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Systematic review of AAC intervention research for adolescents and adults with autism spectrum disorder

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Research Article

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Abstract

Abstract
Much of augmentative and alternative communication (AAC) research for individuals with autism spectrum disorder has focused on young children. Given that the lives, communication, strengths, and needs of adolescents and adults with autism spectrum disorder are quite different from those of young children, the purpose of the current study was to consolidate current AAC intervention research findings specific to these individuals. A systematic review was conducted to identify and evaluate relevant research. Results indicate that AAC intervention benefits adolescents and

adults with autism spectrum disorder. However, more research is urgently needed. Future research focused on supporting communicative functions other than requesting (e.g., social closeness, information transfer) while participating in contexts important to the lives of adolescents and adults may be particularly valuable.
Keywords: Autism spectrum disorder, adolescents, adults, augmentative and alternative communication, systematic review

The number of adolescents and adults with autism spectrum disorder (ASD) in the world is growing (Gerhardt & Lainer, 2011 Gerhardt, P.F., & Lainer, I. (2011). Addressing the needs of adolescents and adults with autism: A crisis on the horizon. Journal of Contemporary Psychotherapy, 41, 37–45. Retrieved from http://dx.doi.org/10.1007/s10879-010-9160-2[Crossref], [Google Scholar]). Unfortunately, the number of opportunities for these individuals to participate successfully in the world is limited and, as a result, they often experience poor outcomes in adulthood relative to their roles in the vocational, community, and social sectors (Howlin, Goode, Hutton, & Rutter, 2004 Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. Journal of Child Psychology and Psychiatry, 45, 212–229. Retrieved from https://doi.org/10.1111/j.1469-7610.2004.00215.x10.1111/j.1469-7610.2004.00215.x[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). These outcomes of isolation and reduced opportunities for participation can be exacerbated by limitations rendering speech unable to meet the daily communication needs of a subset of adolescents and adults with ASD. These individuals face barriers to successful participation typically accessed through oral communication within the classroom, workplace, community, and at home (Beukelman & Mirenda, 2013 Beukelman, D. & Mirenda, P. (Eds.). (2013). Augmentative and alternative communication: Supporting children & adults with complex communication needs (4th ed.). Baltimore, MD: Brookes Publishing. [Google Scholar]).

Augmentative and alternative communication (AAC) interventions allow individuals with ASD access to such participation using forms of communication other than speech (e.g., sign language, computers with speech output) (Beukelman & Mirenda, 2013 Beukelman, D. & Mirenda, P. (Eds.). (2013). Augmentative and alternative communication: Supporting children & adults with complex communication needs (4th ed.). Baltimore, MD: Brookes Publishing. [Google Scholar]). Previous reviews of AAC interventions for individuals with ASD across the age span have consistently demonstrated intervention effectiveness. For example, Ganz and colleagues (Ganz et al., 2012 Ganz, J.B., Earles-Vollrath, T.L., Heath, A.K., Parker, R.I., Rispoli, M.J., & Duran, J.B. (2012). A meta-analysis of single case research studies on aided augmentative and alternative communication systems with individuals with autism spectrum disorders. Journal of Autism and Developmental Disorders, 42, 60–74. Retrieved from http://dx.doi.org/10.1007/s10803-011-1212-2[Crossref], [PubMed], [Web of Science ®], [Google Scholar]), in their evaluation of single subject studies, found both low-tech (e.g., PECS; Bondy & Frost, 1994 Bondy, A.S., & Frost, L.A. (1994). The picture exchange communication system. Focus on Autistic Behavior, 9, 1–19. doi: 10.1177/108835769400900301[Crossref], [Google Scholar]) and high-tech (e.g., communication apps on mobile technology) AAC interventions to be effective in promoting communication skills, social interaction skills, academic performance, and a reduction challenging behaviors. The interventions were conducted in a variety of settings. The majority of settings were school-related, with other settings including isolated rooms, the home, and a hospital. van der Meer and Rispoli (2010 van der Meer, L.A., & Rispoli, M. (2010). Communication interventions involving speech-generating devices for children with autism: A review of the literature. Developmental Neurorehabilitation, 13, 294–306. Retrieved from http://dx.doi.org/10.3109/1751842100-3671494[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) completed a review of AAC intervention studies using AAC technology featuring speech output with children under the age of 18 with autism spectrum disorder. As with the Ganz and colleagues' review of AAC interventions for all ages, school was the most frequent setting for intervention. van der Meer and Rispoli found the following communication skills were targeted in interventions: requesting, commenting, answering questions, spelling, reducing unwanted behavior, and increasing natural speech, among others. Their review found that AAC intervention resulted in largely positive outcomes relative to those behaviors, and these outcomes were often maintained beyond the end of the intervention and generalized outside the intervention contexts.

Despite the rapidly increasing body of research demonstrating the benefits of AAC for young children with ASD (Romski, Sevcik, Barton-Hulsey, & Whitmore, 2015 Romski, M., Sevcik, R.A., Barton-Hulsey, A., & Whitmore, A.S. (2015). Early intervention and AAC: What a difference 30 years makes. Augmentative and Alternative Communication, 31, 181–202. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1064163[Taylor & Francis Online], [Web of Science ®], [Google Scholar]), findings of the effects of AAC intervention for younger individuals have largely outweighed the effects for older children and adults in these previously completed reviews. For instance, 78% of participants in the studies reviewed by Ganz and colleagues (Ganz et al., 2012 Ganz, J.B., Earles-Vollrath, T.L., Heath, A.K., Parker, R.I., Rispoli, M.J., & Duran, J.B. (2012). A meta-analysis of single case research studies on aided augmentative and alternative communication systems with individuals with autism spectrum disorders. Journal of Autism and Developmental Disorders, 42, 60–74. Retrieved from http://dx.doi.org/10.1007/s10803-011-1212-2[Crossref], [PubMed], [Web of Science ®], [Google Scholar]) were in preschool or elementary school; the average age of participants in van der Meer and Rispoli's (2010 van der Meer, L.A., & Rispoli, M. (2010). Communication interventions involving speech-generating devices for children with autism: A review of the literature. Developmental Neurorehabilitation, 13, 294–306. Retrieved from http://dx.doi.org/10.3109/1751842100-3671494[Taylor & Francis

Online], [Web of Science ®], [Google Scholar]) review was 7;7 (years;months) old. Consequently, little is known about the features and effectiveness of AAC intervention specifically for adolescents and adults with ASD (Ganz, 2015 Ganz, J. (2015). AAC interventions for individuals with autism spectrum disorders: State of the science and future research directions. Augmentative and Alternative Communication, 31, 203–214. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1047532[Taylor & Francis Online], [Web of Science ®], [Google Scholar]). Adolescents and adults who have ASD and require AAC have different needs, skills, experiences, and lives than young children. Communicating with the goals of social closeness and information transfer becomes increasingly important as individuals get older, replacing a central need for communicating to express wants and needs in younger children (Light, 1988 Light, J. (1988). Interaction involving individuals using augmentative and alternative communication systems: State of the art and future directions. Augmentative and Alternative Communication, 4, 66–82. Retrieved from http://dx.doi.org/10.1080/07434618812331274657[Taylor & Francis Online], [Google Scholar]). Older individuals have had far more life experiences than young children, shaping the way they perceive and approach the world. Middle- and high-school classrooms and the workplace provide very different settings, opportunities, and challenges from preschool and elementary classrooms. Social and legal expectations for adults, and even adolescents, are far different than those expectations placed upon children. Interaction among adolescents and adults is more complex and demanding than interaction among young children or between young children and adults (Light, Parsons, & Drager, 2002 Light, J., Parsons, A., & Drager, K. (2002). In Reichle, J., Beukelman, D., & Light, J. (Eds.). Exemplary practices for beginning communicators: Implications for AAC (pp. 187–218). Baltimore, MD: Paul. H. Brookes. [Google Scholar]).

Given these differences, relying on general information about AAC interventions for individuals with driven largely by interventions designed for young children, may not result in optimal communication outcomes for adolescents and adults with ASD. Are AAC interventions effective for adolescents and adults with ASD who require AAC? And, if they are effective, what intervention characteristics are specifically effective for this group, and what types of changes are they effective in making? Considering the growing prevalence of ASD among individuals who are adolescents and adults (Gerhardt & Lainer, 2011 Gerhardt, P.F., & Lainer, I. (2011). Addressing the needs of adolescents and adults with autism: A crisis on the horizon. Journal of Contemporary Psychotherapy, 41, 37–45. Retrieved from http://dx.doi.org/10.1007/s10879-010-9160-2[Crossref], [Google Scholar]) and the lack of specific knowledge about AAC intervention for this particular group (Ganz, 2015 Ganz, J. (2015). AAC interventions for individuals with autism spectrum disorders: State of the science and future research directions. Augmentative and Alternative Communication, 31, 203–214. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1047532[Taylor & Francis Online], [Web of Science ®], [Google Scholar]), there is an urgent need for a systematic review to address these posed questions. Such a review could inform clinicians about the potential effects of AAC for adolescents and adults with ASD and to inform future research to advance the evidence base for this group.

The purpose of this study was to conduct a systematic review of AAC intervention research involving adolescents and adults with a diagnosis of ASD. Specifically, objectives of the review were to examine published AAC intervention studies (utilizing group or single-subject methodologies) including participants with ASD aged 11 years or older to determine (a) the participants and their characteristics, (b) the independent variables (i.e., the interventions implemented) and their characteristics, (c) the dependent variables (i.e., the skills targeted) and their characteristics, and (d) the effects of interventions based on changes to dependent variables following introduction of independent variables.

Method

The Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011 Higgins, J., & Green, S. (Eds.). (2011). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration. Retrieved from www.handbook.cochrane.org [Google Scholar]) served as a guide for decision-making throughout the search, coding, and reporting processes. In accordance with the recommended procedures, search and coding procedures were outlined and documented before the systematic review was conducted. A protocol was created and used to analyze all included articles (Higgins & Green, 2011 Higgins, J., & Green, S. (Eds.). (2011). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration. Retrieved from www.handbook.cochrane.org [Google Scholar]).

Search procedures

Articles meeting the following criteria were sought for inclusion in the current review: (a) had been peer-reviewed; (b) had been published in or after 1995 in order to capture research trends over 20 + years; (c) were original intervention studies (i.e., gathered and evaluated data that had not been previously reported); (d) included AAC intervention as an independent variable; (e) included only individuals with ASD at or above the age of 11 and/or their communication partners as participants (in order to determine characteristics and effectiveness of AAC interventions designed for this group specifically); and (f) were published in English. See Figure 1 for the breakdown of the search that occurred to identify all relevant articles. First, four electronic databases housing journals that contain research in ASD and AAC were screened to identify studies for inclusion: PsycINFO, PsycArticles, ERIC, and PubMed. Search terms included the following four word groups: (a) “autis*” or “autism spectrum disorder*,” and (b) “augmentative and alternative communication” or “AAC” or “augmentative communication” or “alternative communication” or “augmented communication” or “communication device*” or “multimodal communication” or “speech generating device*” or

"PECS" or "picture exchange communication system" or "sign language" or "ASL" or "American Sign Language," and (c) "adolescent*" or "adult*" or "middle school*" or "middle-school*" or "high school" or "high-school*" or "vocation*" or "employment" or "transition*" or "elementary school*" or "elementary-school*" or "school-age*" or "school age," and (d) "single subject design" or "single subject" or "single-subject" or "group design" or "intervention*" or "treatment*." In accordance with Cochrane collaborative recommendations, a limited number of word groups with a large number of synonyms were used, and the operator "or" was used between word groups while the operator "and" was used to connect word groups (Higgins & Green, 2011 Higgins, J., & Green, S. (Eds.). (2011). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration. Retrieved from www.handbook.cochrane.org [Google Scholar]). The databases were first searched in July 2015, and the search was repeated in February 2017 to identify any newly published articles. The *Journal of Autism and Developmental Disorders* was hand searched at both search points because of its high number of intervention studies for individuals with ASD (Higgins & Green, 2011 Higgins, J., & Green, S. (Eds.). (2011). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration. Retrieved from www.handbook.cochrane.org [Google Scholar]). Articles yielded from the two searches that appeared to meet inclusion criteria based on the title and abstract passed the initial screening (Higgins & Green, 2011 Higgins, J., & Green, S. (Eds.). (2011). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration. Retrieved from www.handbook.cochrane.org [Google Scholar]). Articles were either excluded at this point, or subjected to a full-text analysis of eligibility for inclusion. Articles meeting all inclusion criteria based on full-text analysis were included in the current study.

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Figure 1. Flowchart of article identification and inclusion.

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Figure 1. Flowchart of article identification and inclusion.

Coding procedures

A protocol was used to guide the coding of all articles. The protocol contained coding choices for (a) study ID/design; (b) participant characteristics; (c) means of communication/AAC; (d) intervention characteristics (e.g., instructional strategies, context of intervention); (e) dependent variable characteristics (e.g., target skill); (f) results including effect size/IRD; and (g) certainty of evidence. These categories allowed for the identification of technology and techniques employed to date, the individuals who benefited, and the certainty with which those benefits derived from the intervention. The protocol allowed for study classification and the gathering of participant information. Studies were classified into one design type (group design; single subject, multiple baseline or multiple probe design; single subject, AB design; single subject, alternating or adapted alternating treatment design; single subject, withdrawal design; single subject, changing criteria design). Participants' ages and concurrent diagnoses were identified.

Information was also gathered about the intervention components utilized. Any changes occurring at the onset of intervention (i.e., manipulations in the study that were components of the independent variable) were classified as intervention components. Each component was organized into one of the following categories: instruction (i.e., teaching), prompting (e.g., verbal, visual), modeling (i.e., demonstration of target behavior), video modeling (i.e., demonstration of target behavior via video), communication support strategies (i.e., provision of a cluster of behaviors to promote communication), responding (i.e., behavior contingent on communication), wait time (i.e., pause for communicative response), or partner instruction (i.e., teaching of professionals, peers, or family). Changes in study procedures evaluating the generalization of the intervention were not coded because generalization and maintenance data were not included in the analyses of the current study. Other information about the intervention was also gathered. This included the setting of the intervention (e.g., at home, at school) and the context of the intervention (e.g., leisure). Features of the AAC technology used in each intervention were also outlined in the protocol. The level of technology was classified as the following: (a) no-tech (i.e., unaided AAC component such as sign language, not requiring anything external to the participant), (b) low-tech (i.e., AAC with no battery or computer component, (c) mid-tech (i.e., AAC with a battery component, but no computer component, or (d) high-tech (i.e., AAC with a computer component). The representation and organization used within the AAC technology was also determined. Additionally, the number of target messages for each participant, as well as the symbol and output associated with each message, was extracted. Foils or messages that were not targeted for increase in the intervention were not included in target messages. Furthermore, the protocol allowed for the gathering of information about the dependent variable. First, the nature of the dependent variables was categorized. Variable categories included communicative behavior (e.g., requesting) and other behavior (e.g., social withdrawal). Second, for those variables that measured communication via AAC by participants

with ASD, the function of the target communication was identified. Definitions for communicative function followed those outlined by Light (1988 Light, J. (1988). Interaction involving individuals using augmentative and alternative communication systems: State of the art and future directions. Augmentative and Alternative Communication, 4, 66–82. Retrieved from http://dx.doi.org/10.1080/07434618812331274657[Taylor & Francis Online], [Google Scholar]). Additionally, each dependent variable was categorized by the factor of disability it addressed. These factors were adopted from the World Health Organization's (2001 World Health Organization. (2001). International classification of functioning, disability and health: ICF. Geneva: World Health Organization. [Google Scholar]) International Classification of Functioning, Disability, and Health. In order to promote reliability of the discrimination of dependent variables into a factor, however, operational definitions adapted from those outlined in the ICF were created by the investigator and included in the protocol. A dependent variable was organized as addressing body structures and function if it measured anatomical parts or physiological function. A dependent variable was considered to address activities if (a) it measured the completion of a task (communication or other), and (b) the behavior occurred during interaction with communication partner(s) and within context(s) not typically occurring in the participants' life. For instance, if the behavior was measured during a task created by the researcher during a one-on-one interaction with that researcher, it was coded as addressing the activity factor. For dependent variables to be considered to measure the function of participation (communication or other), one of the following was required to be consistent with the interaction during which the behavior occurred: (a) other individual(s) involved were people typical in the participant's life (e.g., friends, family members, peers, professionals), and/or (b) the context of the interaction was typical to the participant's life (e.g., a regularly occurring classroom event, a task the participant completes at work). Dependent variables measured environmental factors if they measured the physical, social, or attitudinal environment (e.g., the behavior of others, access to technology). Although personal factors such as gender and geographical location are other factors of disability outlined by the World Health Organization, they were not included as a category for dependent variables because they are not conducive to serving as dependent variables.

Finally, the protocol contained a framework for analyzing the certainty of evidence, adopted from the protocol used by Kent-Walsh, Murza, Malani, and Binger (2015 Kent-Walsh, J., Murza, K.A., Malani, M.D., & Binger, C. (2015). Effects of communication partner instruction on the communication of individuals using AAC: A meta-analysis. Augmentative and Alternative Communication, 31, 271–284. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1052153[Taylor & Francis Online], [Web of Science ®], [Google Scholar]). The following information about studies was classified as strong, having minor flaws, or having fatal flaws/being missing: design, dependent variable reliability, and treatment integrity. Based on the strength of these three categories, studies were determined to provide conclusive, preponderant, suggestive, or inconclusive evidence. Design was considered (a) to be strong if it contained three phase shifts between baseline and intervention and five or more data points per phase, (b) to have minor flaws if it had two to four data points per phase and/or two phase shifts, or (c) to have fatal flaws if it had no experimental control, utilized an AB design, and/or had only one data point per phase. Dependent variable reliability was considered (a) to be strong if inter-observer agreement was at or above 90% for 20% of sessions or more, (b) to have minor flaws if inter-observer agreement was below 90% or was reported for less than 20% of sessions, or (c) to be missing if it was not reported. Treatment integrity was considered (a) to be strong if procedural fidelity was at or above 90% across 20% of sessions or more and inter-observer agreement was reported, (b) to have minor flaws if inter-observer agreement was below 90% or reported for less than 20% of sessions, or (c) to be missing if it was not reported. If the above three considerations (i.e., design, dependent variability reliability, and treatment integrity) were all categorized as strong, the study was classified as providing conclusive evidence. The study was classified as providing preponderant evidence if the design was strong with minor flaws in reliability and/or treatment integrity or if the design had minor flaws but dependent variable reliability and treatment integrity were both strong. The study was classified as providing suggestive evidence if it had minor flaws within all three considerations or if it had minor design flaws and had missing dependent variable reliability or treatment integrity. If the study had fatal design flaws or was missing both dependent variable reliability and treatment integrity, it was classified as providing inconclusive evidence.

Effect size

Improvement rate difference (IRD; Parker, Vannest, & Brown, 2009 Parker, R.I., Vannest, K.J., & Brown, L. (2009). The improvement rate difference for single-case research. Exceptional Children, 75, 135–150. doi: 10.1177/001440290907500201[Crossref], [Web of Science ®], [Google Scholar]) was the measure of effect size used in the current study. IRD quantifies the change in success demonstrated from baseline to intervention (Parker et al., 2009 Parker, R.I., Vannest, K.J., & Brown, L. (2009). The improvement rate difference for single-case research. Exceptional Children, 75, 135–150. doi: 10.1177/001440290907500201[Crossref], [Web of Science ®], [Google Scholar]). IRD was calculated only for those variables (a) for which experimental control was established (i.e., a causal relationship between the independent and dependent variables had been demonstrated), and (b) that measured the behavior of participants with ASD (i.e., not communication partner-related measures). Therefore, those studies providing inconclusive evidence were not included in the effect size calculations. IRD was calculated using a free online calculator (Vannest, Parker, Gonen, & Adiguzel, 2016 Vannest, K., Parker, R., Gonen, O., & Adiguzel, T. (2016). Single case research: Web based calculators for SCR analysis. (Version 2.0) [Web-based application]. College Station, TX: Texas A&M University. Retrieved from singlecaseresearch.org [Google Scholar]). IRD was chosen as the

summary measure because it accounts for all baseline points rather than placing the greatest weight on extreme points in baseline (Kent-Walsh et al., 2015 Kent-Walsh, J., Murza, K.A., Malani, M.D., & Binger, C. (2015). Effects of communication partner instruction on the communication of individuals using AAC: A meta-analysis. Augmentative and Alternative Communication, 31, 271–284. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1052153[Taylor & Francis Online], [Web of Science ®], [Google Scholar]; Parker et al., 2009 Parker, R.I., Vannest, K.J., & Brown, L. (2009). The improvement rate difference for single-case research. Exceptional Children, 75, 135–150. doi: 10.1177/001440290907500201[Crossref], [Web of Science ®], [Google Scholar]). Although benchmarks for level of effect size based on IRD have not been firmly established, they have been estimated (Parker et al., 2009 Parker, R.I., Vannest, K.J., & Brown, L. (2009). The improvement rate difference for single-case research. Exceptional Children, 75, 135–150. doi: 10.1177/001440290907500201[Crossref], [Web of Science ®], [Google Scholar]). The following benchmarks were used to estimate effect size in the current review: An IRD less than 0.50 indicated small or questionable effects, an IRD between 0.50 and 0.70 indicated moderate effects, an IRD above 0.70 and up to 0.75 indicated large effects, and an IRD above 0.75 indicated very large effects (Kent-Walsh et al., 2015 Kent-Walsh, J., Murza, K.A., Malani, M.D., & Binger, C. (2015). Effects of communication partner instruction on the communication of individuals using AAC: A meta-analysis. Augmentative and Alternative Communication, 31, 271–284. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1052153[Taylor & Francis Online], [Web of Science ®], [Google Scholar]; Parker et al., 2009 Parker, R.I., Vannest, K.J., & Brown, L. (2009). The improvement rate difference for single-case research. Exceptional Children, 75, 135–150. doi: 10.1177/001440290907500201[Crossref], [Web of Science ®], [Google Scholar]).

Reliability

The third author, who was trained on the article identification and coding procedures and calculating the summary measure, IRD, completed all reliability for the systematic review. Following her training, she and the first author calibrated using a randomly selected database and a randomly selected article. She then replicated both searches (between July 2015 and February 2017) for one randomly selected database (i.e., 25% of databases) to determine the reliability of article identification. For each search, reliability was calculated by tabulating the number of articles for which the third author drew the same conclusion as the first author on inclusion or exclusion at each level of review (i.e., initial screening and full text review) and the reason for inclusion or exclusion. This point-by-point analysis rendered a number that was divided by the total number of agreements + disagreements then multiplied by 100 to extract a percentage. Reliability for this article inclusion analysis was 92%. Reliability for the final inclusion of articles was 100%.

The third author also completed reliability for the coding procedures on a randomly selected 28% of included studies, in accordance with the 20%-30% of studies recommended by Schlosser, Wendt, and Sigafoos (2007 Schlosser, R., Wendt, O., & Sigafoos, J. (2007). Not all systematic reviews are created equal: Considerations for appraisal. Evidence-Based Communication Assessment and Intervention, 1, 138–150. Retrieved from http://dx.doi.org/10.1080/17489530701560831[Taylor & Francis Online], [Google Scholar]), and independently coded each variable included within the review from those studies. One category, evidence appraisal, contained multiple levels of coding. For this variable, coding for each step of the process as well as the overall determination was included in the calculation of overall reliability. For instance, if both coders determined the study to provide preponderant evidence, but the coders arrived at that determination with different coding of study design, reliability, and treatment integrity, points of disagreement were included for each of those steps while a point of agreement was included for the overall determination. To calculate the overall reliability score, the total number of agreements for all coding variables was divided by the total number of agreements + disagreements and multiplied by 100 to yield a percentage of reliability for coding procedures. Reliability for independent coding was 94% agreement. Any disagreements in coding were resolved between the first and third author until 100% agreement was established. Using the procedures established by Kent-Walsh and colleagues (Kent-Walsh et al., 2015 Kent-Walsh, J., Murza, K.A., Malani, M.D., & Binger, C. (2015). Effects of communication partner instruction on the communication of individuals using AAC: A meta-analysis. Augmentative and Alternative Communication, 31, 271–284. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1052153[Taylor & Francis Online], [Web of Science ®], [Google Scholar]), IRD calculations within 0.05 points of each other qualified as agreement in article coding. This small range of error minimized noise from differences in graph reading for studies that plotted points on a graph with percentages not labeled on the graph (e.g., a graph labeled every 10% and a point plotted on the graph falling between 20% and 30% without a set number of trials).

Results

Across the initial search, a total of 247 publications were identified for screening from the included databases. A final pool of 14 publications containing 16 distinctive intervention studies met the criteria for inclusion. When updating the search, an additional two publications were identified. Therefore, a total of 16 publications containing 18 distinctive intervention studies were ultimately included in the current review. See Figure 1 for a complete breakdown of article inclusion. All studies identified for inclusion utilized single subject methodology. Table 1 describes the participants, the interventions, the dependent variables, the results, and the certainty of evidence of the included studies.

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Table 1. Summary of AAC intervention research for adolescents and adults with autism spectrum disorder.
CSVDisplay Table
Participant characteristics
In all, 19 unique adolescents and adults with ASD participated in the included studies. The average age was 17.6 years (range: 1-40). The majority of these participants were adolescents; only four of the participants were adults (i.e., 18 or older). Only one study (Reichle et al., 2005 *Reichle, J., McComas, J., Dahl, N., Solberg, G., Pierce, S., & Smith, D. (2005). Teaching an individual with severe intellectual delay to request assistance conditionally. Educational Psychology, 25, 275–286. Retrieved from http://dx.doi.org/10.1080/0144341042000301201[Taylor & Francis Online], [Google Scholar]) included a participant who had reached middle-aged life (age 40), and no studies included older adults. The studies included mostly males, with only two unique females included across three studies (Lund & Troha, 2008 *Lund, S., & Troha, J. (2008). Teaching young people who are blind and have autism to make requests using a variation on the picture exchange communication system with tactile symbols: A preliminary investigation. Journal of Autism and Developmental Disorders, 38, 719–730. Retrieved from https://doi.org/10.1007/s10803-007-0439-4[Crossref], [PubMed], [Web of Science ®], [Google Scholar]; Sigafoos, Drasgow et al., 2004 *Sigafoos, J., Drasgow, E., Halle, J., O'reilly, M., Seely-York, S., Edrisinha, C., & Andrews, A. (2004). Teaching VOCA use as a communicative repair strategy. Journal of Autism and Developmental Disorders, 34, 411–422. Retrieved from https://doi.org/10.1023/B:JADD.0000037417.04356.9c[Crossref], [PubMed], [Web of Science ®], [Google Scholar]; Sigafoos, O'Reilly, Seely-York, & Edrishna, 2004 *Sigafoos, J., O'reilly, M., Seely-York, S., & Edrisinha, C. (2004). Teaching students with developmental disabilities to locate their AAC device. Research in Developmental Disabilities, 25, 371–383. Retrieved from https://doi.org/10.1016/j.ridd.2003.07.002[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). Notably, two of the studies (Hong, Ganz, Gilliland, & Ninci, 2014 *Hong, E., Ganz, J., Gilliland, W., & Ninci, J. (2014). Teaching caregivers to implement an augmentative and alternative communication intervention to an adult with ASD. Research in Autism Spectrum Disorders, 8, 570–580. Retrieved from https://doi.org/10.1016/j.rasd.2014.01.012[Crossref], [Web of Science ®], [Google Scholar]; Trottier, Kamp, & Mirenda, 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) also included communication partners as participants. In Hong et al. these participants were professional care providers. In Trottier et al. the communication partners were peers from the classrooms of the participants with ASD.
Intervention characteristics
AAC systems/devices
Table 2 summarizes the AAC systems and devices that have been employed in AAC intervention research for adolescents and adults with ASD to date. All but two of the included studies (Cornelius Habarad, 2015 *Cornelius Habarad, S.M. (2015). The power of the mand: Utilizing the mand repertoire to decrease problem behavior. Behavioral Development Bulletin, 20, 158–162. Retrieved from http://dx.doi.org/10.1037/h0101310[Crossref], [Google Scholar]; Sigafoos et al., 2009 *Sigafoos, J., Green, V., Payne, D., Son, S., O'reilly, M., & Lancioni, G. (2009). A comparison of picture exchange and speech-generating devices: Acquisition, preference, and effects on social interaction. Augmentative and Alternative Communication, 25, 99–109. Retrieved from http://dx.doi.org/10.1080/07434610902739959[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) targeted just one AAC mode for each participant. Sigafoos and colleagues compared two AAC device options. Meanwhile, Cornelius Habarad implemented an intervention that targeted the participants' use of two different modes of AAC – adaptive signs and PECS. All levels of AAC technology (i.e., no- tech, low-tech, mid-tech, and high-tech) have been leveraged, but investigators most commonly explored use of high-tech AAC, as was the case for seven of the 18 studies. Still, the current review suggests adolescents and adults with ASD can learn to fulfill communicative functions using AAC across a range of technology levels.
Systematic review of AAC intervention research for adolescents and adults with autism spectrum disorder
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Table 2. AAC technologies utilized in intervention research for adolescents and adults with autism spectrum disorder.

CSVDisplay Table

Picture symbols were used as representation in most (12 of 18) studies, making them the most frequently employed representation option; two of the 18 studies (Banda, Copple, Koul, Sancibrian, & Bogschutz, 2010 *Banda, D., Copple, K., Koul, R., Sancibrian, S., & Bogschutz, R. (2010). Video modelling interventions to teach spontaneous requesting using AAC devices to individuals with autism: A preliminary investigation. Disability and Rehabilitation, 32, 1364–1372. Retrieved from: http://dx.doi.org/10.1044/aac20.4.109[Taylor & Francis Online], [Web of Science ®], [Google Scholar]; Hong et al., 2014 *Hong, E., Ganz, J., Gilliland, W., & Ninci, J. (2014). Teaching caregivers to implement an augmentative and alternative communication intervention to an adult with ASD. Research in Autism Spectrum Disorders, 8, 570–580. Retrieved from https://doi.org/10.1016/j.rasd.2014.01.012[Crossref], [Web of Science ®], [Google Scholar]) used photographs; and one of the studies utilized tactile symbols in order to accommodate lack of vision in participants (Lund & Troha, 2008 *Lund, S., & Troha, J. (2008). Teaching young people who are blind and have autism to make requests using a variation on the picture exchange communication system with tactile symbols: A preliminary investigation. Journal of Autism and Developmental Disorders, 38, 719–730. Retrieved from https://doi.org/10.1007/s10803-007-0439-4[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). Two studies included no-tech AAC, and concepts were represented using adaptive signs (Cornelius Habarad, 2015 *Cornelius Habarad, S.M. (2015). The power of the mand: Utilizing the mand repertoire to decrease problem behavior. Behavioral Development Bulletin, 20, 158–162. Retrieved from http://dx.doi.org/10.1037/h0101310[Crossref], [Google Scholar]) and American Sign Language (Kee, Casey, Cae, Bicard, & Bicard, 2012 *Kee, S., Casey, L., Cae, C., Bicard, D., & Bicard, S. (2012). Increasing communication skills: A case study of a man with autism spectrum disorder and vision loss. Journal of Visual Impairment and Blindness, 106, 120–125.[Web of Science ®], [Google Scholar]); one study exploited orthography as representation (Carnett & Ingvarsson, 2016 *Carnett, A., & Ingvarsson, E.T. (2016). Teaching a child with autism to mand for answers to questions using a speech-generating device. The Analysis of Verbal Behavior, 32, 233–241. Retrieved from: http://dx.doi.org/10.1007/s40616-016-0070-6[Crossref], [Web of Science ®], [Google Scholar]); and one study did not make use of any representation; rather, the participants used an unmarked single-message button to communicate in the study (Sigafoos, Drasgow et al., 2004 *Sigafoos, J., Drasgow, E., Halle, J., O'reilly, M., Seely-York, S., Edrisinha, C., & Andrews, A. (2004). Teaching VOCA use as a communicative repair strategy. Journal of Autism and Developmental Disorders, 34, 411–422. Retrieved from https://doi.org/10.1023/B:JADD.0000037417.04356.9c[Crossref], [PubMed], [Web of Science ®], [Google Scholar]).

Grid displays were used to organize AAC messages in nine of the 18 studies. AAC messages were organized in a multi-symbol array (e.g., multiple PECS symbols on the front of a binder) in five studies (Cornelius Habarad, 2015 *Cornelius Habarad, S.M. (2015). The power of the mand: Utilizing the mand repertoire to decrease problem behavior. Behavioral Development Bulletin, 20, 158–162. Retrieved from http://dx.doi.org/10.1037/h0101310[Crossref], [Google Scholar]; Ganz, Sigafoos, Simpson, & Cook, 2008 *Ganz, J., Sigafoos, J., Simpson, R., & Cook, K. (2008). Generalization of a pictorial alternative communication system across instructors and distance. Augmentative and Alternative Communication, 24, 89–99. Retrieved from http://dx.doi.org/10.1080/07434610802113289[Taylor & Francis Online], [Web of Science ®], [Google Scholar], Phases 1 and 2; Lund & Troha, 2008 *Lund, S., & Troha, J. (2008). Teaching young people who are blind and have autism to make requests using a variation on the picture exchange communication system with tactile symbols: A preliminary investigation. Journal of Autism and Developmental Disorders, 38, 719–730. Retrieved from https://doi.org/10.1007/s10803-007-0439-4[Crossref], [PubMed], [Web of Science ®], [Google Scholar]; Sigafoos et al., 2009 *Sigafoos, J., Green, V., Payne, D., Son, S., O'reilly, M., & Lancioni, G. (2009). A comparison of picture exchange and speech-generating devices: Acquisition, preference, and effects on social interaction. Augmentative and Alternative Communication, 25, 99–109. Retrieved from http://dx.doi.org/10.1080/07434610902739959[Taylor & Francis Online], [Web of Science ®], [Google Scholar]).

AAC messages appeared as single symbols or messages in three studies (Reichle et al., 2005 *Reichle, J., McComas, J., Dahl, N., Solberg, G., Pierce, S., & Smith, D. (2005). Teaching an individual with severe intellectual delay to request assistance conditionally. Educational Psychology, 25, 275–286. Retrieved from http://dx.doi.org/10.1080/0144341042000301201[Taylor & Francis Online], [Google Scholar]; Sigafoos, Drasgow et al., 2004 *Sigafoos, J., Drasgow, E., Halle, J., O'reilly, M., Seely-York, S., Edrisinha, C., & Andrews, A. (2004). Teaching VOCA use as a communicative repair strategy. Journal of Autism and Developmental Disorders, 34, 411–422. Retrieved from https://doi.org/10.1023/B:JADD.0000037417.04356.9c[Crossref], [PubMed], [Web of Science ®], [Google Scholar]; Sigafoos, O'Reilly et al., 2004 *Sigafoos, J., O'reilly, M., Seely-York, S., & Edrisinha, C. (2004). Teaching students with developmental disabilities to locate their AAC device. Research in Developmental Disabilities, 25, 371–383. Retrieved from https://doi.org/10.1016/j.ridd.2003.07.002[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). In one study, letters were organized on a QWERTY keyboard (Carnett & Ingvarsson, 2016 *Carnett, A., & Ingvarsson, E.T. (2016). Teaching a child with autism to mand for answers to questions using a speech-generating device. The Analysis of Verbal Behavior, 32, 233–241. Retrieved from: http://dx.doi.org/10.1007/s40616-016-0070-6[Crossref], [Web of Science ®], [Google Scholar]).

Eight of the 18 studies targeted eight or more AAC messages per participant. Six of the 18 studies (Kee et al., 2012 *Kee, S., Casey, L., Cae, C., Bicard, D., & Bicard, S. (2012). Increasing communication skills: A case study of a man with autism spectrum disorder and vision loss. Journal of Visual Impairment and Blindness, 106, 120–125.[Web of Science ®], [Google Scholar]; Lund & Troha, 2008 *Lund, S., & Troha, J. (2008). Teaching young people who are

blind and have autism to make requests using a variation on the picture exchange communication system with tactile symbols: A preliminary investigation. Journal of Autism and Developmental Disorders, 38, 719–730. Retrieved from https://doi.org/10.1007/s10803-007-0439-4[Crossref], [PubMed], [Web of Science ®], [Google Scholar]; Reichle et al., 2005 *Reichle, J., McComas, J., Dahl, N., Solberg, G., Pierce, S., & Smith, D. (2005). Teaching an individual with severe intellectual delay to request assistance conditionally. Educational Psychology, 25, 275–286. Retrieved from http://dx.doi.org/10.1080/0144341042000301201[Taylor & Francis Online], [Google Scholar]; Sigafoos, Drasgow et al., 2004 *Sigafoos, J., Drasgow, E., Halle, J., O'reilly, M., Seely-York, S., Edrisinha, C., & Andrews, A. (2004). Teaching VOCA use as a communicative repair strategy. Journal of Autism and Developmental Disorders, 34, 411–422. Retrieved from https://doi.org/10.1023/B:JADD.0000037417.04356.9c[Crossref], [PubMed], [Web of Science ®], [Google Scholar]; Sigafoos et al., 2009 *Sigafoos, J., Green, V., Payne, D., Son, S., O'reilly, M., & Lancioni, G. (2009). A comparison of picture exchange and speech-generating devices: Acquisition, preference, and effects on social interaction. Augmentative and Alternative Communication, 25, 99–109. Retrieved from http://dx.doi.org/10.1080/07434610902739959[Taylor & Francis Online], [Web of Science ®], [Google Scholar]; Sigafoos, O'Reilly et al., 2004 *Sigafoos, J., O'reilly, M., Seely-York, S., & Edrisinha, C. (2004). Teaching students with developmental disabilities to locate their AAC device. Research in Developmental Disabilities, 25, 371–383. Retrieved from https://doi.org/10.1016/j.ridd.2003.07.002[Crossref], [PubMed], [Web of Science ®], [Google Scholar]) targeted a single AAC message per participant. The majority of studies (10/18) targeted only nouns – mostly related preferred items, particularly food (e.g., "cracker"). Two studies (Cafiero, 2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. Focus on Autism and Other Developmental Disabilities, 16, 179–189. Retrieved from: https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar]; Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) targeted AAC messages from multiple parts of speech that could be combined with one another to create a multi-message utterance. Eight studies included phrase- or sentence-level messages (Achmadi et al., 2012 *Achmadi, D., Kagohara, D., van der Meer, L., O'reilly, M., Lancioni, G., Sutherland, … Sigafoos, J. (2012). Teaching advanced operation of an iPod-based speech-generating device to two students with autism spectrum disorders. Research in Autism Spectrum Disorders, 6, 1258–1264. Retrieved from: http://dx.doi.org/10.1016/j.rasd.2012.05.005[Crossref], [Web of Science ®], [Google Scholar]; Carnett & Ingvarsson, 2016 *Carnett, A., & Ingvarsson, E.T. (2016). Teaching a child with autism to mand for answers to questions using a speech-generating device. The Analysis of Verbal Behavior, 32, 233–241. Retrieved from: http://dx.doi.org/10.1007/s40616-016-0070-6[Crossref], [Web of Science ®], [Google Scholar]; Hong et al., 2014 *Hong, E., Ganz, J., Gilliland, W., & Ninci, J. (2014). Teaching caregivers to implement an augmentative and alternative communication intervention to an adult with ASD. Research in Autism Spectrum Disorders, 8, 570–580. Retrieved from https://doi.org/10.1016/j.rasd.2014.01.012[Crossref], [Web of Science ®], [Google Scholar]; Kagohara et al., 2010 *Kagohara, D., van der Meer, L., Achmadi, D., Green, V., O'reilly, M., Mulloy, A., … Sigafoos, J. (2010). Behavioral intervention promotes successful use of an iPod-based communication device by an adolescent with autism. Clinical Case Studies, 9, 328–338. Retrieved from https://doi.org/10.1177/1534650110379633[Crossref], [Google Scholar]; Sigafoos, Drasgow et al., 2004 *Sigafoos, J., Drasgow, E., Halle, J., O'reilly, M., Seely-York, S., Edrisinha, C., & Andrews, A. (2004). Teaching VOCA use as a communicative repair strategy. Journal of Autism and Developmental Disorders, 34, 411–422. Retrieved from https://doi.org/10.1023/B:JADD.0000037417.04356.9c[Crossref], [PubMed], [Web of Science ®], [Google Scholar]; Sigafoos et al., 2009 *Sigafoos, J., Green, V., Payne, D., Son, S., O'reilly, M., & Lancioni, G. (2009). A comparison of picture exchange and speech-generating devices: Acquisition, preference, and effects on social interaction. Augmentative and Alternative Communication, 25, 99–109. Retrieved from http://dx.doi.org/10.1080/07434610902739959[Taylor & Francis Online], [Web of Science ®], [Google Scholar]; Sigafoos, O'Reilly et al., 2004 *Sigafoos, J., O'reilly, M., Seely-York, S., & Edrisinha, C. (2004). Teaching students with developmental disabilities to locate their AAC device. Research in Developmental Disabilities, 25, 371–383. Retrieved from https://doi.org/10.1016/j.ridd.2003.07.002[Crossref], [PubMed], [Web of Science ®], [Google Scholar]; Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]).

Intervention components

Six different instructional strategies have been implemented in AAC intervention studies for adolescents and adults with ASD: unspecified instruction, prompting, responding, video modeling, communication support strategies, and partner strategy instruction. In 12 of the 18 studies, interventions included more than one of these components. Prompting was the most common strategy implemented, appearing in 14 of the 19 interventions. In all but two (16/18) of the studies (Hong et al., 2014 *Hong, E., Ganz, J., Gilliland, W., & Ninci, J. (2014). Teaching caregivers to implement an augmentative and alternative communication intervention to an adult with ASD. Research in Autism Spectrum Disorders, 8, 570–580. Retrieved from https://doi.org/10.1016/j.rasd.2014.01.012[Crossref], [Web of Science

®], [Google Scholar]; Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]), the individuals with ASD were the sole focus of intervention. Trottier and colleagues included typically developing peers along with the participants with ASD in the intervention. In Hong et al. only professional communication partners participated in the intervention, and, in this study only, there was no direct intervention with the participants with ASD.

Contexts and settings

Table 3 outlines the contexts and settings of the studies. Snack and leisure served as the most common contexts for intervention, accounting alone or together for the context(s) in 10 of the 18 studies. School was the most common intervention setting, although only one of the studies occurred within the context of the academic school day (Cafiero, 2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. Focus on Autism and Other Developmental Disabilities, 16, 179–189. Retrieved from: https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar]). Instead, studies frequently used participants' school buildings as the intervention settings, but contrived situations removed from participants' school day to serve as the contexts for intervention (e.g., an academic task created by the researcher, a snack with the researcher). People regularly occurring in the lives of the participants with ASD were included in the intervention context in six of the 18 studies (Cafiero, 2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. Focus on Autism and Other Developmental Disabilities, 16, 179–189. Retrieved from: https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar]; Cornelius Habarad, 2015 *Cornelius Habarad, S.M. (2015). The power of the mand: Utilizing the mand repertoire to decrease problem behavior. Behavioral Development Bulletin, 20, 158–162. Retrieved from http://dx.doi.org/10.1037/h0101310[Crossref], [Google Scholar]; Ganz et al., 2008 *Ganz, J., Sigafoos, J., Simpson, R., & Cook, K. (2008). Generalization of a pictorial alternative communication system across instructors and distance. Augmentative and Alternative Communication, 24, 89–99. Retrieved from http://dx.doi.org/10.1080/07434610802113289[Taylor & Francis Online], [Web of Science ®], [Google Scholar], Phases 1 and 2; Hong et al., 2014 *Hong, E., Ganz, J., Gilliland, W., & Ninci, J. (2014). Teaching caregivers to implement an augmentative and alternative communication intervention to an adult with ASD. Research in Autism Spectrum Disorders, 8, 570–580. Retrieved from https://doi.org/10.1016/j.rasd.2014.01.012[Crossref], [Web of Science ®], [Google Scholar]; Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]). In each case, these participants were included as implementers of the intervention, and were mostly professionals, except for the peers who were included in the Trotter and colleagues' intervention. The context for Cafiero's intervention included peers because it occurred throughout the regularly scheduled school day, although these peers were not active agents of the intervention. For the other 12 studies, investigators were the sole agents of intervention and other individuals (e.g., peers, school professionals, family were not included in the intervention context).

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Table 3. Factors contributing to functioning, disability, and health (World Health Organization, 2001 World Health Organization. (2001). International classification of functioning, disability and health: ICF. Geneva: World Health Organization. [Google Scholar]) targeted for change in intervention research for adolescents and adults with autism spectrum disorder.

CSVDisplay Table

Dependent variable characteristics

Requests were the most common behavior measured as a dependent variable in included studies: 12 of the 18 measured participants' production of requests, and one study (Kagohara et al., 2010 *Kagohara, D., van der Meer, L., Achmadi, D., Green, V., O'reilly, M., Mulloy, A., … Sigafoos, J. (2010). Behavioral intervention promotes successful use of an iPod-based communication device by an adolescent with autism. Clinical Case Studies, 9, 328–338. Retrieved from https://doi.org/10.1177/1534650110379633[Crossref], [Google Scholar]), measured successful device operation while requesting. Because requesting was the most common behavior measured, the expression of wants and needs was the most common function of communication measured. In fact, it served as the sole communicative function targeted in all but six of the 18 studies (Cafiero, 2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. Focus on Autism and Other Developmental Disabilities, 16, 179–189. Retrieved from:

https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar]; Carnett & Ingvarsson, 2016 *Carnett, A., & Ingvarsson, E.T. (2016). Teaching a child with autism to mand for answers to questions using a speech-generating device. The Analysis of Verbal Behavior, 32, 233–241. Retrieved from: http://dx.doi.org/10.1007/s40616-016-0070-6[Crossref], [Web of Science ®], [Google Scholar]; Kagahora et al., 2012 *Kagahora, D., van der Meer, L., Achmadi, D., Green, V., O'reilly, M., Lancioni, G., … Sigafoos, J. (2012). Teaching picture naming to two adolescents with autism spectrum disorders using systematic instruction and speech generating devices. Research in Autism Spectrum Disorders, 6, 1224–1233. Retrieved from https://doi.org/10.1016/j.rasd.2012.04.001[Crossref], [Web of Science ®], [Google Scholar], Studies 1 and 2; Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]). Within these five studies, three (Carnett & Ingvarsson, 2016 *Carnett, A., & Ingvarsson, E.T. (2016). Teaching a child with autism to mand for answers to questions using a speech-generating device. The Analysis of Verbal Behavior, 32, 233–241. Retrieved from: http://dx.doi.org/10.1007/s40616-016-0070-6[Crossref], [Web of Science ®], [Google Scholar]; Kagahora et al., 2012 *Kagahora, D., van der Meer, L., Achmadi, D., Green, V., O'reilly, M., Lancioni, G., … Sigafoos, J. (2012). Teaching picture naming to two adolescents with autism spectrum disorders using systematic instruction and speech generating devices. Research in Autism Spectrum Disorders, 6, 1224–1233. Retrieved from https://doi.org/10.1016/j.rasd.2012.04.001[Crossref], [Web of Science ®], [Google Scholar], Studies 1 and 2) measured information transfer; and two (Cafiero, 2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. Focus on Autism and Other Developmental Disabilities, 16, 179–189. Retrieved from: https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar]; Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) measured communication across communicative functions. See Table 4 for a breakdown of the functions targeted in each study.

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Table 4. Functions of communication targeted in interventions for adolescents and adults with autism spectrum disorder.

CSVDisplay Table

Table 3 outlines the factors contributing to disability (World Health Organization, 2001 World Health Organization. (2001). International classification of functioning, disability and health: ICF. Geneva: World Health Organization. [Google Scholar]) targeted for change in each study. The activity factor of disability has been overwhelmingly the focus of AAC intervention research for adolescents and adults with ASD to date. It was the factor measured in the majority of included studies. In addition to measures of activity, six of the 18 studies (Cafiero, 2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. Focus on Autism and Other Developmental Disabilities, 16, 179–189. Retrieved from: https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar]; Cornelius Habarad, 2015 *Cornelius Habarad, S.M. (2015). The power of the mand: Utilizing the mand repertoire to decrease problem behavior. Behavioral Development Bulletin, 20, 158–162. Retrieved from http://dx.doi.org/10.1037/h0101310[Crossref], [Google Scholar]; Ganz et al., 2008 *Ganz, J., Sigafoos, J., Simpson, R., & Cook, K. (2008). Generalization of a pictorial alternative communication system across instructors and distance. Augmentative and Alternative Communication, 24, 89–99. Retrieved from http://dx.doi.org/10.1080/07434610802113289[Taylor & Francis Online], [Web of Science ®], [Google Scholar], Phases 1 and 2; Hong et al., 2014 *Hong, E., Ganz, J., Gilliland, W., & Ninci, J. (2014). Teaching caregivers to implement an augmentative and alternative communication intervention to an adult with ASD. Research in Autism Spectrum Disorders, 8, 570–580. Retrieved from https://doi.org/10.1016/j.rasd.2014.01.012[Crossref], [Web of Science ®], [Google Scholar]; Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) measured participation because they measured the behavior of participants with ASD within familiar contexts or while interacting with familiar people. Hong and colleagues and Trottier and colleagues also addressed the environmental factor of disability by including communication partners in intervention and measuring changes in their behavior as a result of intervention.

Effects

A mean IRD of 0.84 (range: 0.13-1.00) was calculated across observations for dependent variables with established experimental control (i.e., for those studies with suggestive evidence or better). According to suggested guidelines, this average IRD score indicated that the effect of AAC interventions on targeted behaviors for adolescents and adults with ASD was very large (Parker et al., 2009 Parker, R.I., Vannest, K.J., & Brown, L. (2009). The improvement rate difference for single-case research. Exceptional Children, 75, 135–150. doi: 10.1177/001440290907500201[Crossref], [Web of Science ®], [Google Scholar]). However, the strength and generalizability of these effects are tempered by the limited number of adolescents and adults with ASD who have been included in AAC intervention research, and the small number of observations included in this analysis from studies rated as suggestive or stronger ($n = 29$ observations across $n = 10$ studies and $n = 12$ unique participants). Therefore, the number of observations with an IRD within the ranges of "very large," "large," "moderate," and "small or questionable" were tabulated across all studies to provide an illustrative breakdown. Of the 29 observations for which IRD was calculated, 22 resulted in a very large effect, five resulted in a moderate effect, and two resulted in a small or questionable effect. See Table 1 for intervention effects for each observation.

Certainty of evidence

Evidence from one of the 18 included studies (Hong et al., 2014 *Hong, E., Ganz, J., Gilliland, W., & Ninci, J. (2014). Teaching caregivers to implement an augmentative and alternative communication intervention to an adult with ASD. Research in Autism Spectrum Disorders, 8, 570–580. Retrieved from https://doi.org/10.1016/j.rasd.2014.01.012[Crossref], [Web of Science ®], [Google Scholar]) was categorized as conclusive; four of the 18 (Achmadi et al., 2012 *Achmadi, D., Kagohara, D., van der Meer, L., O'reilly, M., Lancioni, G., Sutherland, … Sigafoos, J. (2012). Teaching advanced operation of an iPod-based speech-generating device to two students with autism spectrum disorders. Research in Autism Spectrum Disorders, 6, 1258–1264. Retrieved from: http://dx.doi.org/10.1016/j.rasd.2012.05.005[Crossref], [Web of Science ®], [Google Scholar]; Carnett & Ingvarsson, 2016 *Carnett, A., & Ingvarsson, E.T. (2016). Teaching a child with autism to mand for answers to questions using a speech-generating device. The Analysis of Verbal Behavior, 32, 233–241. Retrieved from: http://dx.doi.org/10.1007/s40616-016-0070-6[Crossref], [Web of Science ®], [Google Scholar]; Kagahora et al., 2012 *Kagahora, D., van der Meer, L., Achmadi, D., Green, V., O'reilly, M., Lancioni, G., … Sigafoos, J. (2012). Teaching picture naming to two adolescents with autism spectrum disorders using systematic instruction and speech generating devices. Research in Autism Spectrum Disorders, 6, 1224–1233. Retrieved from https://doi.org/10.1016/j.rasd.2012.04.001[Crossref], [Web of Science ®], [Google Scholar], Study 1; Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) provided preponderant evidence. The evidence from six of the studies (Banda et al., 2010 *Banda, D., Copple, K., Koul, R., Sancibrian, S., & Bogschutz, R. (2010). Video modelling interventions to teach spontaneous requesting using AAC devices to individuals with autism: A preliminary investigation. Disability and Rehabilitation, 32, 1364–1372. Retrieved from: http://dx.doi.org/10.1044/aac20.4.109[Taylor & Francis Online], [Web of Science ®], [Google Scholar]; Kagahora et al., 2012 *Kagahora, D., van der Meer, L., Achmadi, D., Green, V., O'reilly, M., Lancioni, G., … Sigafoos, J. (2012). Teaching picture naming to two adolescents with autism spectrum disorders using systematic instruction and speech generating devices. Research in Autism Spectrum Disorders, 6, 1224–1233. Retrieved from https://doi.org/10.1016/j.rasd.2012.04.001[Crossref], [Web of Science ®], [Google Scholar], Study 2; Kagohara et al., 2010 *Kagohara, D., van der Meer, L., Achmadi, D., Green, V., O'reilly, M., Mulloy, A., … Sigafoos, J. (2010). Behavioral intervention promotes successful use of an iPod-based communication device by an adolescent with autism. Clinical Case Studies, 9, 328–338. Retrieved from https://doi.org/10.1177/1534650110379633[Crossref], [Google Scholar]; Reichle et al., 2005 *Reichle, J., McComas, J., Dahl, N., Solberg, G., Pierce, S., & Smith, D. (2005). Teaching an individual with severe intellectual delay to request assistance conditionally. Educational Psychology, 25, 275–286. Retrieved from http://dx.doi.org/10.1080/01443410420003012O1[Taylor & Francis Online], [Google Scholar]; Sigafoos et al., 2009 *Sigafoos, J., Green, V., Payne, D., Son, S., O'reilly, M., & Lancioni, G. (2009). A comparison of picture exchange and speech-generating devices: Acquisition, preference, and effects on social interaction. Augmentative and Alternative Communication, 25, 99–109. Retrieved from http://dx.doi.org/10.1080/07434610902739959[Taylor & Francis Online], [Web of Science ®], [Google Scholar]; Sigafoos, O'Reilly et al., 2004 *Sigafoos, J., O'reilly, M., Seely-York, S., & Edrisinha, C. (2004). Teaching students with developmental disabilities to locate their AAC device. Research in Developmental Disabilities, 25, 371–383. Retrieved from https://doi.org/10.1016/j.ridd.2003.07.002[Crossref], [PubMed], [Web of Science ®], [Google Scholar]) was suggestive. Evidence from the remaining seven studies was classified as inconclusive. Limitations to the certainty of evidence in the included studies were (a) design flaws (minor, major, and fatal; e.g., a single-phase shift), (b) flaws in treatment integrity or a failure to report treatment integrity, and (c) flaws in reliability or a failure to report reliability. Minor design flaws (11/18) and minor flaws in treatment integrity (5/18) were the two most common methodological flaws. These flaws occasionally appeared together. Table 1 outlines the certainty of evidence for each study and the rationale behind each certainty of evidence classification.

Discussion

The main finding of the current systematic review was that AAC intervention appears to be highly effective for adolescents and adults with autism spectrum disorder. This finding is consistent with previous findings with regard to AAC intervention for individuals with ASD of all ages (Ganz et al., 2012 Ganz, J.B., Earles-Vollrath, T.L., Heath, A.K., Parker, R.I., Rispoli, M.J., & Duran, J.B. (2012). A meta-analysis of single case research studies on aided augmentative and alternative communication systems with individuals with autism spectrum disorders. Journal of Autism and Developmental Disorders, 42, 60–74. Retrieved from http://dx.doi.org/10.1007/s10803-011-1212-2[Crossref], [PubMed], [Web of Science ®], [Google Scholar]) and AAC intervention for children (van der Meer & Rispoli, 2010 van der Meer, L.A., & Rispoli, M. (2010). Communication interventions involving speech-generating devices for children with autism: A review of the literature. Developmental Neurorehabilitation, 13, 294–306. Retrieved from http://dx.doi.org/10.3109/1751842100-3671494[Taylor & Francis Online], [Web of Science ®], [Google Scholar]). The finding is also consistent with the general sentiment that, despite the clear value of early intervention (Romski et al., 2015 Romski, M., Sevcik, R.A., Barton-Hulsey, A., & Whitmore, A.S. (2015). Early intervention and AAC: What a difference 30 years makes. Augmentative and Alternative Communication, 31, 181–202. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1064163[Taylor & Francis Online], [Web of Science ®], [Google Scholar]), one is never too old to benefit from AAC intervention (Beukelman & Mirenda, 2013 Beukelman, D. & Mirenda, P. (Eds.). (2013). Augmentative and alternative communication: Supporting children & adults with complex communication needs (4th ed.). Baltimore, MD: Brookes Publishing. [Google Scholar]). However, the limited number of adolescents and adults with ASD who have participated in AAC intervention research to date tempers these findings; the small number of unique individuals who have participated in this research was a surprising finding of this review. In addition, the inconclusive nature of some studies due to fatal methodological flaws further limited the observations from which effects could be calculated. This resulted in an even smaller number of participants and studies from which the overall finding was drawn.

Interventions in the current review utilized a variety of levels and types of technology with adolescents and adults with ASD with success. A variety of representations (e.g., orthography) were also used with success. It seems that adolescents and adults with ASD can be taught to use AAC successfully across a multitude of technology or representation options. All but one of the studies (Cornelius Habarad, 2015 *Cornelius Habarad, S.M. (2015). The power of the mand: Utilizing the mand repertoire to decrease problem behavior. Behavioral Development Bulletin, 20, 158–162. Retrieved from http://dx.doi.org/10.1037/h0101310[Crossref], [Google Scholar]) targeted participants' use of only one mode of AAC. This finding contrasts with reports from expert AAC users that multiple modes of communication are critical for communicating competently throughout the day (Williams, Krezman, & McNaughton, 2008 Williams, M.B., Krezman, C., & McNaughton, D. (2008). "Reach for the stars": Five principles for the next 25 years of AAC. Augmentative and Alternative Communication, 24, 194–206. Retrieved from http://dx.doi.org/10.1080/07434610701421007[Taylor & Francis Online], [Web of Science ®], [Google Scholar]).

In addition to the varying technologies, the current review revealed that a variety of instructional techniques were also implemented with success. Many of these strategies have been shown to be effective in other populations. For instance, the National Autism Center (2015 National Autism Center. (2015). Findings and conclusions: National standards project, Phase 2. Randolph, MA: National Autism Center. [Google Scholar]) found prompting to be an effective instructional strategy with individuals with autism under the age of 22, Warren and Brady (2007 Warren, S.F., & Brady, N.C. (2007). The role of maternal responsivity in the development of children with intellectual disabilities. Mental Retardation and Developmental Disabilities Research Reviews, 13, 330–338. Retrieved from http://dx.doi.org/10.1002/mrdd.20177[Crossref], [PubMed], [Google Scholar]) have found responding to be an effective tool in interactions with young children with developmental disabilities, and Kent-Walsh and colleagues (Kent-Walsh et al., 2015 Kent-Walsh, J., Murza, K.A., Malani, M.D., & Binger, C. (2015). Effects of communication partner instruction on the communication of individuals using AAC: A meta-analysis. Augmentative and Alternative Communication, 31, 271–284. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1052153[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) have found communication partner instruction to be a highly effective AAC intervention approach for individuals with developmental disabilities in general.

Most of the studies included in the current review focused on the expression of wants and needs. This focus of communicative function was reflected in the target vocabulary, which comprised largely preferred items and particularly preferred edible items. It was also reflected in "snack" serving as the most frequent context in included interventions. It may also have played a role in the small number of vocabulary items targeted in most studies – it requires a far smaller corpus of messages (in fact, just one) to request a favorite snack than to converse with a peer about a favorite television show. Importantly, however, there were examples of interventions targeting a large number of vocabulary words (e.g., Cafiero, 2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. Focus on Autism and Other Developmental Disabilities, 16, 179–189. Retrieved from: https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar]), suggesting that adolescents and adults with ASD can communicate successfully with larger vocabulary when it is available to them. Similarly, examples of studies occurring across communicative functions (e.g., Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from

http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) suggest adolescents and adults with ASD can be supported successfully to communicate a variety of functions.

Another important consideration for AAC interventions is the role of the factor(s) of functioning and disability. Given that the majority of studies in the current review involved one-on-one interactions with an investigator, the interventions largely targeted performance on a task rather than participation in a life arena. Indeed, task performance is much easier to objectify and measure in research (Granlund, 2013 Granlund, M. (2013). Participation: Challenges in conceptualization, measurement, and intervention. Child: Care, Health and Development, 39, 470–473. Retrieved from https://doi.org/10.1111/cch.1208010.1111/cch.12080[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). Importantly, some studies in the current review were able to identify an aspect of participation to target and measure effectively (e.g., Ganz et al., 2008 *Ganz, J., Sigafoos, J., Simpson, R., & Cook, K. (2008). Generalization of a pictorial alternative communication system across instructors and distance. Augmentative and Alternative Communication, 24, 89–99. Retrieved from http://dx.doi.org/10.1080/07434610802113289[Taylor & Francis Online], [Web of Science ®], [Google Scholar]), indicating that not only can AAC intervention support adolescents and adults with ASD in performing tasks more effectively but it can also promote their participation in daily living contexts. The finding that AAC intervention can promote participation for adolescents and adults with ASD is important, considering a lack of participation in major life arenas drives many of the poor outcomes associated with ASD in adulthood (Howlin et al., 2004 Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. Journal of Child Psychology and Psychiatry, 45, 212–229. Retrieved from https://doi.org/10.1111/j.1469-7610.2004.00215.x10.1111/j.1469-7610.2004.00215.x[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). Some included studies also addressed the environmental factors associated with functioning and disability by focusing on partner training (e.g., Hong et al., 2014 *Hong, E., Ganz, J., Gilliland, W., & Ninci, J. (2014). Teaching caregivers to implement an augmentative and alternative communication intervention to an adult with ASD. Research in Autism Spectrum Disorders, 8, 570–580. Retrieved from https://doi.org/10.1016/j.rasd.2014.01.012[Crossref], [Web of Science ®], [Google Scholar]). Therefore, rather than always focusing on targeting change in the individual with ASD, AAC intervention can also be effective through changing environmental factors to promote communicative success for adolescents and adults with ASD.

Implications for research

Based on the limited number of adolescents and adults with ASD who have participated in AAC intervention research, perhaps the largest research implication from the current review is the clear and urgent need for more intervention research focused on this group. Given the limited level of certainty of some of the studies included, this research should also follow recommendations for methodological rigor. Addressing the minor design and treatment integrity flaws that most frequently limit the rigor of included studies requires minimal changes to methodology (e.g., recruiting an additional rater of treatment integrity for the allowance of interrater agreement, or adding a small number of intervention sessions to reach the recommended number of intervention sessions per phase).

AAC intervention research to date has been instrumental in documenting interventions for supporting adolescents and adults with ASD in getting their wants and needs met. This documentation reflects the achievement of a very important goal, given how the expression of wants and needs is both a critical influencer on quality of life (Light, 1988 Light, J. (1988). Interaction involving individuals using augmentative and alternative communication systems: State of the art and future directions. Augmentative and Alternative Communication, 4, 66–82. Retrieved from http://dx.doi.org/10.1080/07434618812331274657[Taylor & Francis Online], [Google Scholar]) and an important skill in exercising self-determination. However, given the strong evidence now existing to demonstrate the value of AAC intervention in supporting this communicative function, future research could shift its focus and prioritize the support of other functions. This shift may be especially appropriate for adolescents and adults with ASD given that (a) individuals with ASD often have the motor capabilities to obtain many of their wants and needs without requesting assistance from others; (b) as people move into adolescence and adulthood, the expression of wants and needs becomes less central to daily communication (Light, 1988 Light, J. (1988). Interaction involving individuals using augmentative and alternative communication systems: State of the art and future directions. Augmentative and Alternative Communication, 4, 66–82. Retrieved from http://dx.doi.org/10.1080/07434618812331274657[Taylor & Francis Online], [Google Scholar]); and (c) social interaction is a primary deficit in ASD (American Psychiatric Association, 2013 American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders. (5th ed.). Washington DC: APA.[Crossref], [Google Scholar]) and is more essential to other functions (e.g., social closeness).

This review also revealed the strong existing evidence regarding AAC intervention in impacting the activity factor of functioning and disability for adolescents and adults with ASD. Importantly, some studies demonstrated the potential for AAC intervention to impact other factors contributing to functioning and disability, namely participation and environmental factors. This potential could be harnessed in future research in an impactful way. For example, despite the challenges of addressing participation in intervention research (Granlund, 2013 Granlund, M. (2013). Participation: Challenges in conceptualization, measurement, and intervention. Child: Care, Health and Development, 39, 470–473. Retrieved from https://doi.org/10.1111/cch.1208010.1111/cch.12080[Crossref], [PubMed], [Web of Science ®], [Google Scholar]), uncovering avenues for doing so effectively would be particularly powerful for older individuals with ASD given the restrictions in participation these individuals face in adulthood (Howlin et al., 2004 Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. Journal of Child Psychology and

Psychiatry, 45, 212–229. Retrieved from https://doi.org/10.1111/j.1469-7610.2004.00215.x10.1111/j.1469-7610.2004.00215.x[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). Environmental factors are likewise promising because, in addition to having a crucial role in functioning and disability (WHO, 2001), they are highly malleable. For instance, one can quickly and easily make changes to AAC technology to promote access. Changing a person's linguistic level of knowledge to promote AAC access, while still an important goal, may not happen so quickly or easily. The behaviors of communication partners and AAC technology itself are two obvious environmental factors central to the communicative experience of adolescents and adults with ASD; however, future research could target other environmental factors for change. For instance, a longitudinal study could evaluate school district policies of inclusion on the number of students with ASD who use AAC who spend time in general education classrooms and associated educational and social outcomes.

Finally, the current review revealed AAC interventions to be effective overall for adolescents and adults with ASD. Therefore, a logical future research direction may be to prioritize comparative research. Through such research, AAC interventions could be honed to incorporate only the essential and more impactful features. Such evidence would be invaluable to clinicians, families, individuals with ASD, and all those invested in optimizing outcomes for these individuals.

Implications for practice

The most important implication for clinicians from the current review is they should be providing adolescents and adults with ASD and limited speech access to AAC intervention as empirical evidence demonstrates its effectiveness. This implication holds true for adolescents and adults across a range of ages who might demonstrate a range of linguistic and social strengths and needs. There is also evidence that clinicians can use AAC interventions to support adolescents and adults with ASD to express a range of communicative functions within a variety of communicative contexts, including participating in the classroom (e.g., Cafiero, 2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and academic program of an adolescent with autism. Focus on Autism and Other Developmental Disabilities, 16, 179–189. Retrieved from: https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar]) and interacting socially with peers (e.g., Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]). The current review also indicates that clinicians can successfully integrate professionals (e.g., Ganz et al., 2008 *Ganz, J., Sigafoos, J., Simpson, R., & Cook, K. (2008). Generalization of a pictorial alternative communication system across instructors and distance. Augmentative and Alternative Communication, 24, 89–99. Retrieved from http://dx.doi.org/10.1080/07434610802113289[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) and peers (e.g., Trottier et al., 2011 *Trottier, N., Kamp, L., & Mirenda, P. (2011). Effects of peer-mediated instruction to teach use of speech-generating devices to students with autism in social game routines. Augmentative and Alternative Communication, 27, 26–39. Retrieved from http://dx.doi.org/10.3109/07434618.2010.546810[Taylor & Francis Online], [Web of Science ®], [Google Scholar]) into interventions, in order to promote positive communication outcomes for adolescents and adults with ASD. Interventions in the current review successfully utilized a range of AAC technology and instructional strategies, providing clinicians with a wide array of options and little guidance in specific technology and instructional features to incorporate. Light, Roberts, Dimarco, and Greiner (1998 Light, J.C., Roberts, B., Dimarco, R., & Greiner, N. (1998). Augmentative and alternative communication to support receptive and expressive communication for people with autism. Journal of Communication Disorders, 31, 153–180. Retrieved from https://doi.org/10.1016/S0021-9924(97)00087-710.1016/S0021-9924(97)00087-7[Crossref], [PubMed], [Web of Science ®], [Google Scholar]) provide a framework for developing AAC assessment and intervention based on the skills and needs of individuals with ASD. This framework could be useful for clinicians in determining the best approach to supporting the adolescents and adults with ASD they serve.

Limitations

Despite the research and clinical implications discussed previously, the current review has several very important limitations that affect the interpretation and application of the results. The first and most important limitation of this study was the limited quality of evidence featured; the results of many included studies were determined to be inconclusive. The authors worked to minimize this limitation by applying a best-evidence analysis (Schlosser et al., 2007 Schlosser, R., Wendt, O., & Sigafoos, J. (2007). Not all systematic reviews are created equal: Considerations for appraisal. Evidence-Based Communication Assessment and Intervention, 1, 138–150. Retrieved from http://dx.doi.org/10.1080/17489530701560831[Taylor & Francis Online], [Google Scholar]). Therefore, effect sizes were not calculated for studies determined to be inconclusive. However, the small number of participants in the current review, particularly the small number participating in studies meeting the quality of evidence standards, limits the generalizability of the findings in the current review. Participant numbers may have been slightly higher had individuals from studies involving participants with a variety of diagnoses and age ranges been included; however, the interventions of these studies would not have been implemented for the specific goal of supporting the communication of adolescents and adults with ASD. Because the goal of the current review was to outline the characteristics and effectiveness of adolescents and adults with ASD, it was important to explore only those studies chosen for

implementation with the group specifically. Hand searching more journals may have had the potential to uncover additional studies, making the hand searching of only one journal another limitation of the study.

A limitation of this (and any) systematic review is the risk of bias that may have been introduced by the methodological decisions made, particularly publication bias (Schlosser et al., 2007 Schlosser, R., Wendt, O., & Sigafoos, J. (2007). Not all systematic reviews are created equal: Considerations for appraisal. Evidence-Based Communication Assessment and Intervention, 1, 138–150. Retrieved from http://dx.doi.org/10.1080/17489530701560831[Taylor & Francis Online], [Google Scholar]). It is possible only the more effective AAC intervention studies have been published in peer-review journals, therefore shifting the purported efficacy of AAC intervention effectiveness upward. This is unlikely, given the relatively small amount of research being completed that includes adolescents and adults with ASD (Ganz, 2015 Ganz, J. (2015). AAC interventions for individuals with autism spectrum disorders: State of the science and future research directions. Augmentative and Alternative Communication, 31, 203–214. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1047532[Taylor & Francis Online], [Web of Science ®], [Google Scholar]). Alternatively, it is also plausible that the potential effectiveness of AAC interventions for adolescents and adults with ASD has been under-estimated, given the small amount of research being completed.

Finally, an important limitation in this systematic review was the lack of inclusion of information about the generalization and maintenance of any observed intervention effects. This limitation is particularly important when considering the value such information has in intervention decision-making and the overall value of interventions; if the effects of an intervention only appear within the context of that intervention and disappear immediately following the end of intervention, there is limited value in any observed effects. As more research becomes available, differences in generalization and maintenance across differing AAC intervention features should be weighed heavily when comparing effectiveness.

Conclusion

The unacceptable reality for many adolescents and adults with ASD is that they are routinely excluded from many aspects of life (Howlin et al., 2004 Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. Journal of Child Psychology and Psychiatry, 45, 212–229. Retrieved from https://doi.org/10.1111/j.1469-7610.2004.00215.x10.1111/j.1469-7610.2004.00215.x[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). An uncomfortable realization is that this theme of exclusion has carried over to AAC intervention research (Ganz, 2015 Ganz, J. (2015). AAC interventions for individuals with autism spectrum disorders: State of the science and future research directions. Augmentative and Alternative Communication, 31, 203–214. Retrieved from http://dx.doi.org/10.3109/07434618.2015.1047532[Taylor & Francis Online], [Web of Science ®], [Google Scholar]). Researchers who have included adolescents and adults in AAC intervention research have provided valuable information about its efficacy for that group. Based on these studies' findings, it is clear that AAC intervention can benefit adolescents and adults with ASD. Clinically, this suggests that adolescents and adults with ASD and limited speech require access to AAC intervention services. With regard to research, much more is to be learned about how best to support these individuals in communicating for a variety of functions across the contexts in which adolescents and adults participate in their daily lives (e.g., educational, vocational, civic, social).

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Table 1. Summary of AAC intervention research for adolescents and adults with autism spectrum disorder.

Study ID; design

Achmadi et al. (2012 *Achmadi, D., Kagohara, D., van der Meer, L., O'reilly, M., Lancioni, G., Sutherland, … Sigafoos, J. (2012). Te
students with autism spectrum disorders. Research in Autism Spectrum Disorders, 6, 1258–1264. Retrieved from: http://dx.doi.org/10.

Banda et al. (2010 *Banda, D., Copple, K., Koul, R., Sancibrian, S., & Bogschutz, R. (2010). Video modelling interventions to teach s
preliminary investigation. Disability and Rehabilitation, 32, 1364–1372. Retrieved from: http://dx.doi.org/10.1044/aac20.4.109[Taylor

Cafiero (2001 *Cafiero, J. (2001). The effect of an augmentative communication intervention on the communication, behavior, and ac
Developmental Disabilities, 16, 179–189. Retrieved from: https://doi.org/10.1177/108835760101600306[Crossref], [Google Scholar])

Carnett and Ingvarsson (2016 *Carnett, A., & Ingvarsson, E.T. (2016). Teaching a child with autism to mand for answers to questions
Retrieved from: http://dx.doi.org/10.1007/s40616-016-0070-6[Crossref], [Web of Science ®], [Google Scholar]); MBD

Cornelius Habarad (2015 *Cornelius Habarad, S.M. (2015). The power of the mand: Utilizing the mand repertoire to decrease problem
http://dx.doi.org/10.1037/h0101310[Crossref], [Google Scholar]); ABAB

Ganz, et al. (2008 *Ganz, J., Sigafoos, J., Simpson, R., & Cook, K. (2008). Generalization of a pictorial alternative communication sys
Communication, 24, 89–99. Retrieved from http://dx.doi.org/10.1080/07434610802113289[Taylor & Francis Online], [Web of Scienc
Phase 2; AB

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ID = identification; IV = independent variable; DV = dependent variable; AAC = augmentative and alternative communication; ASD = autism spectrum disorder; OCD = obsessive-compulsive disorder; ADHD = attention-deficit/hyperactivity disorder; M = male; F = female; MBD = multiple probe or baseline design; ATD = alternating treatment or adapted alternating treatment design; AB = AB design; ABAB = ABAB design; C1 = condition 1; C2 = condition 2; TI = treatment integrity.
[a] Participant identifications based on pseudonyms or other anonymous designations from original study publication.
[b] Improvement Rate Difference (IRD) is a single subject effects measure from Parker et al. (2009 Parker, R.I., Vannest, K.J., & Brown, L. (2009). The improvement rate difference for single-case research. Exceptional Children, 75, 135–150. doi: 10.1177/001440290907500201[Crossref], [Web of Science ®], [Google Scholar]); IRD reported only for variables with established experimental control: IRD for variables measure communication partner behavior not reported; IRD was calculated using a free online calculator (Vannest et al., 2016 Vannest, K., Parker, R., Gonen, O., & Adiguzel, T. (2016). Single case research: Web based calculators for SCR analysis. (Version 2.0) [Web-based application]. College Station, TX: Texas A&M University. Retrieved from singlecaseresearch.org [Google Scholar]); IRD was rounded to nearest hundredth decimal.
* Effects representing a decrease, rather than increase, in the variable.
Table 2. AAC technologies utilized in intervention research for adolescents and adults with autism spectrum disorder.
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High-tech AAC = AAC with a computer component; mid-tech AAC = AAC with a battery component, but no computer component; low-tech AAC = AAC with no battery and no computer component: no-tech AAC = AAC that does not require anything external to the user (e.g., sign language); NR = not reported.

[a] If only one message was targeted in the study, that message was provided as the example; if multiple messages were targeted in a study, one was selected at random.

Table 3. Factors contributing to functioning, disability, and health (World Health Organization, 2001 World Health Organization. (2001). International classification of functioning, disability and health: ICF. Geneva: World Health Organization. [Google Scholar]) targeted for change in intervention research for adolescents and adults with autism spectrum disorder.

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ICF = International Classification of Functioning, Disability, and Health (World Health Organization, 2001 World Health Organization. (2001). International classification of functioning, disability and health: ICF. Geneva: World

Health Organization. [Google Scholar]); ABA = applied behavioral analysis.
[a] Categories of factors and terminology from the International Classification of Functioning, Disability, and Health (World Health Organization, 2001 World Health Organization. (2001). International classification of functioning, disability and health: ICF. Geneva: World Health Organization. [Google Scholar]).
Table 4. Functions of communication targeted in interventions for adolescents and adults with autism spectrum disorder.

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