behaviour Scales 2 = Participants have a formal diagnosis of ASD and completed the Vineland Adaptive Behaviour Scales. 1 = Participants have a formal diagnosis of ASD. 0 = No information provided about the participants diagnosis.	communication for individuals with ASD. The Vineland Adaptive Behaviour Scales can be used to indicate a need for an AAC System (Waddington et al., 2021).
B – Intervention Description	3 = The use of Proloquo2Go is clearly defined, with regards to use for communication, including layout of screen and context used. 2 = The use of Proloquo2Go is defined, with some details given on its use for communication but there are limited details of its use. 1 = Studies use of Proloquo2Go is limited in its use to support communication. 0 = Proloquo2Go is not used within this study.	Information regarding the specific nature of the interventions use allows for replicability of the specific nature of the interventions.
C – Outcome Measures	3 = The post-intervention data was gathered more than one day following the intervention administration.	By measuring post-intervention performance, it can be

	2= The post-intervention data was gathered one day following the intervention administration. 1 = The post-intervention data was gathered shortly following the intervention. 0 = Post-intervention data was not gathered.	established as to whether the results from this study are applicable following the removal of intervention and therefore indicate longer term benefits.
D – Setting	3 = Proloquo2Go used within a school setting with school staff administering the intervention. 2 = Proloquo2Go used within a school setting, administered by trained psychologists/researchers. 1 = Proloquo2Go used outside of a school setting, administered by trained individuals. 0 = Proloquo2Go used outside of a school setting, administered by untrained individuals.	This review is looking into the use of Proloquo2Go within a school setting and therefore those that are more closely linked to a school setting are weighted more highly.

Note: WoE C Rating – Sum of A to D divided by 4.

Table 14

WoE C Ratings

Studies	Criteria A	Criteria B	Criteria C	Criteria D	WoE C
Carnett et al. (2016)	3	1	0	2	1.5
McLay et al. (2017)	2	3	3	2	2.5
McLay et al. (2015)	2	3	3	3	2.75
Sigafoos et al. (2018)	2	3	1	1	1.75
van der Meer et al. (2015)	2	3	3	1	2.25
Waddington et al. (2021)	2	3	0	1	1.5
Waddington et al. (2017)	2	3	0	3	2

Note: WoE C Rating – Sum of A to D divided by 4.

Appendix D

Completed coding protocols [Adapted from the Horner et al. (2005) Single Subject)]

Coding Protocol

Name of Coder:_____ Date: 08/01/22

Full Study Reference: Carnett, A., & Ingvarsson, E. T. (2016). Teaching a Child with Autism to Mand for Answers to Questions Using a Speech-Generating Device. *The Analysis of Verbal Behavior*, *32*(2), 233–241.

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1. **Quality Indicators within Single-Subject Research**

A. Description of Participants and Settings

A1. Participants are described with sufficient detail to allow others to select individuals with similar characteristics (ie age, gender, disability, diagnosis)

☒ Yes

☐ No

☐ Unable to code

A2. The process for selecting participants is described with replicable precision

☒Yes

☐No

☐Unknown/unable to code

A3. Critical features of the physical setting are described with sufficient precision to allow replication

☒Yes

☐No

☐Unknown/unable to code

B. Dependent Variable

B1. Dependent variables are described with operational precision

☒Yes

☐No

☐Unknown/unable to code

B2. Each dependent variable is measured with a procedure that generates a quantifiable index

☒Yes

☐No

☐Unknown/unable to code

B3. Measurement of the dependent variable is valid and described with replicable precision

☒Yes

☐No

☐Unknown/unable to code

B4. Dependent variables are measured repeatedly over time

☒Yes

☐No

☐Unknown/unable to code

B5. Data are collected on the reliability or interobserver agreement associated with each dependent variable . IOA levels meet minimum standards for each dependent variable.

☒Yes (IOA = 80%+, Kappa = 60%+)

☐No (IOA = Less than 80%, Kappa = Less than 60%)

☐ IOA not provided

☐Unknown/unable to code

C. Independent Variable

C1. Independent variable is operationally described with reliable precision

☒Yes

☐No

☐Unknown/unable to code

C2. Independent variable is systematically manipulated and under the control of the experimenter

☒Yes

☐No

☐Unknown/unable to code

C3. Overt measurement of the fidelity of implementation for the independent variable is highly desirable

☒Yes

☐No

☐Unknown/unable to code

D. Baseline

D1. Inclusion of a baseline phase that provides repeated measurement of a dependent variable .

☒Yes

☐No

☐Unknown/unable to code

D2. Baseline phase allows for establishment of a pattern of responding.

☒Yes

☐No

☐Unknown/unable to code

D3. Baseline conditions are described with replicable precision

☒Yes

☐No

☐Unknown/unable to code

E. Experimental Control/Internal Validity

E1. The design provides at least three demonstrations of experimental effect at three different points in time.

☐Yes

☒No

☐Unknown/unable to code

E2. The design controls for common threats to internal validity (e.g., permits elimination of rival hypotheses).

☒Yes

☐No

☐Unknown/unable to code

E3. The results document a pattern that demonstrates experimental control.

☐Yes

☒No

☐Unknown/unable to code

F. External Validity

F1. Experimental effects are replicated across participants, settings or materials to establish external validity.

☒Yes

☐No

☐Unknown/unable to code

G. Social Validity

G1. The dependent variable is socially important.

☒Yes

☐No

☐Unknown/unable to code

G2. The magnitude of change in the dependent variable resulting from the intervention is socially important.

☒Yes

☐No

☐Unknown/unable to code

G3. Implementation of the independent variable is practical and cost effective.

☒Yes

☐No

☐Unknown/unable to code

G4. 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

☒No

☐Unknown/unable to code