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## **An Overview of Review Studies on Effectiveness of Major AAC systems for Individuals with Developmental Disabilities Including Autism**

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This paper provides an overview of five review studies that analyzed 92 single subject studies on the effectiveness of major augmentative and alternative communication (AAC) systems for individuals with developmental disabilities including autism. This paper offers recommendations useful for AAC decision-making points. Research on the effectiveness of main communication systems over the last 25 years has yielded mixed and inconsistent results on communication and preference outcomes. The heterogeneity of a large quantity of studies involved various research designs, participants, and multiple components is a major concern with the review studies. It is recommended to conduct more focused syntheses of empirical studies in terms of research designs, target population, and program components.

*Keywords:* AAC systems, Effectiveness, Review, Developmental Disabilities, Autism

Speech and communication impairments are the most common characteristics of children with developmental disabilities including autism. The National Research Council (2001) reported that "one-third to one-half of children and adults with autism do not use speech functionally" (p. 48). Furthermore, nearly all individuals with severe to profound developmental disabilities experience communication difficulties (Sigafoos, O'Reilly, & Green, 2007). Many of them rely on non-symbolic and challenging

behavior to express their wants and needs including informal gestures, vocalizations, eye gazing, crying, and throwing things to communicate. Reliance on idiosyncratic communication forms is problematic because these acts are difficult to interpret and often socially inappropriate (Sigafoos, O'Reilly, & Green, 2007).

Given these high prevalence rates and associated problems, it is a major priority to provide Augmentative Alternative Communication (AAC) methods for children with developmental disabilities

including autism. AAC methods use a variety of techniques and devices, including picture communication boards, manual signs, speech-generating devices (SGDs), gestures, and tangible objects, to help the child express thoughts, needs, feelings, and ideas. The primary purpose of any AAC method is to “compensate (either temporarily or permanently) for the impairment and disability patterns of individuals with severe expressive communication disorders” (American Speech-Language-Hearing Association [ASHA], 1989, p.107). An AAC system is an integrated group of components used to enhance communication. These components include forms of AAC (aided or unaided), symbols, selection techniques, and strategies incorporating each child’s communication abilities (ASHA, n.d.). Due to the variability across AAC systems and individual differences, the decision-making process used to select an appropriate AAC system for a child with developmental disability is complicated, even for skilled practitioners (Boesch, Shukla Mehta, & Da Fonte, 2016). The decision-making process involves different decision points that take into account a number of variables such as environmental demands, individual abilities, symbols, and features of available AAC systems. Each child presents unique cognitive, motor, and communication abilities and barriers and there are advantages, disadvantages, and limitations of each AAC system. Evaluating research evidence to address important questions raised at different decision points would increase the chances for practitioners to select the best alternative; however, it is unlikely that all practitioners will have the time, skills, and resources to evaluate this evidence and incorporate it into their decision-making process. This review

responds to this challenge by evaluating and synthesizing research evidence on AAC systems commonly used for children with developmental disabilities including autism.

The most studied and common AAC systems for children with developmental disabilities are manual signs (MS), picture exchange (PE), and speech generating devices (SGDs). AAC systems can be divided into two broad categories, unaided and aided. Unaided AAC does not require any equipment that is external to the body and involves the use of symbols such as manual signs and gestures. Aided AAC includes procedures, such as PE and SGD communication aids that rely on material external to the child’s body (Mirenda, 2003). PE is a system for communication that promotes behaviors such as continuity of communication by requiring students to exchange their desired items or activities with pictures (Flores et al., 2012). SGD is an electronic communication aid that generates digitized or synthesized speech activated by individuals with limited or no functional speech (Boesch, Wendt, Subramanian, & Hsu, 2013b). It may be necessary to first understand what research tells us about the effectiveness of these AAC systems. The purpose of this review is to a) provide an overview of current research on the effectiveness of the major AAC systems for individuals with developmental disabilities including autism and b) offer recommendations useful in the AAC decision-making process.

### **Methods**

To identify research articles for the first purpose, the first author searched the following electronic databases: PsycInfo, ERIC, Academic Search Premier, Education Full Text (H.W. Wilson), and PubMed. The search words with Boolean operators used to initially screen research articles in the

electronic databases were: manual signs, picture exchange, PECS, SGD, VOCA (Voice Output Communication Aid), compar\*, review, and developmental disabilities or autism. Then, the first author manually searched and identified five research articles that met the following inclusion criteria: a) a review study that employed systematic methods; b) evaluated single-subject studies that involved participants diagnosed with developmental disabilities including autism; c) compared one AAC system to another; and d) was published in a peer-reviewed journal in English. This study excluded reviews involving group experimental studies in order to mitigate the heterogeneity in study designs.

When the inclusion criteria were initially applied by reviewing abstracts, 26 studies were identified for further review. Ultimately, five of 26 studies met the inclusion criteria.

The final five studies that met inclusion criteria were summarized in terms of a) participants, b) AAC systems compared, c) methods, and d) findings and suggestions. Participants were coded in terms of age range and disability diagnoses. Methods were categorized into time period of review, inclusion criteria, number of studies reviewed, and analyses. Findings and suggestions were narratively summarized. For the second purpose of this study, recommendation for AAC decision-making points, the authors synthesized the research findings from the five review articles. Our recommendations were also based on additional references selected along content rather than methodical parameters.

### **Effectiveness of Major AAC Systems**

Table 1 provides an overview of the five review studies. These studies analyzed 92 single-subject studies that compared the

major AAC systems and were conducted between 1992 and 2016. The single-subject studies involved a total of 330 individuals with developmental disabilities whose ages ranged from 2 to 52 years.

Gevarter and colleagues (2013) reviewed 28 single-subject studies that compared major communication systems for individuals with developmental disabilities. The comparisons made in the studies were a) non-electronic PE systems to SGDs, b) aided AAC vs. unaided AAC systems, or c) AAC to speech-language interventions. The results showed unclear and inconsistent differences between communication systems and could not make definitive statements regarding a universal best approach for all people with developmental disabilities. More specifically, there was no consistent differences between the effectiveness of PE systems and SGDs for communication outcomes. However, a significant number of studies provided preponderant to conclusive evidence that PE systems are equally effective as SGDs during acquisition, immediate post-training, or fluency stages. Across studies, preference data favored the choice of SGDs over PE, but individual differences were also noted. Findings regarding collateral vocal speech outcomes, decreases in problem behavior, and generalization were mixed. It was noted “a majority of vocalization outcomes were inconclusive due to either limited speech use across participants and/or indistinguishable patterns” (p. 4426). With regard to problem behavior, studies provided preponderant evidence that the use of PE and SGDs in requests were equally effective at maintaining low levels of problem behavior (Gevarter et al., 2013).

While empirical studies supported a greater likelihood for advantages of aided

systems (PE and SGDs) over manual signs for acquiring mands (requests), functional communication- related mand outcomes were mixed. A greater number of empirical studies concluded that aided systems were more effective than manual signs or equally effective as manual signs. The study noted that motor imitation skills and manual sign ability corresponded with picture matching skills. Specifically, those with strong motor skills also matched pictures well and did well with both systems, while those with low motor imitation had low picture matching skills and did better with PE systems (Gevarter et al., 2013). The results of this review highlight the importance of comparing different communication systems at the individual level. The study concluded "individualized assessment across a range of communication systems may reveal differences in acquisition rate, preference, effects on problem behavior, and generalization or maintenance that could tip the balance with respect to which system is best suited to any given individual" (p. 4430).

Lancioni et al. (2007) reviewed 37 single-subject studies dealing with the use of AAC systems for promoting the performance of requests. The studies involved 173 students with developmental disabilities and compared PE and SGDs. The findings indicated that most of the students were successful in learning requesting using PE and SGDs. There were not specific or consistent differences in the comparison of PE and SGDs in terms of request acquisition and daily use. In conclusion, "Picture Exchange Communication System (PECS) and SGDs are similarly effective systems for introducing students with developmental disabilities and lack of speech to making requests" (p. 484). Lancioni et al. proposed two hypotheses for the finding. One

hypothesis could be that "the two systems do not really differ much from the standpoint of the students' performance, although they have different implications for caregivers and staff" (p 482). The other hypothesis could be that "the differences were not visible because the systems were mostly used for relatively small numbers of requests" (p. 482). They suggested that by increasing the numbers of requests, one might see the appearance of differences between them.

Lancioni et al. (2007) found a lack of consistent student preference for one system over the other. They argued that "the preferences are more specifically connected to students' personal characteristics than to systems' distinctive features" (p. 482). They also suggested that the preference question might be predetermined by student's motor abilities in many cases and there was clear evidence suggesting a positive and supporting attitude toward SGDs.

Lancioni et al. (2007) made several suggestions to be considered in choosing between AAC options. If the priority is to adopt a cheaper and simpler system, then PE may be recommended. If the emphasis is on a system that helps caregivers be aware of the students' requests at any time and understand them immediately, then a SGD device would be recommended. In regards to the portability, the two systems could be satisfactory provided that a communication book and a simple SGD device are used. There might be some limitations when a micro switch connected to a vocal box or a large communication board is adopted. It may be reasonable to argue, however, that the SGD would generally have some advantages in helping communication partners familiarize themselves with these students and allow

communication to occur even when the partner is not in close proximity of the student.

Lorah, Parnell, Whitby, and Hantula (2015) reviewed 17 empirical studies on the use of handheld computers as SGDs and the acquisition of a communicative repertoire for individuals with developmental disabilities. Participants who used handheld computers as SGDs acquired verbal repertoire effectively and acquisition of the communication repertoire was often quicker when using a SGD. In addition, the vast majority of participants preferred using the SGD to PE or manual signs (Lorah et al., 2015).

Nam and Hwang (2016) reviewed three empirical studies that compared PE and manual sign communication training in terms of mands acquisition as a dependent variable. The review indicated a tendency that children with autism acquire PE responses more easily and rapidly than signed responses. The review also noted a strong relation between motor imitation, matching skills, and manual signs acquisition. Both motor imitation and matching skills seem prerequisites for acquisition of manual signs based on the study by Gregory, DeLeon, and Richman (2009). Nam and Hwang suggest

considering more sophisticated symbolic communication forms such as writing, typing, and signs first before choosing non-symbolic forms. If symbolic forms are not possible, then non-symbolic forms of communication such as gestures and eye gaze can be considered.

van der Meer and colleagues (2011) evaluated 7 empirical studies that involved 12 individuals with developmental disabilities and assessed preference for using SGDs, PE systems, and/or manual signs. For the studies that compared preference for SGD vs. PE, 50% of the participants demonstrated a high preference for the SGD over PE while 30% of the participants demonstrated a high preference for PE. When comparing all three communication options (SGD, PE, and manual signing) across all studies included, 67% of participants demonstrated some degree of preference for using SGDs compared to 33% of participants who demonstrated some degree of preference for PE. Although a greater number of participants showed a preference for SGDs over PE and manual signs, the review modestly concluded that "individuals with developmental disabilities often show a preference for different AAC options" (p. 1422).

Table 1  
*Overview of the Review Studies Comparing the Major AAC Systems*

Citation	Purpose of Review	Review Period	# of Studies; # of Participants (ages)	Analysis
Gevarter et al., 2013	Studies compared different communication systems for individuals with DD	2004-2012	28; 77 (2-52)	Non-electronic picture systems to speech generating devices; aided AAC to unaided AAC systems (manual sign); or AAC to speech-language interventions.
Lancioni et al., 2007	Studies on PE and SGDs for promoting the performance of requests by students with DD	1992-2006	37; 173 (3-42)	The use of the PE or equivalent, the use of SGDs or equivalents; the comparison of both of these approaches
Lorah et al., 2015	Studies on handheld computers as SGDs for individuals with ASD or related DD.	2007-2014	17; 57 (3-23)	The acquisition of a mand or functional communication repertoire as the primary dependent measure; acquisition of other verbal operants as the primary dependent measure; comparisons to other methods of AAC; participant device preference, etc.
Nam & Hwang, 2016	Studies assessed acquisition of picture exchange-based vs. signed mands	2004-2016	3; 11 (2-17)	Picture exchange-based and manual sign communication training as independent variable; acquisition of mands as dependent variable
van der Meer, 2011	Studies assessed preference for using SGDs, PE systems, and/or manual signs	1993-2009	7; 12 (2. 8-22)	Communication options; design; communication skill(s) taught; intervention procedures; outcomes of the intervention and outcome of the preference assessment, etc.

Note: DD = Developmental Disabilities

PE = Picture Exchange

SGDs = Speech Generating Devices

## Discussion

This section discusses considerations, advantages, and disadvantages of different AAC options by integrating research evidence from the review studies as well as clinical experience from the book authors referenced. This section also offers recommendations for important AAC decision-making points.

**Speech or AAC?** Speech is obviously the most common form used by a large speaking community and the most preferred form of communication for all children. Effort should always be given to developing vocal communication prior to considering AAC options. In considering speech as a viable response form, one should assess the strength of the child's echoic repertoire. If echoic behavior is moderate or strong, then a vocal response form should be pursued. Even a very small amount of echoic behavior may be enough to immediately get started with mand training. AAC options are considered for children who are not able to use speech as their primary mode of communication (Sundberg & Partington, 1998). If multiple attempts made to establish verbal communication have been unsuccessful, AAC options and alternatives that enable the student to communicate his/her everyday needs and wants should be considered.

**Unaided or Aided AAC?** Table 2 shows major unaided and aided AAC

options to be considered for an individual with developmental disability. While an AAC option would be sufficient for many children, it is possible that a combination of different systems can be beneficial for some children (Sundberg & Partington, 1998). In fact, most people use a combination of unaided and aided communication techniques, depending on the context and communication partner (Mirenda, 2003). Overall, research indicates that aided systems such as PE or SGDs enable children to acquire the target skills quicker and are generally preferred by children over manual signing (Gevarter et al., 2013; Nam & Hwang, 2016). It is also noted that adults working with children using PE or SGDs better understand what is being pointed to than they would by simply looking at what a child is pointing to or by listening alone.

Practitioners might want to strongly consider aided systems over manual signs, particularly for children with fine motor limitations. Children with intellectual disabilities can benefit from an aided graphic symbol that functions as a prompt or reminder. It is noted that the aided systems generally do not require learning new motor response form for each new word; rather, the child is taught the same response form (e.g., pointing to a picture on a SGD) for each request (Gevarter et al., 2013).



Table 2  
*Major Unaided and Aided AAC Options*

	Unaided	Aided
Non-electronic	Manual signs	
	Low-tech eye gaze	PE
	Gestures	Writing texts
	Facial expression	
Electronic	High-tech eye gaze	SGDs Typing texts

***Non-Electronic or Electronic Aided System?*** Lancioni et al. (2007) indicates that most of the students ( $n= 173$ ) in the single subject studies ( $n= 37$ ) were successful in using both non-electronic and electronic picture systems. There were not any specific or consistent differences in the comparison of non-electronic and electronic picture systems in terms of request acquisition and daily use. According to Bock, Stoner, Beck, and Hanley (2005), some children ( $n= 3$ ) with developmental disabilities acquired requests using PECS at a slightly faster rate, while the other children ( $n= 3$ ) acquired requests using both devices (PECS and SGDs) at equal levels. It seems that personal preference and characteristics (e.g., motor abilities) are more influential than a systems' effectiveness at this decision point. Although there are individual differences, research evidence (Lancioni et al., 2007; van der Meer et al., 2011) generally indicates children with developmental disabilities show some degree of preference for SGDs compared to PE or manual signs.

Electronic options might be preferred when the intervention focus is to help caregivers be aware of a child's requests at any time and immediately (Lancioni et al., 2007). When a child needs to learn functional communication skills without gaining the listener's attention

before communicating, electronic systems would be appropriate (Lorah et al., 2013). Also, when a child requires an AAC system with various symbol options and input modes (i.e., touch, eye gaze), electronic options would be more appropriate than non-electronic ones. The following section further discusses advantages and disadvantages of picture exchange (PE) as a non-electronic aided system and speech generating devices (SGDs) as an electronic aided system.

***Picture Exchange (PE) Systems.*** Perhaps the main advantage of PE systems is that the communication partner does not need any special training to understand what the child is saying. Also, PE systems are easier for the instructor because the response topography (i.e., motor movement) is the same for each word. The child always points to (i.e., touches, exchanges) specific pictures, so complex motor movement and training differential responding is not necessary. It is also noted that PECS, a PE system, starts with the teaching of requesting for preferred items by pointing to pictures. Many individuals with autism prefer visual stimuli over auditory stimuli; thus, PE systems may be advantageous for use with these children (Boesch et al., 2013b).

One of the most significant disadvantages of PE systems is that

successful communication is dependent upon auxiliary equipment, including a communication book or board which may be difficult to carry at all times (Mirenda, 2003). If the board is not available, the response cannot occur. PE systems also require a large amount of response time for the student. He or she must scan the array of stimuli, find and locate the desired picture, point to or exchange, and request the desired pictures. Additionally, PE systems are often limited when it comes to representing complex words or phrases (i.e., words in pictorial form, prepositions). Lastly, some boards and books provide little space and they need to be in close proximity to the listener (Sundberg & Partington, 1998).

#### ***Speech-Generating Devices (SGDs).***

SGDs or Voice Output Communication Aids (VOCAs) are electronic devices that allow a person with a severe speech impairment to communicate using electronic speech generation. Usually the person presses a picture, word, or other symbol depicting an item, activity, response, or statement on an electronic screen to evoke an electronic speech output (Lancioni et al. 2007). Many SGD devices exist and range greatly in cost and technological capabilities. In recent years, hand-held computers (i.e., iPad, Galaxy notebook) and smart phones (i.e., iPhone, Galaxy phone) are adapted to function as SGDs.

A major advantage of SGDs is that the output mode of the communication is spoken messages. Because of this, gaining the listener's attention before communicating is not a necessary part of initial communication training (Lorah et al., 2013). The spoken messages generated by SGDs are also easily understood by parents, staff, and other caregivers. Spoken messages can be understood even by a

person who is not looking at or is not in close proximity to the child, or someone who is unfamiliar with the symbols the child uses (Lancioni et al., 2007). Given recent technological advances in the development of powerful hand-held computers, SGDs can potentially store an almost limitless number of pictures or icons in a much more efficient manner than a picture exchange systems. These technological advancements have also made SGDs more socially accepted and more readily available. A child using a device such as an iPad as a SGD may be more socially accepted and less stigmatized than a child using a dedicated AAC system such as PECS. Finally, the use of hand-held computers and smartphones allows the child greater flexibility and options in terms of the function of the device. Although the primary purpose of such a device may be to function as a SGD, the device can be used for secondary purposes including academic and leisure applications (Lorah et al., 2015).

***Manual Signs.*** The use of sign language with children with developmental disabilities has proven to be an effective way to engage in functional communication. Manual signs may be a suitable form of communication if a child cannot imitate sounds or words but can imitate some fine or gross motor movements (Sundberg & Partington, 1998). A number of advantages of using manual sign have been noted. First of all, sign language, like speech is portable and does not require added materials such as a communication book or a voice output device (Mirenda, 2003; Sundberg & Partington, 1998). In addition, a message sent via manual signs can be delivered quicker than a communication board or device, which involves scanning an array of pictures.

There are fairly serious drawbacks in adopting manual signs as an AAC option

(Lancioni et al., 2007). The primary disadvantage of this system is that the communication partners must learn and use manual signs. Too often, parents, families, and teachers are unfamiliar or not proficient in manual signs, which limits the child's exposure to verbal vocabulary (Sundberg & Partington, 1998). Another disadvantage is that because sign language is a topography-based system where each response form (i.e., sign) must be individually shaped, it requires that staff have special training in shaping, prompting and fading, and the use of differential reinforcement procedures. This training is costly and time-consuming. Other disadvantages of manual signs include the students not using the signs spontaneously and not generalize the signs to other environments (Mirenda, 2003). Children with intellectual disabilities may show difficulty learning a significant number of signs because the system requires a different sign for each object, action, letter, etc. (Sundberg & Partington, 1998). Also, manual signs may be particularly challenging for children with limited fine motor skills, a common characteristic of children with severe developmental disabilities.

**Texts.** There are a number of children with developmental disabilities who are unable to speak, but are able to read and write texts. When a child – particularly a child with weaknesses in echoic and imitative skills – demonstrates good literacy and fine motor skills, writing and typing texts would be an effective communication form. However, if a child is not literate or does not have preexisting verbal skills, text would probably not be effective (Sundberg & Partington, 1998). With writing and typing, the communication partners do not have to learn a new symbol

system. A child with average vocabulary skills can express complex thought in symbol form. When using a portable word processor (i.e., AlphaSmart), the child can type a message into the device using a keyboard. With some devices, the message appears on a viewing screen for the communication partner to view. Other devices utilize speech output so that the communication partner can hear the intended message.

Like other aided methods, writing and typing requires auxiliary equipment such as a portable word processor or handheld computer (i.e., iPad). In order to successfully communicate with a portable word processor, the device must be present. If the device is not readily available, a response cannot occur. Portable typing devices require communication partners in close proximity. Additionally, the response of writing or typing is naturally slower than speaking because of the required time to write, type, and read the message.

**Non-Symbolic Methods.** All communication options discussed involve some kind of symbol such as a sign, word, or picture. Some children with severe intellectual disability may not understand symbols and signs, but have the ability to move some part of their bodies. Non-symbolic communication methods might be considered for these children. Non-symbolic forms of communication include facial expressions, eye gaze, body movements, and gestures. It is noted that there are a variety of new eye gaze methods (low-tech boards to high-tech computer-based systems) that are on the market. Non-symbolic forms of communication do not use aided materials like communication boards or books. Some non-symbolic forms such as gestures and facial expressions can

be delivered quickly as compared to picture exchange systems or SGDs.

Non-symbolic forms are limited in terms of vocabulary and range of functions because children with severe speech and motor impairments have to rely on limited gestures and body movements to communicate various needs. Also, non-symbolic forms are often personal to the child, and teachers and staff who are unfamiliar with the child's gestures may not understand what the child is trying to communicate. This is problematic for a child with a severe or profound disability whose primary or only means of communication is non-symbolic.

#### **Limitations and Future Research**

Over the last 25 years, research on the effectiveness of three AAC systems have yielded mixed and inconsistent results for communication outcomes (Gevarter et al., 2013; Lorah et al., 2015; van der Meer et al., 2011). For example, some research indicates children with developmental disabilities acquire both PE and manual signing at an equally rapid pace (Boesch et al., 2013a, 2013b), while other studies suggest that PE is acquired more effectively than manual signing (Barlow, Tiger, Slocum, & Miller, 2013) or that acquisition varies between participants as a function of individual characteristics (Gregory, DeLeon, & Richman, 2009; Lorah et al., 2013; Tincani, 2004; van der Meer, 2011). Similarly, research results comparing PE and SGD are also inconsistent (Lorah et al., 2013; van der Meer et al., 2011).

Searching for the best AAC system for all children is like an effort to find the end of a rainbow. Practitioners should be concerned with matching the child's skills with the features, advantages, and disadvantages of a given AAC system. For instance, good fine motor and memory

skills could be matched with the advantages of manual signs such as their portability and unlimited vocabulary size. A child with poor fine motor skills and weak memory, however, may have difficulty with learning and using manual signs.

Gregory, DeLeon, and Richman (2009) conducted an exemplary study that investigated the relationship between children's existing skills and learning of two forms of AAC systems - PE and manual signs. They assessed the existing matching and motor-imitation skills of children with autism and intellectual disability and found that these skills are prerequisites for learning manual signs. Considerable future research is needed to support practitioners searching for the best AAC system compatible with existing skills and abilities of the individual.

Although individual differences were noted, research shows that children with developmental disabilities prefer PE over manual signs as a communicative response form (Gevarter et al., 2013; Nam & Hwang, 2016). Also, the majority of children with developmental disabilities show some degree of preference for using SGDs compared to PE or manual signs (Gevarter et al., 2013; Lancioni et al., 2007; van der Meer et al., 2011). It is unclear, however, whether children's characteristics and environmental demands are correlated with their AAC device preference.

Giving children the opportunity to select their most preferred AAC system positively influences progress in learning to communicate and maintain the acquired skills. The acquisition of requesting skills was faster when learning a preferred AAC system for some children (Couper et al., 2014). Such findings support the value of assessing children's preference in the AAC

decision-making process (van de Meer et al., 2014).

The heterogeneity of a large quantity of studies involving various research designs, participants, and multiple components is a major concern with the review studies. For example, Gervarter et al (2013) reviewed 28 single-subject studies involving 77 participants whose ages ranged from 2 to 52 years. Concerning the issue of heterogeneity, Boesch and colleagues (2016) pointed out, “studies comparing multiple communication systems yielded mixed results indicating that a broad focus may lead to narrow recommendations” (p. 108). Therefore, it is necessary to conduct more focused analyses of empirical studies in terms of research designs, target population, and program components. Also, mixed-methods approaches which incorporate qualitative and quantitative

synthesis are promising ways of negotiating heterogeneity.

Another limitation is the uncertainty as to whether inconsistent preferences between AAC systems were due to the effectiveness of the AAC system or response efficiency. Response efficiency can be explained in terms of the physical or motor demands required to use a particular AAC system (Boesch, Shukla Mehta, & Da Fonte, 2016). It can be affected by various characteristics of a developmental disability (e.g., severity and multiple disabilities). Response efficiency associated with heterogeneous participants increases outcome constraints in comparing main AAC systems. In other words, it is unclear whether the response efficiency for an AAC system is affected by the physical or motor demands of using the AAC system.

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