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REVIEW PAPER

A Meta-analysis of Peer-Mediated Instructional Arrangements and Autism

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Abstract We conducted a meta-analysis of 13 instructional arrangement studies that were conducted with children with autism spectrum disorders to improve academic and social communication skills and behavior. Results across the studies indicate that peer-mediated instructional arrangement is a robust method for teaching and improving various academic and other related skills—communication and social. Peer-mediated instructional arrangement strategies also facilitated maintenance and generalization of learned skills in half of the reviewed studies. We discuss the results and make suggestions for future researchers and practitioners.

Keywords Autism · Peer-mediated instruction · Academic skills · Social skills · Meta-analysis

Introduction

Children with autism spectrum disorders (ASD) display deficits in social interaction and communication. Additionally, they may also display self-injurious, ritualistic, or compulsive behaviors (Scott et al. 2000). ASD is one of the most common diagnoses in the USA (Bhat et al. 2011). Recent estimates from the Centers for Disease Control and Prevention (CDC) show that 1 in 88 children are diagnosed with ASD; boys are almost five times more likely to be diagnosed than girls (CDC 2012). With increasing diagnoses and inclusion of children with ASD in general education classrooms, teachers need evidence-based strategies that can be implemented in inclusive settings. Teachers who are untrained in educating students with ASD in the general education classrooms may struggle meeting these needs. Teachers need to be trained in evidence-based instructional practices to better meet the needs of students with ASD.

In addition to communication, social, and behavioral difficulties, children with ASD may also display problems in academic areas. Several strategies have been recommended and utilized to teach academic skills. Examples include the early use of adult direction (Rogers 2000) and manipulating environmental contingencies through reinforcement of appropriate social behaviors (Kennedy and Shukla 1995). However, these strategies resulted in minimal success in generalization skills to other behaviors or settings (Rogers 2000).

Investigations have supported the use of alternative instructional formats for teaching typical peers to model appropriate discrimination and social behaviors for their peers with disabilities (Campbell et al. 1983). Appropriately implemented, peer-mediated instructional strategies facilitate active student engagement; frequent opportunities to respond; and provide error correction, prompting, and feedback. These methods include, but are not limited to, whole class instruction, small group instruction, one-to-one instruction, and independent work time (Friedlander 2009). Peer-mediated instruction involves training neuro-typical peer(s) to model and reinforce pre-determined academic or social behaviors (Dugan et al. 1995; Krebs et al. 2010). In a team building model, students may work together in small group teams, with each student assuming a role within the group or having responsibility for a particular portion of the assignment (Dugan et al. 1995). Similarly, students may work in cooperative learning teams to promote collaboration and social interaction among the team members (Dugan et al. 1995). Students may also work in same age or mixed age dyads for tutoring in academic and social skills (Kamps et al. 1999). In addition, these strategies encourage the integration and acceptance of children with disabilities in the general education classrooms (Beattie et al. 2006; Harper and Maheady 2007).

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Compared to traditional methods such as teacher-mediated instruction, research shows that peer-mediated instructional arrangements and peer tutoring programs increase time on academic tasks such as writing, spelling, solving mathematical equations, oral reading, and task completion (Rogers 2000). Peer-mediated instructional arrangements provide students with more opportunities to respond in which students with and without disabilities can use teacher–student discussions, worksheets, workbooks or other written tasks, computer tasks, or structured projects as contexts for enhancing academic and social skills. Although peer-mediated interventions have shown promise, maintenance and generalization issues remain in the area of social interaction (Kohler et al. 1997; Krantz 2000).

Peer-mediated method may be explained in the context of social learning theory which is one of the leading theories of learning (Bandura 1977). This theory focuses on learning that occurs within a social context, such as observational learning, imitation, or modeling, which provides the foundation for peer-mediated instructional strategies (Bandura 1977; Bhat et al. 2011).

A variety of peer-mediated strategies have been used in the past four decades to improve the social functioning of children with ASD. They include the use of selected peers to model, prompt, and reinforce appropriate social and academic behaviors. Several studies have shown that the peer-mediated instructional strategies resulted in marked improvements in the social skills of children with ASD (DiSalvo and Oswald 2002).

The purpose of this paper is to review the literature that examined peer-mediated instructional arrangements (e.g., cooperative learning, peer tutoring, peer-mediated learning, group learning, and same age peer instruction) with children with ASD in academic settings. The National Autism Center published a National Standards Report (Boucher and Wolfberg 2003; National Autism Center 2009) which synthesized a broad overview of the autism literature published prior to 2007. This report classified various behavioral and educational treatments based on empirical evidence of their effectiveness with students with ASD. However, in the area of instructional arrangements, the report only included 11 studies and classified the strategy as an emerging treatment in autism. Although the report is a major initiative in the field of autism treatments, specifics of the peer-mediated instructional arrangement were not addressed. For example, the report does not address design issues, social validity, maintenance, and generalization. The present review is important because it includes additional studies, provides the current status of research in instructional arrangement, analyzes studies on several variables, and assesses the quality of studies, whereas the previous review addressed children aged 6–9, the current review addressed children aged 5 to 17. The following research questions were answered in this study:

(a) What is the effectiveness of peer-mediated instructional arrangements with students with ASD?
(b) Are peer-mediated instructional arrangement strategies socially valid interventions?
(c) What are some methodological strengths and issues of the reviewed studies?

Method

We searched EBSCO databases, which included PsychInfo, ERIC, Social Sciences Index, and Psychological Abstracts using the following terms: *cooperative learning*, *peer tutoring*, *peer-mediated learning*, *instructional groups*, *group learning*, *reciprocal teaching*, *peer mentoring*, *peer instruction*, *instructional arrangement*, *autism*, *ASD*, *Asperger*, and *high functioning autism.* We selected studies that met the following criteria: (a) researchers used typical peers to teach, mediate, model, prompt, reinforce, and correct errors during academic activities with children with ASD; (b) investigators used a single-subject research design or group design; (c) studies included at least one child with ASD and a typical peer; (d) studies targeted academic instruction (reading, language arts, and math); (e) studies published in a peer-reviewed journal; and (f) studies were available in English. We conducted an ancestral search for additional studies under the reference section of each selected study and found none. Overall, we selected 14 studies that met the inclusion criteria. A special education faculty member examined 30 % of the selected studies to determine fidelity to the inclusion criteria and found 100 % agreement regarding the identification and presence of the inclusion criteria. We analyzed the selected studies across several variables including demographics, target skills, designs, results [effect sizes using non-overlap of all pairs (NAP)], maintenance, generalization, and social validity.

Method for Calculating Effect Sizes

We used the NAP method to calculate overall effect size (Parker and Vannest 2009). NAP is an index of data overlap between conditions in single-subject design research. It has been confirmed and field tested with 200 published AB design contrasts. NAP is an innovative application of an established effect size for single-subject design studies. Its various forms include area under the curve (AUC), the common language effect size (CL), the probability of superiority (PS), the dominance statistic (DS), Mann–Whitney's *U*, and Sommers D. NAP's main hypothetical benefit is that it is a comprehensive test of all possible sources of data overlap. All baselines are measured against all treatment data points. NAP is a probability score, generally ranging from 0.5 to 1 (Parker and Vannest 2009). NAP has been described as a strong

methodology. It discriminates better among results from a large group of published studies and produces less human errors in calculations than the other three hand-calculated indices [i.e., percent of non-overlapping data points (PND), percent of non-overlapping data (PAND), and percent of data exceeding the median (PEM)]. It was also argued that a third advantage sought from NAP was stronger validation by R2 perceived as the leading effect size in publication (Parker and Vannest 2009).

We calculated NAP between baseline and intervention conditions (AB) and then calculated the overall effect size and confidence interval. One study was excluded because the data presented in the study did not allow us to calculate the NAP (Cushing et al. 1997). A faculty member independently calculated NAP for 30 % of studies and found 100 % agreement with the NAP calculations. Tables 1 and 2 provide a detailed summary of studies with effect sizes.

Results

Participants

The 14 studies included a total of 32 participants. All 32 participants were diagnosed with ASD alone or with other disabilities (i.e., intellectual disabilities). The studies included 214 typical peers. The age range for all participants with ASD varied from 5 to 17 years with an average age of 8.7. The age range for typical peers varied from 5 to 17 years as well. However, the specific age group of typical peers could not be determined in many of the studies to compute average age. In addition, there was limited information on the severity of autism or intellectual functioning of the participants.

Settings

The researchers conducted studies in various settings. Seven studies were in the general education classrooms (Carter et al. 2005; Dugan et al. 1995; Hunt et al. 1994; Kamps et al. 1994b, 1995, 1999), and four other studies were conducted in special education classrooms (Egel et al. 1981; Grey et al. 2007; Kamps et al. 1989; Petursdottir et al. 2007). One study was conducted both in general education and special education classrooms (Kamps et al. 1999) and two other studies were conducted off-campus—one in a large conference room at the cafeteria of an institute (Chung et al. 2007) and the other in a private therapy room (Krebs et al. 2010).

Trainers

Trainers included mostly teachers: general education teachers (Kamps et al. 1989, 1994b); general education teachers and paraprofessionals (Kamps et al. 1995); special education teachers, paraprofessionals, and researchers (Carter et al. 2005; Grey et al. 2007; Kamps et al. 1999); general and special education teachers (Hunt et al. 1994); and a general education teacher and the special education paraprofessional (Dugan et al. 1995).

Instructional Arrangement

Researchers in all 13 studies used a variety of peer instructional strategies. They included modeling (Egel et al. 1981) and prompting in which peer tutors prompted, assisted, cued, and provided feedback to children with ASD (Carter et al. 2005; Chung et al. 2007; Grey et al. 2007; Hunt et al. 1994; Kamps et al. 1989, 1994b, 1999; Krebs et al. 2010; Petursdottir et al. 2007). Instructional arrangements included cooperative learning group techniques in which teachers presented material and observed the cooperative learning activities in various academic settings (Dugan et al. 1995; Kamps et al. 1995).

For example, in the study of Kamps et al. (1995), students worked in peer tutoring groups to complete structured activities such as practice with vocabulary words and comprehension questions. Students also practiced academic games involving four to five identified characters and related facts from a story. The teacher led the reading activities and presented new vocabulary, provided main ideas, and did reading and sequencing. In addition, cooperation and appropriate social interactions were promoted. The peer tutors were assigned roles such as material managers or leader to facilitate smooth transition among activities. Similarly, during the intervention in the study of Dugan et al. (1995), students were assembled in assigned groups which included an academically high functioning peer, two students functioning at a moderate level, and one peer with autism functioning at a low level. The students were presented with a 10-min whole class lecture in which they reviewed new social studies material and received information. Example of lecture consisted of showing the location of a region on the map or indicating the states that were included in that region. The next step consisted of the implementation of the cooperative learning groups. Group work included activities such as the distribution of materials tubs, keyword peer tutoring for 10 min, and fact card peer tutoring for a few minutes. Results showed that students with autism successfully mastered the content and increased peer interactions and academic engagement.

Target Behaviors

Researchers in all of the studies addressed various academic skills: reading (Kamps et al. 1989, 1994b, 1995; Petursdottir et al. 2007); word recognition (Kamps et al. 1999); object discrimination (Egel et al. 1981); social studies (Dugan et al. 1995); question generation and responses (Whalon and

Table 1 Summary of studies

Authors	Participants/age	Target behaviors	Intervention	Results (effect sizes) NAP
Carter et al. (2005)	Two children with autism and moderate intellectual disabilities aged 12 and 13 Six peers without disabilities aged 11–17	The social and academic outcomes of students with severe disabilities: listening to lectures, independent seat work, small group and large group activities	Students with disabilities were paired with two peers and peers were asked to share responsibilities (e.g., adapting activities, providing behavioral support, facilitating interactions) with the student with disabilities	Social and academic=0.58
Chung et al. (2007)	Two children with autism aged 6 years old One child with ASD aged 7 years. One child with PDD-NOS aged 7 years Four children without autism aged 8 years old	Verbal communication skill (e.g., answering and asking questions)	Orient peer prompt, encourage, and praise	Communication =0.61
Dugan et al. (1995)	Two children with autism aged 9 years old Sixteen peers without autism aged 9 years old	Social studies (e.g., show locations, indicate states, keyword peer tutoring (c) fact card peer tutoring)	Teacher presented material and children participated in cooperative learning/group activities	Social studies=0.98
Egel (1981)	Four children with autism aged 6 years old Four peers without autism aged between 6 and 8 years old	Discrimination of objects and words (square vs. circle; on vs. under)	Children with autism observed peers and modeled correct responding	Object discrimination/ words=1
Grey et al. (2007).	Two children with ASD aged 8 years Twenty typical developing peers (age not given)	Cooperative learning (CL): explore the extent to which CL could facilitate participation in school tasks and social engagement for children with ASD	The teachers implemented CL about poetry writing to artwork aimed at student engagement in conversations or seeking/receiving/ giving help, task materials, affection or praise and task participation, either verbal or non-verbal	Cooperative learning=0.65
Hunt et al. (1994)	One child with autism and severe intellectual disabilities aged 7 Eighty-one to 96 students without disabilities (age or grade not provided)	Communication and motor skills during classroom instruction: (e.g., look at peer and smile when he or she calls name; pass an object to peer when the object is required)	Peers provided cues to students with disabilities to evoke the target communication and motor response. Also, provided the assistance and feedback when needed	Communication and motor skills=0.88
Kamps et al. (1989)	Two students with autism aged 9 and 11 years old Four peers without disabilities	Academic tasks; coin identification and value, verbal response to questions, oral reading and comprehension	Peer tutors provided one to one instruction for 20 min three times per week	Academic tasks= 0.97
Kamps et al. (1994a, b)	Three children with autism aged 8 years old Fourteen children of the same grade without disabilities	Reading skills (fluency and comprehension) and social interaction	Peers tutors worked with d participants with autism in reading, gave feedback, and provided corrections	Reading/social interaction=0.87
Kamps et al. (1999)	Five children with autism aged 9 to 11 years Seventeen peers without autism aged 6 to 9 years	Sight word recognition (providing students with words to use during tutoring)	Cross-age tutoring. The experimenter modeled and students role-played with students with autism	Sight word recognition= 0.68
Kamps et al. (1995)	Three children with autism aged 8 to 12 years old Thirty-nine peers without autism aged 8 to 10 years	Reading (vocabulary words, comprehension, and academic games)	Peer tutored on vocabulary in cooperative learning group	Reading=0.98
Krebs (2010)	Two children with ASD aged 9 years Four peers without autism aged 9 years	Maintaining attention (e.g., maintaining eye contact or directional gaze; maintaining close proximity to peer while interacting)	Perform behavior to elicit response from participants with ASD	Maintaining attention=1.00

Table 1 (continued)

Authors	Participants/age	Target behaviors	Intervention	Results (effect sizes) NAP
Petursdottir (2007)	One child with ASD aged 5 years old Three peers without autism aged 5 years old	Identifying decoding (i.e., identifying letter sounds, decoding, reading sight words, and reading sentences)	Prompt peer to identify and to decode	Identifying, decoding/ reading=0.64
Whalon and Hanline (2008)	One child with ASD aged 7 years One child with PDD aged 7 years One child with autism aged 8 years Nine peers without disabilities	Question generating and responding after listening to a story (e.g., who, where, why, when)	Prompting students with autism to ask question and answer question	Question generating/ responding=0.98

Hanline 2008); classroom tasks—poetry writing, art work, and social engagement (Grey et al. 2007); and other learning strategies (e.g., lecture, worksheet, cards, and facts) (Carter et al. 2005). In three studies, investigators focused on other skills/behaviors: social communication skills (Chung et al. 2007), communication and motor skills (Hunt et al. 1994), and decreasing problem behaviors (Krebs et al. 2010).

Effect Sizes

Overall effect size for all studies using NAP method was 0.82 with a 95 % CI [0.50, 1]. We split the data by types of teaching content (academic subjects, social communication, and behaviors). The effect size for academic subjects was 0.82 (Carter et al. 2005; Dugan et al. 1995; Egel et al. 1981; Grey et al. 2007; Kamps et al. 1989, 1994b, 1995, 1999; Petursdottir et al. 2007; Whalon and Hanline 2008) and 0.83 for social communications and behaviors (Chung et al. 2007; Hunt et al. 1994; Krebs et al. 2010). We also split the data by age groups (elementary, middle, and high school). Age range for elementary students varied from 5 to 12 years and the effect size was 0.84. Age mean for middle and high school students with ASD was 12.5, and the effect size for peer-mediated instructional arrangement was 0.82. A *t* test yielded non-significant results. There was no difference in terms of ages and no difference between teaching content and social communication/behaviors either. Peer-mediated instructional arrangement was evidenced to be effective across age groups, social and behavioral, and academic activities.

Parker and Vannest (2009) proposed tentative NAP ranges: 0–0.65=weak effects, 0.66–0.92=medium effects, and 0.93–1.0 l=large or strong effects. Transforming NAP to a zero chance level gives these corresponding ranges: weak effects, 0–0.31; medium effects, 0.32–0.84; and large or strong effects, 0.85–1.0. Thus, we interpreted the overall effect size of 0.82 as being a strong effect for peer-mediated instructional arrangements. In addition, peer-mediated instruction arrangement that addressed both the teaching of classroom content and social communication and behavior patterns had an effect size of 0.82, which we interpreted as strong effect.

Maintenance and Generalization

Maintenance and generalization were assessed in less than half of the reviewed studies. Four studies reported maintenance and generalization (Egel et al. 1981; Kamps et al. 1994a, 1999; Krebs et al. 2010) and one study assessed for generalization (Hunt et al. 1994). Only one study asserted the lack of generalization of peer tutoring interactions to other settings (Petursdottir et al. 2007).

Social Validity

Seven of 13 studies collected social validity data. For example, in the study of Kamp et al. (1994a, b), teachers were interviewed about the effectiveness of the intervention. The teachers strongly agreed that class-wide peer tutoring was easy and that students with ASD and peers benefited in social and academic skills. In another study, teachers expressed moderate to high levels of satisfaction with cooperative learning groups (Kamps et al. 1995). In the study of Dugan et al. (1995), teachers and paraprofessionals completed satisfaction surveys at the end of the study and they agreed that the groups were easy to organize and manage, and that the students benefited from the intervention. Anecdotal reports from the study of Kamps et al. (1999) supported positive social validity for the peer tutoring program at the end of the intervention. Egel and colleagues (1981) assessed social validity with teachers and found that children with autism imitated the typical peers after the study. In the study of Chung et al. (2007), parents expressed that their children enjoyed participating in the peer tutoring group. In another study (Petursdottir et al. 2007), the teaching staff completed a questionnaire on the acceptability and effectiveness of reading

Table 2 Methodological parameters

Study/author	Design	Interobserver agreement	Procedural integrity	Social validity	Maintenance	Generalization
Carter et al. (2005)	A-B-A-B and B-A-B-A designs	Y	N	N	N	N
Chung et al. (2007)	A basic comparison design	Y	Y	Y	N	N
Dugan et al. (1995)	ABAB reversal design	Y	Y	Y	N	N
Egel (1981)	Multiple baseline design across subjects	Y	N	Y	Y	Y
Grey et al. (2007).	AB multi-element design	Y	Y	N	N	N
Hunt et al. (1994)	ABAB with replication designs	Y	Y	N	N	Y
Kamps et al. (1994a, b)	Multiple baseline design across subjects with reversal	Y	N	Y	Y	Y
Kamps et al. (1989)	Multiple baseline across tasks	Y	N	N	N	N
Kamps et al. (1999)	ABAB reversal design with a multiple component	Y	N	Y	Y	Y
Kamps et al. (1995)	A reversal design	Y	N	Y	N	N
Krebs (2010)	A multiple probe across tasks	Y	N	N	Y	Y
Petursdottir (2007)	Withdrawal design with multiple baseline across subjects	Y	Y	Y	N	N
Whalon and Hanline (2008)	Single-subject multiple baseline design across participants	Y	Y	Y	N	N

activities, and results indicated that the program was acceptable, effective, and simple.

Discussion

The purpose of this study was to analyze the impact of peer-mediated instructional arrangements on the academic learning of children with ASD. Results showed that peer-mediated instructional arrangements have strong impact on students with ASD in academic content areas as well as social communication skills and reducing problem behaviors. In half of the studies, participants with ASD maintained and generalized the skills learned to new settings or behaviors. Additionally, these interventions can be successfully implemented over a comparatively short period of time (DiSalvo and Oswald 2002; Harrower and Dunlap 2001). Parents, teachers, and peers indicated positive perception of peer-mediated instruction in some of the studies. Krebs et al. (2010) reported an unexpected increase in untargeted social skills in addition to the target behaviors.

Based on the results across studies, the peer-mediated instructional arrangement strategy is a promising method for enhancing academic and social skills in children with ASD. There may be several possible reasons for the success of this intervention. This method is based on peer modeling, praising, and providing feedback, which are fundamental principles of best practices in teaching and can increase skill acquisition in children with autism (Carr and Darcy 1990). In many of the studies reviewed, an important component of the intervention was positioning the peer model in close proximity to the target student so as to increase his/her attention to the presented model. It appears based on some studies that children with ASD learn better from peers than they do from adult instructors.

Social learning theory, as explained by Bandura (1977), supports the effectiveness of peer-mediated instructional arrangements that involve the use of observational learning, imitation, or modeling. Specifically, the benefits of peer-mediated instructional arrangements and motivation in classrooms have been empirically demonstrated through several studies (Kim and Baylor 2006). This implies that classroom arrangements that favor peer interaction for learning, particularly peer-mediated instructional arrangements, should be considered when designing courses for children with ASD.

Several studies used single-subject designs and assessed maintenance and generalization. Most of the studies used multiple baseline designs, multiple probe design, or multiple baseline design with a reversal component. This indicates that a majority of studies used sound experimental designs to determine the impact of instructional arrangements. Future studies should continue to assess social validity, maintenance, and generalization. Additional suggestions for future research include exploring peer-mediated instructional arrangements for children with disabilities across ages and disability categories.

Limitations

Some limitations of the study should be noted. First, we did not include unpublished studies, studies available in other languages, and/or unpublished dissertations indicating a publication bias, which may have overestimated effect sizes for the academic content areas and social communication and

behaviors. Second, some studies did not provide a clear graphic analysis of results limiting the calculation of effect sizes for some variables. In several studies, test scores or cognitive functions of the participants were not provided. Thus, no effect sizes were computed across severities.

Implications for Practice

Peer-mediated instruction is a flexible and effective approach that provides peer support and modeling of social and academic behaviors. As with any teaching strategy, peer-mediated instruction should be designed to easily fit into the instructional day and should enhance learning opportunities for both students with autism and their typically developing peers (Kamps et al. 1994b). Peer groupings and dyad pairings should be well planned, with students receiving clear instructions about expectations and the work to be accomplished. Students may work in small groups or dyads to accomplish class assignments and projects or to practice new skills (Kamps et al. 1995; Krebs et al. 2010). Group work may use any number of structured formats, including working as competitive teams, group investigation, structured group tutoring, etc. (Kamps et al. 1995). Chung et al. (2007) emphasize the need to consider the individual academic, social, behavioral, and learning style needs of students who are participating in peer training settings.

Some other suggestions for practitioners that emerged from this review are the following: (a) providing training of typical peers prior to the initiation of peer tutoring, (b) utilizing no more than two to three tutoring behaviors, (c) considering the tutor's capability to model the skill accurately, and (d) ensuring that the learning tasks are developmentally appropriate for the students. In addition, an effective student tutor should display good interaction levels with other learners in class. Chung et al. (2007) suggested that peer tutors should possess the ability to attend and listen to others, engage in turn-taking, and maintaining appropriate voice level. If typical peers are trained prior to the implementation of the intervention, they are more likely to successfully present the learning content to their classmates. In addition, consistent teacher feedback and reinforcement are recommended during the intervention process. Thus, general education teachers should carefully select typical peers and train peers to present the content, model, and provide consistent feedback in general education settings. Teachers also are encouraged to promote social communication activities in groups that include students with and without ASD.

Conclusions

This review shows that peer-mediated instructional arrangements may be viable methods for teaching and improving academic and social skills. Peer-mediated instructional arrangement strategies facilitated maintenance and generalization of learned skills in several of the participants. Additional research is needed to determine the impact of peer-mediated instructional arrangements across age groups (including adults), disability categories, and severities.

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