Augmentative and alternative communication interventions for persons with developmental disabilities: narrative review of comparative single-subject experimental studies

Ralf W. Schlosser\textsuperscript{a,\!*}, Jeff Sigafoos\textsuperscript{b}

\textsuperscript{a}Department of Speech-Language Pathology and Audiology, Northeastern University, 151C Forsyth, Boston, MA 02115, USA
\textsuperscript{b}University of Texas at Austin, USA

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Abstract

Augmentative and alternative communication (AAC) as an area of clinical and educational practice involves a myriad of decisions related to the symbols, devices, and strategies from which each client must choose. These decision-making points can be productively informed through evidence from comparative intervention studies. The purpose of this review was to synthesize comparative AAC intervention studies using single-subject experimental designs involving participants with developmental disabilities. Following a systematic search, each qualifying study was reviewed in terms of a priori determined appraisal criteria, and summarized in tabular format. Studies were divided into three groups according to their study of aided approaches, unaided approaches, or a combination of both. Results are discussed in terms of methodological adequacy of the studies and their implications for future research and practice.

Keywords: Augmentative and alternative communication; Comparisons; Developmental disabilities; Effectiveness; Efficacy; Efficiency; Interventions; Review; Single-subject experimental designs

* Corresponding author. Tel.: +1 617 373 3785; fax: +1 617 373 2239.
E-mail addresses: R.Schlosser@neu.edu, rwschlosser@earthlink.net (R.W. Schlosser).

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Many individuals with developmental disabilities have severe speech and language impairments (Abbeduto, Evans, & Dolan, 2001) and may thus require intervention to develop augmentative and alternative forms of communication (Baumgart, Johnson, & Helmstetter, 1990; Beukelman & Mirenda, 1998; Lloyd, Fuller, & Arvidson, 1997; Romski & Sevcik, 1996). Augmentative and alternative communication (AAC) is an area of clinical and educational practice that offers a set of strategies and approaches to supplement or replace natural speech and/or handwriting (Lloyd et al., 1997). Aided AAC approaches involve an external aid or device such as a communication board or a speech-generating device (SGD). Unaided approaches involve only the person’s own body to communicate such as manual signs or the use of gestures (Lloyd et al., 1997). Once it has been decided that AAC may be a viable option to consider for an individual, practitioners and stakeholders need to choose from a myriad of symbol sets/systems, assistive communication devices, and intervention strategies. Thus, the practitioner is faced with the question as to which symbols, devices, and strategies to choose over others. Answering these questions always involves some sort of comparison. For example, one may need to decide between (a) a gestural mode and a graphic mode, (b) a graphic mode and traditional orthography, (c) picture exchange and direct selection, (d) scanning method A and scanning method B, (e) direct instruction and activity-based intervention, and (g) SGDs and non-electronic communication boards.

These and many other scenarios could be illuminated through comparative efficacy studies, which are deemed especially helpful to inform these and similar decision-making scenarios (Schlosser, 1999). Using an evidence-based practice approach to decision-making, however, requires an appraisal of this research evidence in order to identify the best and current research evidence (Schlosser, 2003). Using a priori appraisal criteria, the purpose of this paper is to provide a narrative review of comparative AAC efficacy studies with single-subject experimental designs involving persons with developmental disabilities as participants.

1. Method

1.1. Inclusion criteria

The intervention evaluated needed to be within the realm of AAC, defined as “an area of clinical practice that attempts to compensate (either temporarily or permanently) for the impairment and disability patterns of persons with severe expressive communication disorders (i.e., people with severe speech-language and writing impairments)” (American Speech-Language-Hearing Association, 1989, p. 107). While the intervention needed to be classifiable as involving AAC, it was not necessary that the dependent measure involved graphic or gestural modes. For example, a study comparing the effects of simultaneous communication with speech-only treatment would qualify even when the dependent measure was concerned with natural speech production. The recipient of the intervention had to be an individual with a developmental disability (e.g., autism, intellectual disability, and cerebral palsy) regardless of age. Studies involving sign language or manual signing with individuals who were deaf were excluded, unless the
hearing impairment was only one of several concomitant disabilities that included a developmental disability. Manual sign instruction involving participants with intellectual disabilities and hearing impairment, for example, qualified for inclusion whereas studies involving only deaf children were excluded. Intervention studies targeting individuals with acquired disorders were excluded (e.g., Angelo, Deterding, & Weisman, 1991; Fox, Moore Sohlberg, & Fried-Oken, 2001). Similarly, studies comparing strategies for training or calibrating a device, such as a voice recognition system (e.g., Alcantara et al., 1990; Alcantara, Cowan, Blamey, & Clark, 1990), were excluded. Studies comparing instructional reading methods were excluded even though they may have involved pictorial stimuli (e.g., Pufpaff, Blischak, & Lloyd, 2000). Comparison studies focused on testing the validity of facilitated communication were excluded even when they met some or all of the other criteria (e.g., Kerrin et al., 1998; Kerrin, Murdock, Sharpton, & Jones, 1998) because these have been recently reviewed elsewhere (Mostert, 2001).

In order to be included, the studies had to aim at a comparison of at least two treatments or conditions in terms of their effectiveness and/or efficacy. Comparisons of performance between or among subpopulations were excluded (e.g., Brady & McLean, 1998). Similarly, comparisons of the effects of communication partners’ behavior on the behavior of individuals using AAC were excluded. For example, Drasgow, Halle, and Phillips (2001) evaluated the effects of differential partner reinforcing behavior on the type of request topographies emitted by children with developmental disabilities. Because their purpose was not to test the comparative efficacy of two treatments, but rather to examine the impact of partner behavior on request behavior (personal communication, Erik Drasgow, 9/30/2003), the study was excluded from the present review. To be included the study also had to involve a comparative single-subject experimental design (Schlosser, 1999). Quasi-experimental group designs (e.g., Kahn, 1981) were excluded due their relatively low incidence in AAC and developmental disabilities (Iacono, 2003). Finally, the study had to be published in a peer-reviewed journal, as a chapter in a book, or a dissertation and written in English. Studies published in languages other than English, articles in proceedings (e.g., Bravo, LeGare, Cook, & Hussey, 1990) or grant reports (e.g., LeBlanc & Barker, 1982) were excluded.

1.2. Search methods

Studies were drawn from a number of sources. In preparation for the search, the authors first retrieved 45 studies from an earlier discussion of methodologic issues on comparative single-subject experimental designs in AAC (Schlosser, 1999) supplemented by studies from the authors’ respective personal databases from a previous meta-analysis (Schlosser & Lee, 2000) and other research (Sigafoos, 2003). For each of these studies, an author search was conducted using the Cumulative Index for Allied Health Literature (CINAHL), the Educational Resources in Education Clearinghouse (ERIC), MEDLINE<sup>®</sup>, and PsycINFO. Based on the indexing information of each study, a more elaborate search strategy was designed by examining whether or not the study was indexed at all, and if so, what keywords were used to do so. Of the 45 identified studies, 6 studies were indexed in CINAHL, 12 studies were indexed in ERIC, 19 studies were
entered in MEDLINE, and 33 studies were available through PsycINFO. Next, we examined how many of the entries contributed by each database were contributed by none of the others (i.e., unique entries). It turns out that PsycINFO contributed 10 unique entries (33% of its entries), MEDLINE added 4 unique entries (21% of its entries), and ERIC (8.3%) and CINAHL (16.7%) contributed 1 unique entry each. These findings emphasized the need to use multiple databases for this review. Also, it was noticed that none of the databases adequately distinguished between manual signs and sign language using them as if they were one and the same. In AAC, these terms are distinct from one another (see Lloyd et al., 1997). Based on this experience, the most successful search strategies combined key words (e.g., communication aids for disabled) with free text words such as “compar*” or alternating treatments design. Using other quality filters such as “comparative study” (a Medical Subject Heading term in MEDLINE), demonstrated to be less reliable for retrieving studies that met our inclusion criteria.

1.3. Review categories

Each of the studies is reviewed in tabular narrative form in terms of the following broad categories: (a) author/s, (b) purpose of study, (c) participants, (d) design, (e) results, and (f) appraisal of evidence. In terms of the appraisal of evidence, each of the included studies was reviewed in terms of several methodological criteria deemed essential for determining the certainty of the evidence stemming from comparison studies (Schlosser, 1999, 2003): (1) bias of participants toward a particular condition due to prior experiences; (2) adequate control of sequence effects and carry-over effects by using an appropriate design; (3) the design allows for within-subject replication of effects; (4) carryover effects/sequence effects are further minimized through procedural safeguards; (5) a learning criterion was set; (6) a teaching criterion was set; (7) the equivalence of instructional sets is demonstrated and based on current knowledge of contributing factors to equivalency; (8) treatments are randomly assigned to instructional sets; (9) the functional independence of sets is demonstrated; (10) interobserver agreement data for the dependent measure(s) is/are adequate for the particular target behaviors; (11) treatment integrity is comparable across conditions; (12) procedures are held constant except for to be examined differences across conditions; (13) effectiveness of conditions is demonstrated unequivocally through the attainment of a learning criterion; and, (14) efficiency comparisons are based on attainment of an a priori learning criterion for all conditions compared.

1.4. Analysis

The analysis of the above categories served as a basis for the narrative review offered in Tables 1–10 and the subsequent text, particularly for the appraisal of the evidence generated from each of the reviewed studies.

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1 The asterisk symbol allows for truncation of a term and thereby retrieves all related terms such as “compared,” “comparison,” and “comparative.”
Table 1
Comparative studies involving unaided AAC modes: simultaneous communication, sign-alone instruction, and oral instruction

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose—to compare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrera et al. (1980)</td>
<td>O, SA, and SC in terms of natural speech production or expressive signing</td>
</tr>
<tr>
<td>Barrett and Sisson (1987)</td>
<td>O (required a vocal response), SC (vocal and signed), and modified SC (vocal) in terms of natural speech production and/or signing</td>
</tr>
<tr>
<td>Brady and Smouse (1978)</td>
<td>O, SA, and SC in terms of receptive speech</td>
</tr>
<tr>
<td>Carr et al. (1984)</td>
<td>receptive O vs. SA in terms of receptive discriminations (sign and speech)</td>
</tr>
<tr>
<td>Clarke et al. (1988—1)</td>
<td>SC vs. SA for receptively known words in terms of expressive signing and natural speech production</td>
</tr>
<tr>
<td>Clarke et al. (1988—2)</td>
<td>SC vs. SA for receptively known words in terms of sign acquisition and expressive speech</td>
</tr>
<tr>
<td>McDonald (1977)</td>
<td>SC vs. O and O with prompts and fading in terms of expressive vocal imitation</td>
</tr>
<tr>
<td>Remington and Clarke (1983)</td>
<td>SC vs. SA in terms of expressive sign labeling and receptive speech</td>
</tr>
<tr>
<td>Sisson and Barrett (1984)</td>
<td>O vs. SC in terms of spoken and/or signed sentence imitation</td>
</tr>
<tr>
<td>Wells (1981)</td>
<td>O vs. SC on natural speech production (i.e., word articulation)</td>
</tr>
<tr>
<td>Wherry and Edwards (1983)</td>
<td>O, SA, and SC in terms of receptive speech, natural speech production, and eye contact</td>
</tr>
</tbody>
</table>

Notes: O, oral instruction; SA, sign-alone instruction; SC, simultaneous communication instruction.

2. Results

A summary of the narrative review for unaided approaches is provided in Tables 1–3. A summary of the narrative review for aided approaches is offered in Tables 4–8, and the review of comparisons of unaided with aided approaches is provided in Tables 9 and 10. The references for the reviewed studies are available in the “Included studies”.

3. Comparison studies involving unaided approaches

The long-standing history of unaided approaches is reflected in the more prominent role of comparisons among unaided efficacy evaluations. A total of 23 studies were identified and reviewed. An attempt was made to group the studies according to common intervention themes.

3.1. Simultaneous communication, sign-alone instruction, and oral instruction

3.1.1. Simultaneous communication versus sign-alone instruction

3.1.1.1. Expressive signing. In several studies, reviewed in Table 1, the effects of simultaneous communication (SC) versus sign-alone (SA) instruction were investigated

2 Due to page restrictions, Tables 1–10 only provide the first/sole author of the study along with the purpose of the comparison. The complete tables, including study authors, purpose of comparison, participants, design, results, and appraisal, may be requested from Ralf Schlosser via e-mail (R.Schlosser@neu.edu; rwschlosser@earthlink.net).
(e.g., Barrera, Lobato-Barrera, & Sulzer-Azaroff, 1980; Brady & Smouse, 1978; Clarke, Remington, & Light 1988; Remington & Clarke, 1983; Wherry & Edwards, 1983). Several of these studies focused on expressive signing as an outcome variable (Clarke et al., 1988 [Studies 1 and 2]; Remington & Clarke, 1983). Taken together these three studies indicate that while SA may be as effective as SC, SC tends to be more efficient than SA in yielding expressive signing.

3.1.1.2. Natural speech production. Wherry and Edwards (1983) and Barrera et al. (1980) compared SC with SA in terms of natural speech production. The data from these studies are, however, inconclusive due to a serious lack of methodological rigor.

3.1.1.3. Receptive speech. As far as receptive speech, the existing data from two studies are not compelling due to serious methodological concerns (Brady & Smouse, 1978; Wherry & Edwards, 1983).

3.1.2. Simultaneous communication versus oral instruction

3.1.2.1. Expressive signing. In several studies, researchers compared SC with direct oral instruction in terms of expressive signing (see Table 1). The participants were instructed to sign and speak in the SC condition while the oral condition necessitated only a spoken response (Barrett & Sisson, 1997; Sisson & Barrett, 1984). In these cases, comparisons of SC and oral instruction in terms of expressive signing were not feasible.

3.1.2.2. Natural speech production. The results for natural speech production are inconsistent across the studies with two studies reporting better outcomes with SC over O (Barrera et al., 1980; Wells, 1981), one study reporting both being ineffective (Wherry & Edwards, 1993), and one study reporting mixed results (Barrett & Sisson, 1987). In two studies (Barrett & Sisson, 1987; Sisson & Barrett, 1984), comparisons in terms of natural speech production are compromised because spoken responses were not coded separately from signed responses in SC. Only modified SC, which required a vocal response only, permitted comparisons with oral instruction. Here, one of the two participants in the Barrett and Sisson study yielded better results with modified SC than with oral instruction. The second participant, however, yielded both interventions as effective with oral instruction being more efficient than modified SC.

3.1.2.3. Receptive speech. Results from two studies suggest that SC is more efficient than O in yielding receptive speech gains (Brady & Smouse, 1978; Wherry & Edwards, 1983). However, as previously pointed out, both studies present with serious methodologic shortcomings.

3.1.3. Sign-alone versus oral instruction

This comparison was the subject of four studies in terms of natural speech production and receptive speech (Table 1).

3.1.3.1. Natural speech production. Only Wherry and Edwards (1983) compared SA versus O in terms of natural speech production. Given that both treatments were
ineffective, there were no differences to detect. This finding has to be viewed in light of the methodologic concerns raised in the appraisal of this study.

3.1.3.2. Receptive speech. In two studies, SA was found more effective than O in terms of receptive speech (Brady & Smouse, 1978; Wherry & Edwards, 1983). Both studies, however, display serious methodologic weaknesses and included only one participant each. Carr, Pridal, and Dores (1984) compared SA and O in terms of receptive speech discrimination involving participants who were classified as poor verbal imitators or good verbal imitators. Five of the six poor imitators failed to reach criterion in O and all of the four good imitators were equally effective and efficient in O and SA.

3.2. Determining the necessary conditions for simultaneous communication

Studies reviewed in Table 2 were concerned with the conditions under which SC works more effectively or efficiently. This included introduction of manual signs for known words rather than unknown words, over-instruction (i.e., extensive sign instruction), pre-teaching of receptive skills (i.e., mediated sign instruction, receptive–expressive order) or expressive skills (i.e., expressive–receptive order), and by mixing some oral-only trials into SC (i.e., differential sign instruction) (Clarke, Remington, & Light, 1986; Remington & Clarke, 1993a, 1993b; Watters, Wheeler, & Watters, 1981).

Table 2
Comparative studies involving unaided approaches: determining the necessary conditions for simultaneous communication

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose—to compare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarke et al. (1986)</td>
<td>Known vs. unknown words on expressive signing, receptive speech, and natural speech production</td>
</tr>
<tr>
<td>Conaghan et al. (1992)</td>
<td>DH vs. DH plus PR with a control condition, on expressive signing and natural speech production</td>
</tr>
<tr>
<td>Duker and Moonen (1986)</td>
<td>Complete vs. in-complete delivery of items on expressive signing</td>
</tr>
<tr>
<td>Duker et al. (1994)</td>
<td>Complete vs. in-complete delivery of items on expressive signing</td>
</tr>
<tr>
<td>Goodman and Remington (1993)</td>
<td>Specific (gets what requested) vs. non-specific reinforcement on expressive signing</td>
</tr>
<tr>
<td>Linton and Singh (1984)</td>
<td>DH, DH plus PR, and a control condition on expressive signing and natural speech production</td>
</tr>
<tr>
<td>Remington and Clarke (1993a—I)</td>
<td>ES vs. MS on expressive signing, receptive speech and stimulus over-selectivity</td>
</tr>
<tr>
<td>Remington and Clarke (1993a—II)</td>
<td>ES vs. MS on expressive signing, receptive speech and stimulus over-selectivity</td>
</tr>
<tr>
<td>Remington and Clarke (1993b)</td>
<td>DS vs. ES on expressive signing, receptive speech, and stimulus over-selectivity</td>
</tr>
<tr>
<td>Watters et al. (1981)</td>
<td>Two orders (RE, ER) on expressive and receptive sign use with SC</td>
</tr>
</tbody>
</table>

Notes: DH, directed rehearsal (repetition of correct response); PR, positive reinforcement; ES, extensive sign instruction (overinstruction); MS, mediated sign instruction (receptive pre-instruction); DS, differential sign instruction (SC mixed with only spoken cues); RE, receptive–expressive order; ER, expressive–receptive order.
3.2.1. Known versus unknown words

One study examined whether SC works more effectively and efficiently when introducing manual signs for known words than signs for unknown words (Clarke et al., 1986). These comparisons have been made in terms of expressive signing, natural speech production, and receptive speech.

3.2.1.1. Expressive signing. Results indicated that SC is more efficient in terms of expressive signing when the signs are introduced for known words rather than for unknown words. This finding supports the notion that individuals with receptive knowledge of the referent take a different (i.e., shorter) route to symbol acquisition. Thus, when possible it may be beneficial to introduce symbols for vocabulary that the individual already understands receptively.

3.2.1.2. Natural speech production. Only one of the three students improved in terms of natural speech production for both known and unknown words. The other two participants were tested on known words only and there were no improvements noted. Thus, the differential effects of SC on natural speech production for words of varying receptive status remain unclear.

3.2.1.3. Receptive speech. The effects on receptive speech were not convincing—only one of the three children improved receptive speech. Clarke et al. (1986) hypothesized that it may be due to this child not showing stimulus over-selectivity whereas the other children did. Put another way, the effects of SC on receptive speech may play out differently depending on child characteristics.

3.2.2. Manipulating reinforcement

Several studies manipulated the amount or type of reinforcement presented to the learners during SC. This included the adding of positive reinforcement versus no reinforcement (Conaghan, Singh, Moe, Landrum, & Ellis, 1992; Linton & Singh, 1984), complete versus incomplete presentation of requested items (Duker & Moonen, 1986; Duker, Kraaykamp, & Visser, 1994), and specific versus non-specific reinforcement (Goodman & Remington, 1993).

3.2.2.1. Expressive signing. A subgroup of studies reviewed in Table 2 examined various roles of positive reinforcement in teaching manual signs via SC instruction. Adding positive reinforcement to directed rehearsal (DH; repeating the correct response) was more efficient in terms of expressive sign acquisition (Linton & Singh, 1984) and generalization across novel phrases, settings, and instructors compared to DH alone (Conaghan et al., 1992). Once determined that positive reinforcement aides manual sign acquisition it is important to focus on the types of reinforcement that may yield better outcomes than others. In a sequence of two studies, Duker and colleagues (1986, 1994) demonstrated that an incomplete provision of requested items is more effective in eliciting greater expressive signing than a complete presentation. Although these findings are intuitively appealing, they are tempered by several methodological shortcomings (request complete Table 2). Finally, Goodman and Remington (1993) showed that specific reinforcement (i.e., presenting to the learner what he or she was signing for) is more efficient than presenting a
non-specific reinforcer (i.e., a reinforcer unrelated). Specific reinforcement is typically used when teaching requesting, whereas non-specific reinforcement is more consistent with a naming or labeling task. Although both conditions were effective, the specific reinforcement strategy produced faster acquisition of expressive signing than the nonspecific strategy for three of the four participants. This preliminary evidence suggests that expressive signing may be accomplished more rapidly when teaching a requesting function rather than a labeling function.

3.2.3. Maximizing SC instruction through procedural variations

A body of four studies evaluated how to further maximize SC instruction through various procedural variations, including (a) extensive sign instruction (i.e., over-instruction), (b) mediated sign instruction (i.e., receptive pre-instruction), (c) differential sign instruction (SC mixed with only spoken cues), (d) receptive–expressive order, and (e) expressive–receptive order.

3.2.3.1. Expressive signing. Depending on the study, extensive sign instruction was either more effective or equally as effective as mediated sign instruction; across studies, extensive sign instruction was more efficient than mediated sign instruction for expressive signing (e.g., Remington & Clarke, 1993a). In another study, extensive sign instruction was also found more efficient than differential sign instruction in terms of expressive signing (Remington & Clarke, 1993b).

Watters et al. (1981) compared two different orders for introducing manual signs to children with autism. In one order, the participants were pre-taught receptive skills before moving on to expressive signing. The second order involved the pre-teaching of expressive skills. While both orders were effective for both of the children, the expressive–receptive order was more efficient in yielding expressive signing. This less efficient showing for the receptive–expressive order is consistent with the finding for receptive pre-instruction (i.e., mediated signing instruction).

3.2.3.2. Stimulus overselectivity and receptive speech. Stimulus overselectivity, which precluded the acquisition of receptive speech, however, could not be overcome through any of the above instructional strategies (Remington & Clarke, 1993a, Studies I and II). Because of these continued problems, a subsequent study involved yet another variation of SC procedures in an effort to remedy stimulus overselectivity (Remington & Clarke, 1993b). That is, differential sign instruction was designed as a method whereby SC is intermixed with some trials of oral-only. This was deemed to shift the overselective attention of the learners from the visual stimuli (i.e., manual signs) to the auditory stimuli (i.e., word referents). As predicted, only differential sign instruction overcame stimulus overselectivity and improved receptive speech.

3.3. Other instructional strategies for introducing manual signs

The group of studies reviewed in Table 3 involved comparisons of various other instructional strategies for introducing manual signs, including prompting strategies, and environmental arrangement strategies.
3.3.1. Prompting strategies

3.3.1.1. Expressive signing. Bennett, Gast, Wolery, and Schuster (1986) compared progressive time delay (TD) with a system of least prompts (SLP) and found both equally effective; yet, progressive TD was more efficient in two of the three participants and equally efficient in the third participant. A subsequent investigation focused solely on the delivery of the more efficient of these methods, the progressive TD (Wolery, Munson Doyle, Gast, Jones Ault, & Lichtenberg, 1993). In one condition, TD was applied in a massed trial format and in the other condition in a distributed trial format during transition periods. Both were found equally effective without consistent differences in efficiency, suggesting that TD can be used also during transitional periods.

Dalrymple and Feldman (1992) examined the effects of directed rehearsal (DH) when added to an existing prompt procedure. One group of participants was taught expressive signing via sequential prompting in one condition and sequential prompting plus DH in the second condition, along with a no-treatment control condition. The other group received the same arrangement except that graduated guidance was used as the prompting procedure. The addition of DH resulted in increased accuracy, reduced speed, and enhanced generalization (across trainers, objects, and settings) when added to sequential prompting and graduated guidance.

3.3.1.2. Receptive signing. Iacono and Parsons (1986) compared physical shaping versus modeling in the teaching of receptive sign labeling. Although the results indicate that physical shaping was more effective than modeling, the study is too severely compromised in terms of internal validity to draw any firm conclusions.

3.3.2. Environmental arrangement strategies

3.3.2.1. Expressive signing and challenging behaviors. Sigafoos and Meikle (1995) compared the missing-item format with the interrupted behavior chain to increase signed requesting in two children with autism. They found both to be equally effective. This study also examined potential side effects of these methods, which rely on creating the need for communication by giving the child a wrong item or interrupting an ongoing behavior.
However, neither procedure was associated with relatively higher levels of challenging or stereotyped behaviors.

4. Comparison studies involving aided approaches

The number of comparative studies involving aided approaches \( (n = 20) \) is somewhat less than those identified for unaided approaches. This may be explained by the relative more recent history of aided approaches. Studies involving aided approaches involve comparisons as outlined in Tables 4–8.

4.1. Instructional strategies and formats for introducing aided approaches

4.1.1. Instructional strategies

Various instructional strategies were compared to one another for teaching spelling, receptive graphic symbol learning, expressive graphic symbol use, and the acceptance of requested items (Berkowitz, 1990; Hetzroni, Quist, & Lloyd, 2002; McNaughton & Tawney, 1993; Sigafoos & Meikle, 1995; Sigafoos & Reichle, 1992; Vaughn & Horner, 1995) (see Table 4).

4.1.1.1. Spelling. McNaughton and Tawney (1993) found the “copy-write-compare” strategy to be as effective as “student-directed cueing” in terms of spelling with no consistent differences in efficiency across the two participants.

4.1.1.2. Receptive graphic symbol learning. Berkowitz (1990) compared delayed prompting versus fading for teaching receptive symbol discrimination and found no consistent differences in effectiveness between the two strategies. Delayed prompting, however, turned out to be more efficient than fading. In the only other study in this category, Hetzroni et al. (2002) compared teacher-presentation versus computer-presentation

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose—-to compare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berkowitz (1990)</td>
<td>Delayed-prompting vs. fading on discrimination of graphic symbols</td>
</tr>
<tr>
<td>Hetzroni et al. (2002)</td>
<td>Computer vs. teacher presentation on receptive identification of Blissymbols</td>
</tr>
<tr>
<td>McNaughton and Tawney (1993)</td>
<td>CWC vs. SDC on the acquisition and retention of spelling vocabulary</td>
</tr>
<tr>
<td>Oliver (1983)</td>
<td>Group (same or different symbols for everyone) vs. individual formats and a control on Blissymbol identification</td>
</tr>
<tr>
<td>Sigafoos and Meikle (1995)</td>
<td>Missing-item format with the interrupted behavior chain in terms of requests and challenging and stereotypical behaviors</td>
</tr>
<tr>
<td>Sigafoos and Reichle (1992)</td>
<td>Explicit (specific symbol) vs. generalized requesting (generalized symbol) on requests</td>
</tr>
<tr>
<td>Vaughn and Horner (1995)</td>
<td>Choices offered verbally vs. verbally plus photos on acceptance of food items</td>
</tr>
</tbody>
</table>

Notes: CWC, copy-write-compare; SDC, student-directed cueing (student makes first attempt).
in terms of receptive Blissymbol identification. Because no differences were found, it seems that computers can be used as effectively as teachers to deliver the instruction as studied.

4.1.1.3. Expressive graphic symbol use. Several studies contrasted instructional strategies to facilitate expressive graphic symbol use such as requesting. Sigafoos and Meikle (1995) found no differences between the missing-item strategy and the interrupted behavior chain in two children with autism when they were taught to request sets of objects by either using manual signs (Set 1 only) or by pointing to line drawings (Sets 2 and 3). There had been concerns about potential negative side effects of interrupting behavior chains. Therefore, the lack of increased challenging behaviors with this strategy is noteworthy, suggesting that it is safe to use to evoke aided requesting. In related work, Sigafoos and Reichle (1992) investigated whether it is more beneficial to introduce a generalized request symbol or an explicit request symbol. They found no consistent differences between these strategies.

4.1.1.4. Acceptance of requested items. Vaughn and Horner (1995) compared two types of input modalities in terms of acceptance or refusal of requested items. When choices were offered through augmented input (photographs plus verbal) as opposed to “verbal only,” the child appeared to accept more of the items. The study, however, is seriously flawed in terms of internal validity, and its findings are inconclusive.

4.1.2. Instructional formats

Oliver (1983) compared the effects of various instructional formats, a related yet different and severely understudied issue. The study documented advantages for using the group instructional format over the individual format. Children taught in the group format identified more symbols than students taught one-on-one. However, the study presents with serious methodologic concerns.

4.2. Various graphic symbol sets and systems

In several studies, investigators compared the effectiveness and/or efficiency of various graphic symbol sets and systems (see Table 5). The majority of these studies examined outcomes in terms of receptive symbol learning.

Table 5
Comparison studies involving aided approaches: graphic symbol sets and systems

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose— to compare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brady and McLean (1996)</td>
<td>Lexigrams vs. TO using match-to-sample in terms of symbol learning</td>
</tr>
<tr>
<td>Briggs (1983)</td>
<td>PIC, Bliss, and TO using match-to-sample with reinforcement and physical</td>
</tr>
<tr>
<td></td>
<td>guidance on symbol learning, time, TTC, and natural speech production</td>
</tr>
<tr>
<td>Hetzroni et al. (2002)</td>
<td>Symbols of varied translucency-complexity on receptive learning of Blissymbols</td>
</tr>
<tr>
<td>Hurlbut et al. (1982)</td>
<td>Bliss vs. Rebus-like symbols on the acquisition of labeling, spontaneous use,</td>
</tr>
<tr>
<td></td>
<td>stimulus generalization, and response generalization</td>
</tr>
<tr>
<td>Kozleski (1991)</td>
<td>Various graphic symbol sets/systems (Blissymbolics, Premack tokens, TO, Rebus,</td>
</tr>
<tr>
<td></td>
<td>Photopictorial) on requesting</td>
</tr>
</tbody>
</table>

Notes: PIC, Picture Ideogram Communication; TO, traditional orthography.
4.2.1. Receptive graphic symbol learning

Two studies involved a comparison of non-phonetic graphic symbol systems—Lexigrams, which are black and white symbols composed of arbitrary geometric designs—with traditional orthography (TO), which is phonetic (Brady & McLean, 1996; Briggs, 1983). Brady and McLean (1996) compared Lexigrams with TO. Although participants learned the Lexigrams effectively while they never reached criterion with TO, these findings need to be viewed cautiously due to a lack of methodologic rigor. Briggs (1983) found that PIC was learned more readily than Blissymbols, followed by TO. As in the previous study none of the children reached criterion with TO. Of the three children that met criterion in both, PIC and Blissymbols, the efficiency results were mixed; PIC was more efficient for one child and Blissymbols for the other, and there were no difference for the third. Thus, it seems that TO is more difficult to acquire for these children than non-phonetic graphic symbol systems, including those that are arbitrary (i.e., Lexigrams). Rebus-like graphic symbols were learned as effectively as Blissymbols, but the children took far fewer trials to criterion with Rebus-like graphic symbols (Hurlbut, Iwata, & Green, 1982). Whether or not these differences in receptive symbol learning are due to differential iconicity ratings is difficult to ascertain from these data because iconicity was not manipulated per se and these symbol sets/systems may differ not only in terms of iconicity but also other variables. Hetzroni et al. (2002) investigated this issue by using a priori iconicity ratings along with complexity ratings within Blissymbols. Results suggest that high translucency symbols were learned faster than low translucency symbols. High complexity symbols were learned faster when translucency was high, but hindered learning when translucency was low.

4.2.2. Expressive graphic symbol use

Hurlbut et al. (1982) also examined the effects on spontaneous use and found that Blissymbol use was restricted to previously taught symbols whereas Rebus use often included transfers from concepts previously taught in Bliss. Kozleski (1991) implemented the only other study that compared various graphic symbol sets/systems in terms of expressive use. This author asserted that sets/systems that are associated with a higher degree of iconicity took fewer trials to criterion than those with lower iconicity. In absence of a priori iconicity ratings along with other methodologic shortcomings, however, this explanation cannot be upheld.

4.3. Access, selection techniques, and symbol organization

The group of studies summarized in Table 6 dealt with positioning and access issues, selection techniques, and symbol organization.

4.3.1. Positioning and access

McEwen and Karlan (1989) evaluated the effects of varying positions in a wheelchair or other adaptive seating device for accessing communication displays. They found noteworthy differences between some of the positions. The sidelyer position was least efficient while there were no differences among the three more efficient positions (i.e., chair, stander, prone-wedge). It is important to identify a position that facilitates access to displays before considering different selection techniques.
4.3.2. Selection techniques

In three studies, researchers compared different means for selecting graphic symbols (Angelo, 1992; Everson & Goodwyn, 1987; Horn & Jones, 1996). Horn and Jones (1996), for example, compared a scanning technique with direct selection in one child with cerebral palsy. Direct selection was used more effectively than inverse circular scanning in terms of response accuracy, acquisition rate, and response time. Unfortunately, there were several methodologic concerns with this study. Once it has been determined that scanning is appropriate for a given child, the question becomes what type of scanning technique should be selected. Angelo (1992) compared three types of scanning, including inverse scanning, automatic scanning, and step scanning. Two of three children with spastic cerebral palsy (CP) and athetoid CP, respectively, were most accurate with inverse scanning. The three children with spastic CP did worst with automatic scanning whereas the three children with athetoid CP were least accurate with step scanning. A related issue pertains to the type of switch to be used for scanning. Everson and Goodwyn (1987) compared the flap switch with the pillow switch and the pad switch in terms of accuracy and speed. Because no consistent differences across participants were identifiable, it appears that these decisions need to be made on an individual basis.

4.3.3. Symbol organization

Two studies looked into the role of variables that affect the efficiency in selecting symbols depending on how the symbols were organized on a display. Belfiore, Lim, and Browder (1993) examined the effects of physical distance between two symbols that need to be combined through direct selection. The adult participant required less time to sequence the symbols when presented with the low difficulty task (i.e., short distance) than with the high difficulty task. This suggests that symbols that are high frequency combinations should be placed close together on the display. Lim, Browder, and Sigafuos (1998) investigated the role of high versus low physical effort needed to access a “Help” symbol in order to communicate a request for assistance. There were no differences detected between the children pointing to a “help” flashcard and opening a book to select
the “help” symbol. It is possible that the two conditions were either not different enough in terms of response effort and/or that the methodologic problems failed to detect actual differences.

An issue closely related to symbol organization is that of the type of display selected for organizing vocabulary. In one study, three display types for organizing vocabulary on SGD’s (i.e., fixed, dynamic active, dynamic passive) were compared in terms of response time and accuracy (Reichle, Dettling, Drager, & Leiter, 2000). Response time was the fastest and accuracy was the greatest for the fixed and dynamic active display types. These differences became more pronounced after distracter symbols were added. Methodologic concerns render these findings, however, inconclusive.

4.4. Beneficial components of an AAC system

Several studies looked into the role of the components of speech output and word prediction as part of an AAC system. Essentially, the studies pursued the question as to the effects of having a component available to a learner as opposed to not having it available.

4.4.1. With or without speech output

Four studies reviewed in Table 7 share the common focus of investigating the effects of speech output in comparison to instruction without speech output (Blischak, Schlosser, & Miller, 2000; Parsons & LaSorte, 1993; Schlosser, Belfiore, Nigam, Blischak, & Hetzroni, 1995; Schlosser & Blischak, 2004; Schlosser, Blischak, Belfiore, Bartley, & Barnett, 1998; Sigafoos, Didden, & O’Reilly, 2003).

4.4.1.1. Spelling. In terms of spelling, more favorable results were found in a preliminary study with one child with autism in conditions where speech output was present (Schlosser et al., 1998). In a systematic replication (Schlosser & Blischak, 2004), all four children reached criterion across conditions. Although three children reached criterion first with

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose—to compare</th>
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</thead>
<tbody>
<tr>
<td>Blischak et al. (2000)—1</td>
<td>Partner natural speech vs. synthetic speech on graphic symbol learning</td>
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<tr>
<td>Blischak et al. (2000)—2</td>
<td>Natural speech from device vs. synthetic speech on graphic symbol learning</td>
</tr>
<tr>
<td>Parsons and La Sorte (1993)</td>
<td>Synthetic speech vs. no speech output on spontaneous natural speech production</td>
</tr>
<tr>
<td>Schlosser et al. (1995)</td>
<td>Speech output vs. no speech output on graphic symbol learning</td>
</tr>
<tr>
<td>Schlosser et al. (1998)</td>
<td>Three feedback conditions (speech-synthesizer on; print-display; and both) on spelling</td>
</tr>
<tr>
<td>Schlosser and Blischak (2004)</td>
<td>Three feedback conditions (speech; print, speech-print) on spelling</td>
</tr>
<tr>
<td>Sigafoos et al. (2003)</td>
<td>Speech output vs. no speech output on the maintenance of requesting and vocalizations</td>
</tr>
<tr>
<td>Tam et al. (2002)</td>
<td>Typing with and without word prediction in three word list locations in terms of text entry accuracy and rate</td>
</tr>
</tbody>
</table>
print or speech-print feedback, one child was most efficient with speech-print followed by speech feedback. Based on the findings of both studies, these authors proposed two distinct profiles of feedback efficiency. Children that exemplify the primarily visual profile spell words most efficiently when feedback involves print. Children that fit the auditory profile spell words most efficiently when feedback involves speech. Given the current state of research and the proposed profiles, children’s performance needs to be assessed on an individual basis to determine the feedback conditions that appear most efficient for a given child.

4.4.1.2. Receptive graphic symbol learning. Individuals using aided communication often need to learn to associate graphic symbols with their referents. What is the role of speech output, if any, in facilitating this learning? All three participants in the Schlosser et al. (1995) study reached criterion when provided with synthetic speech output, indicating that instruction with speech output was effective. Although two of the participants also reached criterion without speech output, the addition of speech output resulted in more efficient learning. In a follow-up study, Blischak et al. (2000) addressed the question whether it was merely the quantity of the feedback that made a difference rather than the type of feedback (i.e., synthetic speech). So, they designed a study whereby the quantity of feedback was equated by having the communication partner supply as much feedback (with natural speech) as provided by the device in the other condition (with synthetic speech). Despite this equation in quantity, the three participants learned more effectively and efficiently with synthetic speech. In a second experiment, the investigators had the device produce both natural and the synthetic speech. Again, the participants learned best with synthetic speech. This suggests, that it is not just the quantity of feedback but also the type of feedback (i.e., synthetic speech) that facilitates graphic symbol learning.

4.4.1.3. Expressive graphic symbol use. Sigafoos et al. (2003) taught three children to request using an SGD. Once the learners had acquired the requesting behavior, a maintenance phase was implemented in which the presence of speech output was manipulated. The aim was to determine whether speech output is necessary to maintain the requesting behavior. Results suggest no differences between the two conditions. Yet, methodologic issues may have contributed to this finding.

4.4.1.4. Natural speech production. Parsons and La Sorte (1993) found that computer-assisted instruction with additional synthetic speech output resulted in greater spontaneous natural speech production than without speech output in six children with autism. Sigafoos et al. (2003) found no consistent differences in vocalization patterns during the maintenance phase in which the speech output was turned on and off. Methodological limitations, however, delimit the internal validity of both of these studies.

4.4.1.5. With or without word prediction. Tam, Reid, Naumann, and O’Keefe (2002) evaluated the effects of word prediction on text accuracy and rate during typing. In one condition, word prediction was available to the students (using three different locations for the word prediction list) and in another condition word prediction was not available.
Although word prediction failed to improve rate it did improve accuracy depending on the location of the word prediction list. Together, these studies on speech output and word prediction illustrate the importance of selecting appropriate components as part of an AAC system.

4.5. Communication boards versus speech-generating devices

Three studies evaluated the relative effects of non-electronic communication boards versus SGDs or SGD software (see Table 8; Dyches, Davis, Lucido, & Young, 2002; Soto, Belfiore, Schlosser, & Haynes, 1993; VanAcker & Grant, 1995). These two AAC systems differ along more than the presence or absence of speech output (e.g., proprioceptive feedback) and any differences found cannot be attributed to speech output alone (Schlosser, 1999). In the Soto et al. (1993) study, both an SGD and a communication board were found equally effective in terms of requesting for a young adult with profound intellectual disabilities. Yet, methodologic issues render these findings inconclusive. Even though preference assessments suggest that the participant may have preferred the SGD when given a choice, these preference data are inconclusive because the data were only collected post-acquisition. The study by Dyches et al. (2002) detected no differences between the two systems in terms of requesting and other variables under generalization conditions. It is difficult to determine, however, whether there were no actual differences or whether the methodological shortcomings failed to detect differences. The study by Van Acker and Grant (1995) found differences in favor of a computer-based SGD in terms of differential requesting of preferred and disliked objects. Unfortunately, methodological shortcomings render these findings inconclusive.

5. Comparison studies involving aided and unaided approaches

The research base involving both aided and unaided approaches is more recent and as of yet less substantive than for aided or unaided approaches alone. Nonetheless, a few studies are available as summarized in Tables 9 and 10 (Anderson, 2002; Chambers & Rehfeldt, 2003; Iacono & Duncum, 1995; Iacono, Mirenda, & Beukelman, 1993; Rotholz, Berkowitz, & Burberry, 1989; Sundberg & Sundberg, 1990; Wraikat, Sundberg, & Michael, 1991).
5.1. Aided versus unaided approaches

One group of studies compared unaided with aided approaches (see Table 9; Anderson, 2002; Chambers & Rehfeldt, 2003; Rotholz et al., 1989; Sundberg & Sundberg, 1990; Wraikat et al., 1991). Three of these studies involved manual signing and communication boards or books, which are accessed through direct selection. The study by Rotholz et al. (1989) found the communication book to be more effective than manual signing. The study by Sundberg and Sundberg (1990) indicated that for three participants manual signing and pointing to symbols on a board were both effective (the fourth participant attained criterion with manual signs only) for tacts (i.e., pointing to a symbol or making a sign when shown an object) and intraverbals (i.e., pointing to a symbol or making a sign when an object name was spoken), but manual signing was more efficient for two of the three participants (for the third participant, the board was slightly more efficient than manual signing). Wraikat et al. (1991) also compared graphic symbols with manual signing yielding mixed results in terms of effectiveness and efficiency. Variations were evident across individuals and behavioral relations studied. In interpreting these seemingly discrepant findings across the three studies, the reader needs to keep in mind the methodologic shortcomings (they render these data inconclusive) along with the differences in participants, in the communicative functions being taught, and in the settings across these studies.

Two studies have compared PECS versus manual sign instruction in children with autism (Anderson, 2002; Chambers & Rehfeldt, 2003). Anderson (2002) found that with PECS, learners generalized the rule of matching novel symbols to new items whereas no generalization occurred in signing. Manual signing also resulted in more eye contact than PECS. PECS, however, resulted in faster acquisition rates than manual sign instruction. During free choice items were made available assigned to the PECS condition and items assigned to the signing condition. Learners initiated more with PECS than with signing. Because the items were equated for reinforcement value this was interpreted as a modality preference for PECS. The vocalization results favored signing, but were compromised due to the lack of a comparable baseline. Chambers and Rehfeldt (2003) also found faster acquisition of requests using PECS versus manual signs in four adults with severe/profound intellectual disabilities. Design and other limitations render the findings inconclusive.

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose— to compare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson (2002)</td>
<td>Manual signing vs. PECS instruction on expressive learning, maintenance, challenging behavior, eye-contact and vocalizations</td>
</tr>
<tr>
<td>Chambers and Rehfeldt (2003)</td>
<td>PECS vs. manual signing in terms of requesting</td>
</tr>
<tr>
<td>Rotholz et al. (1989)</td>
<td>Manual signing vs. a communication book on requesting in a fast-food restaurant</td>
</tr>
<tr>
<td>Sundberg and Sundberg (1990)</td>
<td>Manual signing with graphic symbols on accuracy and rate for tacts and intraverbals, and generalization to receptive speech</td>
</tr>
<tr>
<td>Wraikat et al. (1991)</td>
<td>Manual signing with graphic symbols in terms of accuracy and efficiency for tacts and INTRA, and receptive speech</td>
</tr>
</tbody>
</table>

Note: INTRA: intraverbal.

Table 9
Comparative studies involving aided vs. unaided approaches
5.2. Unaided versus combined approaches

The second group of studies compared the use of unaided approaches to combined approaches, consisting of unaided approaches plus SGDs (Iacono et al., 1993; Iacono & Duncum, 1995) (see Table 10). Essentially, the two studies were concerned with evaluating what would happen if a SGD was added to the use of simultaneous communication. Even though both studies involved young children with intellectual disabilities and similar dependent measures, no clear pattern has emerged from the data.

6. Discussion

6.1. Methodological adequacy

This review documents several methodological issues that impact on the certainty of evidence emerging from comparative studies, including (a) design issues, (b) measurement issues, and (c) procedural issues.

6.1.1. Design issues

Some single-subject experimental designs lend themselves more readily than others for drawing valid conclusions about the relative efficacy of two or more interventions, resulting in a design hierarchy that impacts on the certainty of the results generated (Schlosser, 1999, 2003). The parallel treatments design (PTD) ranks highest because it allows for intrasubject replications across equated sets by combining an adapted alternating treatment design (AATD; see next) with the features of a multiple-probe design. This intrasubject replication has the potential to enhance the internal validity of a comparison. Despite its appeal in terms of internal validity, the PTD has been employed in only a few studies (Bennett et al., 1986; Schlosser et al., 1995; Wolery et al., 1993). The PTD is closely followed by the AATD, which allows for the creation of equal but independent sets and thereby minimizes threats to internal validity such as carryover effects. The AATD is a solid design and it is noteworthy that it is frequently employed in comparative studies. All remaining designs are suboptimal. The traditional alternating treatments design (ATD), for example, follows the adapted version of the same design because the same sets are used for each treatment; this causes concern about carryover effects. Despite these shortcomings it continues to be used as evident in the tables.

Another group of designs allows for counterbalancing, but only across participants. This introduces demands for a larger n consistent with other group designs (Schlosser, 1999). The

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose—to compare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iacono and Duncum (1995)</td>
<td>SC vs. SC with a SGD in terms of the number of words/word combinations produced</td>
</tr>
<tr>
<td>Iacono et al. (1993)</td>
<td>SC vs. SC with a SGD on expressive use of two-word semantic combinations</td>
</tr>
</tbody>
</table>
A–B–BC–B–BC/A–BC–B–BC design (Parsons and La Sorte, 1993), for example, offers counterbalancing but is less suitable than the previous designs because the counterbalancing is done across rather than within subjects. ABAB-designs (e.g., Duker et al., 1994; Rotholz et al., 1989) are not suitable for a comparison of two interventions because one of the conditions is presented as a baseline, which raises concerns about order effects.

6.1.2. Measurement issues
There are also measurement issues to consider when evaluating the certainty of research evidence, including treatment integrity and interobserver agreement. Although most of the studies reported interobserver agreement data for the dependent measure, a majority of studies failed to report treatment integrity data. This makes it difficult to attribute the changes observed to the treatments because it is unclear whether the treatments were carried out as planned (Schlosser, 2002).

6.1.3. Procedural issues
The appraisal of studies (detailed tables are available upon request) clearly demonstrate the importance of procedural safeguards such as counterbalancing the sequence of conditions across days or sessions, randomizing the sequence, inserting an adequate time interval between conditions, and enhancing discriminability of conditions through verbal and nonverbal means. Further, it is crucial that instructional sets be equated based on current knowledge of factors contributing to learning difficulty. Because our knowledge-base is not static, the factors contributing to learning difficulty may change over time. For example, it is now clear that the receptive status of referents impacts on the ease of acquisition of manual signs (perhaps also of graphic symbols). Yet, several studies failed to equate sets based on the receptive status of referents (e.g., Barrera et al., 1980; Bennett et al., 1986; Conaghan et al., 1992; Dalrymple & Feldman, 1992; Linton & Singh, 1984). Thus, comparative efficacy studies such as these require replications, as the field uncovers new factors contributing to learning difficulty (Schlosser, 1999).

6.2. Directions for future research
A first step might be to conduct systematic replications of those studies identified to be of questionable internal validity. Until the above-discussed methodological weaknesses are addressed in replication studies, practitioners cannot place a lot of confidence in the trustworthiness of the respective findings. Among the studies that need to be replicated are those that present with the following appraisal characteristics: (a) with inadequate designs or (b) without treatment integrity, or (c) interobserver agreement data, or (d) biased participants, or (e) without a learning or teaching criterion, (f) instructional sets that were not matched or matched based on an inadequate recognition of variables contributing to learning difficulty per today’s knowledgebase.

In single-subject experimental designs the number of participants across which an effect is replicated contributes to its external validity. About 22% of all studies reviewed included only one participant and 88% of the studies included four or fewer participants. This suggests that the majority of comparative efficacy studies do not meet the n criteria set forth by the American Psychological Association for empirically-supported treatments (e.g.,
Chambless, 2002). It is important that the affected studies be replicated with a larger n and newly designed studies consider these criteria during the planning stage.

The research comparing aided approaches with manual signing has documented some of the consequences of differences that are inherent in these two respective approaches. For example, the finding that with PECS learners with autism were able to generalize the rule of matching novel symbols to new items (and with manual signing they were not) (Anderson, 2002) is to be expected given that PECS users can rely on recognition memory with only one novel symbol in front of them when selecting symbols. With signing, on the other hand, the learner has to produce the sign out of “thin air” so to speak. While it is important to document these approach-specific consequences, future research should explore the boundaries of these consequences. For example, if learners were presented with more than one novel symbol as part of PECS, at what point would this advantage of recognition memory fade to the extent that it renders generalization performance comparable to manual signing? Another approach-specific consequence is the finding that manual signing resulted in more eye contact than PECS (Anderson, 2002). PECS does not require the seeking of the communication partner’s eye contact when handing over a picture. The simple receipt of the picture can help the learner be assured that the message was received. With signing this cannot be assumed; perhaps the communication partner was looking away while the learner was signing. The only way to ensure the partner’s attention is to seek the partner’s eye contact. Future research should examine the long-term effects of using PECS on learner’s development of eye contact.

Most studies focused on comparing acquisition, generalization or maintenance of communication skills. Only one study focused on a preference for communication devices after acquisition (Soto et al., 1993). Considering that many studies found relatively differences in acquisition rates, a more important clinical measure may be a learner’s small preference for using some type of device over another (e.g., manual sign versus PECS). A comparison of this type requires attention to unique methodological details. For example, prior to assessing preference, experience with respect to both systems must be equated. In addition, the learner would have to be equally proficient with both systems. Procedures must also be developed so as to ensure there is no bias towards the use of a device over another. For example, the mere presence of a device may evoke a selection of that response and may therefore not necessarily reflect a learner’s preference. Future research should examine how best to assess preference for various AAC systems during and after acquisition training as this may prove useful is assisting clinicians with the difficult task of selecting AAC systems for individual clients.

7. Conclusion

The intent of this review was to inform the decision-making of practitioners when faced with clinical or educational situations that allow for more than one solution. In such situations, it is recommended that practitioners follow the EBP process, beginning with the development of a well-built question, the searching for evidence, followed by an appraisal of evidence (Schlosser, 2003). This is where this review may be helpful. The practitioner can determine relatively quickly whether there has been any comparative research related
Table 11
Recommendations for various instructional goals based on appraised research evidence

<table>
<thead>
<tr>
<th>Approach</th>
<th>Instructional goal</th>
<th>Research evidence suggests</th>
<th>Appraisal</th>
<th>Certainty</th>
<th>N</th>
<th>Participant type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaided</td>
<td>To improve (a) expressive signing, (b) natural speech production, and (c) receptive speech</td>
<td>Use simultaneous communication rather than sign-alone</td>
<td>Suggestive (a, b, and c)</td>
<td>Suggestive</td>
<td>4 (a, b)</td>
<td>Severe intellectual disabilities (a, b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 (a, b)</td>
<td>Autism (c)</td>
</tr>
<tr>
<td></td>
<td>To increase or expedite expressive signing acquisition</td>
<td>Add positive reinforcement when using directed rehearsal as an instructional method</td>
<td>Preponderant 6 (a)</td>
<td>Preponderant</td>
<td>4 (b)</td>
<td>Moderate to profound intellectual disabilities and hearing impairments (a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Introduce known words (i.e., words that a learner understands receptively) rather than unknown words when using simultaneous communication as an instructional method</td>
<td>Suggestive 3</td>
<td>Suggestive</td>
<td>3</td>
<td>Severe intellectual disabilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use progressive time delay rather than the system of least prompts</td>
<td>Suggestive/ preponderant</td>
<td>Suggestive</td>
<td>4</td>
<td>Severe intellectual disabilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide learners with the referent represented by the produced sign rather than a reinforcer that is unrelated to the sign</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Use overinstruction rather than receptive pre-instruction</td>
<td>Suggestive 4</td>
<td>Suggestive</td>
<td>4</td>
<td>Severe intellectual disabilities</td>
</tr>
<tr>
<td></td>
<td>To overcome stimulus overselectivity and facilitate receptive speech during simultaneous communication</td>
<td>Intermix simultaneous communication with oral-only trials rather than relying on overinstruction</td>
<td>Suggestive 5</td>
<td></td>
<td></td>
<td>Intellectual disabilities</td>
</tr>
<tr>
<td>Aided</td>
<td>To increase receptive graphic symbol discriminations</td>
<td>Use delayed prompting rather than fading</td>
<td>Suggestive 4</td>
<td></td>
<td></td>
<td>Autism</td>
</tr>
<tr>
<td>Approach</td>
<td>Instructional goal</td>
<td>Research evidence suggests</td>
<td>Appraisal</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Certainty</td>
<td>N</td>
<td>Participant type</td>
<td></td>
</tr>
<tr>
<td>To increase receptive graphic symbol identifications</td>
<td>Use computer presentation or a teacher presentation</td>
<td>Preponderant 3</td>
<td>Communication impairments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To evoke expressive graphic symbol use (i.e., requesting)</td>
<td>Teach generalized or explicit requests</td>
<td>Conclusive 4</td>
<td>Intellectual disabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To improve receptive graphic symbol acquisition</td>
<td>Choose Picture Ideogram Communication symbols over Blissymbols, and traditional orthography Use Rebus-like graphic symbols or Blissymbols</td>
<td>Suggestive 6</td>
<td>Moderate to severe disabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multiple disabilities</td>
<td></td>
</tr>
<tr>
<td>To expedite receptive graphic symbol acquisition</td>
<td>Select Rebus-like graphic symbols over Blissymbols When using Blissymbols, choose high translucency symbol rather than low translucency; avoid low translucency symbols with high complexity</td>
<td>Suggestive 3</td>
<td>Communication impairments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Multiple disabilities</td>
<td></td>
</tr>
<tr>
<td>To facilitate access to communication displays</td>
<td>Choose among three positions (chair, stander, prone-wedge) over the sidelyer position</td>
<td>Suggestive 2</td>
<td>Cerebral palsy (CP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To select symbols from a display</td>
<td>Use inverse scanning rather than automatic or step scanning regardless of type of CP; avoid using automatic scanning for children with spastic CP and step scanning for children with athetoid CP</td>
<td>Suggestive 3</td>
<td>Spastic CP</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Athetoid CP</td>
<td></td>
</tr>
<tr>
<td>To choose an appropriate switch for scanning</td>
<td>In absence of consistent differences, rely on an individualized assessment</td>
<td>Suggestive 3</td>
<td>CP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To arrange symbols so that they facilitate combinations</td>
<td>Move symbols representing high frequency combinations closer together</td>
<td>Preponderant 1</td>
<td>Multiple disabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To program a device with the most beneficial feedback modes for spelling</td>
<td>In absence of consistent differences, conduct individualized assessments</td>
<td>Conclusive 4</td>
<td>Autism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach</td>
<td>Instructional goal</td>
<td>Research evidence suggests</td>
<td>Appraisal</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Certainty</td>
<td>N</td>
<td>Participant type</td>
<td></td>
</tr>
<tr>
<td>To expedite receptive graphic symbol learning</td>
<td>Provide instruction with synthetic speech output rather than no speech output</td>
<td>Conclusive</td>
<td>3</td>
<td>Severe to profound intellectual disabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide instruction with synthetic speech output feedback/input rather than with natural speech</td>
<td>Conclusive</td>
<td>4</td>
<td>Severe to profound intellectual disabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aided vs. unaided</td>
<td>To expedite expressive use</td>
<td>Teach the Picture Exchange Communication System (PECS) rather than manual signing</td>
<td>Conclusive</td>
<td>6</td>
<td>Autism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To increase initiations during free choice</td>
<td>Teach PECS rather than manual signing</td>
<td>Conclusive</td>
<td>6</td>
<td>Autism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To increase eye contact</td>
<td>Teach manual signing rather than PECS</td>
<td>Conclusive</td>
<td>6</td>
<td>Autism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To minimize challenging behaviors during communication instruction</td>
<td>Introduce PECS or manual signing</td>
<td>Conclusive</td>
<td>6</td>
<td>Autism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To facilitate expressive use of two-word semantic combinations through unaided or aided/unaided combined approaches</td>
<td>In absence of consistent differences, conduct individualized assessments to determine best modes</td>
<td>Suggestive</td>
<td>2</td>
<td>Young children with intellectual disabilities</td>
<td></td>
</tr>
</tbody>
</table>
to the well-built question of interest by scanning the relevant tables. To facilitate this process and encourage research uptake, several recommendations were derived from the results and appraisals of Tables 1–10 and summarized in Table 11 according to instructional goals. Evidence that was considered “inconclusive,” based on the threats to internal validity (see descriptions in the “appraisal” column of the respective tables), did not render any practical recommendations. However, evidence that was rated as suggestive or better (i.e., preponderant, conclusive) resulted in proposed recommendations. This progression of internal validity has been used in AAC by several authors (Granlund & Olsson, 1999; Schlosser & Sigafoos, 2002). Suggestive evidence indicates that certain AAC outcomes are plausible, and are within the realm of possibility. This rating is based on minor flaws in design or adequate (or better) design with inadequate interobserver agreement or treatment integrity. Preponderant evidence indicates that certain AAC outcomes are not only possible, but also they are more likely to have occurred than they have not. This rating is based on (a) minor flaws in design with adequate (or better) interobserver agreement or treatment integrity, or (b) strong design with questionable interobserver agreement or treatment integrity. Conclusive evidence indicates that certain AAC outcomes are undoubtedly the result of the interventions being compared. This rating is based on a strong design along with adequate (or better) interobserver agreement and treatment integrity. In addition to the certainty of evidence rating, the reader is also given the number of participants on which these recommendations rest along with the diagnosis or classification of the participants involved. This allows the reader to determine the external validity these recommendations may have. In this review several methodologic shortcomings were uncovered that should be taken into account in the planning and implementation of future comparative efficacy research in AAC. Speaking of future research, several worthy directions for future research were identified.

References


**Included studies**


