

A Meta-Analysis of Video Modeling and Video Self-Modeling Interventions for Children and Adolescents With Autism Spectrum Disorders

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ABSTRACT: *This meta-analysis examined the effectiveness of video modeling and video self-modeling (VSM) interventions for children and adolescents with autism spectrum disorders (ASD). Twenty-three single-subject design studies were included in the meta-analysis. Intervention, maintenance, and generalization effects were measured by computing the percentage of nonoverlapping data points (PND). Results suggest that video modeling and VSM are effective intervention strategies for addressing social-communication skills, functional skills, and behavioral functioning in children and adolescents with ASD. Results also indicate that these procedures promote skill acquisition and that skills acquired via video modeling and VSM are maintained over time and transferred across persons and settings. The results suggest that video modeling and VSM intervention strategies meet criteria for designation as an evidence-based practice.*

Autism spectrum disorder (ASD; including autism, Asperger's syndrome, and pervasive developmental disorder-not otherwise specified [PDD-NOS]) is a complex disability that challenges the capacities of families, organizations, public policy, and communities to deliver effective educational and therapeutic programming.

The drive for effective programming and the elusive quest for a "cure" have created great controversy in the field of autism and have provided an environment that is fertile ground for untested, ineffectual, and sometimes harmful intervention strategies (Heflin & Simpson, 1998; Simpson, 2005). In some instances, this debate has led to acrimonious court cases and due process hearings requiring judges and due process hearing officers

to decide the appropriateness of instructional strategies and to discern between untested and evidence-based practices (Yell & Drasgow, 2000). Over the past 5 years, various researchers, professional committees, and expert groups have sought to identify evidence-based practices for individuals with ASD (National Research Council, 2001; Simpson) and to develop criteria for identifying a practice as "evidence-based" (Horner et al., 2005; Odom et al., 2005; Simpson). The result is a collection of recommended practices for individuals with ASD that include intervention strategies with varying evidence of efficacy (Simpson).

DEFINING EVIDENCE-BASED PRACTICES

As part of their work with the Quality Indicator Task Force sponsored by the Council for Exceptional Children Division for Research, Horner et al. (2005) outlined criteria for evaluating single-subject research and standards for identifying evidence-based intervention strategies. The panel suggests that single-subject research plays an important role in identifying evidence-based practices because of the nature of the studies (i.e., intervention based) and the documentation of experimenter control. This is particularly important in determining the efficacy of intervention modalities for individuals with ASD because a large quantity of published studies utilize single-subject designs. Horner et al. state that "single-subject research documents a practice as evidence-based when: (a) the practice is operationally defined; (b) the context in which the practice is to be used is defined; (c) the practice is implemented with fidelity; (d) results document the practice to be functionally related to change in dependent measures; and (e) the experimenter effects are replicated across a sufficient number of studies, researchers, and participants to allow confidence in the findings" (pp. 176-177). Horner et al. recommend that the efficacy of the strategy be documented by at least five published studies in peer-reviewed journals. Horner et al. further assert that efficacy studies be conducted by at least three different researchers across three different geographical locations, and that the combined

studies include at least 20 total participants before a practice should be deemed "evidence-based."

The panel recommends that studies must demonstrate experimental control through the use of multiple baseline, reversal, or alternating treatment designs. According to the panel, experimental control can be documented in multiple baseline designs by the "staggered introduction of the independent variable at different points in time" (Horner et al., 2005, p. 168). More specifically, experimental control is demonstrated when the independent variable is introduced or removed at three points in time or across three or more data series (across three participants, across three settings, etc.).

A final quality indicator of single-subject design research is the social validity of the intervention and of the dependent variables (Horner et al., 2005). Social validity refers to the social importance and acceptability of the intervention from the perspective of the consumer of services (Schwartz & Baer, 1991). It has a direct impact on intervention fidelity and is important to the development of new or existing practices, and as such should be measured routinely in single-subject research.

VIDEO MODELING AND VIDEO SELF-MODELING

The concept of modeling, or observational learning, as an intervention technique was introduced 40 years ago by Albert Bandura as part of his seminal work on social learning theory. Over the course of his career, Bandura (1977, 1997) demonstrated that modeling has a profound impact on the development of children. In particular, Bandura (1977) showed that children acquire a vast array of skills by observing other people perform the skills, rather than just through personal experience. Bandura also found that observers will imitate behaviors with or without the presence of reinforcement, and will perform the behavior in settings other than the setting where it was originally observed. Attention and motivation are essential to observational learning. If a child does not attend to a model, she will not be able to imitate the model's behavior. According to Bandura, children are most likely to attend to a

model that they perceive as competent, and who is similar to themselves in some way (physical characteristics, age, group affiliation, ethnicity, etc.).

Self-efficacy is another important feature of Bandura's social learning theory. Bandura (1994) defined self-efficacy as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave" (p. 2). According to Bandura (1997), individuals can acquire self-efficacy through external support and encouragement and, in particular, through the observation of their own success. Over the past 2 decades, the technique of modeling has been further explored and implemented using video technology, which provides a vehicle for self-modeling.

Video modeling is a technique that involves demonstration of desired behaviors through video representation of the behavior. A video modeling intervention typically involves an individual watching a video demonstration and then imitating the behavior of the model. Video modeling can be used with peers, siblings, adults, or self as a model (video self-modeling). Video self-modeling (VSM) is a specific application of video modeling that allows the individual to imitate targeted behaviors by observing her or himself successfully performing a behavior (Dowrick, 1999). VSM would seemingly address Bandura's belief that children are most likely to attend to a model similar to themselves in some way. Further, watching predominantly positive and/or successful behaviors of self, as opposed to negative and/or unsuccessful behaviors, is essential to effective modeling as it increases both attention and motivation to attend to the modeled behaviors (Dowrick) and self-efficacy (Bandura, 1997). Video modeling and VSM have been used across multiple disciplines and populations to reach a wide variety of skills including motor behaviors, social skills, communication, self-monitoring, functional skills, vocational skills, athletic performance, and emotional regulation (Dowrick; Dowrick & Raeburn, 1995; Hitchcock, Dowrick, & Prater, 2003; Kehle, Clark, Jenson, & Wampold, 1986; Starek & McCullagh, 1999). In all, over 200 applica-

tions of video modeling have been reported in print (Dowrick; Hitchcock et al.).

Though often excluded from published recommendations of evidence-based practices for individuals with ASD (National Research Council, 2001; Simpson, 2005), an emerging body of research demonstrates great promise for the use of video modeling (peer, adult, or self as model) as an effective intervention modality for individuals with ASD. Video modeling and VSM integrate a powerful learning modality for children with ASD (visually cued instruction) with a frequently studied intervention strategy (modeling). In addition, research has supported the notion that skills learned via video modeling and VSM generalize across different settings and conditions and that the positive gains made during the video modeling intervention are maintained for months following the conclusion of the intervention (Dowrick, 1999). This is particularly important for children with ASD who have considerable difficulties transferring skills from one setting to another.

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A recent review of the literature by Ayres and Langone (2005) demonstrates the benefits of video instruction, including video modeling, for children and adolescents with ASD. The researchers provide a thorough qualitative review of studies that used video as an instructional modality. Though not focusing specifically on modeling, the review does include 14 studies that utilized video modeling and VSM (1 study utilized video priming without models). A limitation of the literature review was the lack of a quantitative metric to evaluate treatment effectiveness. As such, the researchers relied on the conclusions drawn by the studies' authors to determine treatment effectiveness. Also, the previous study did

not attempt to determine whether video instructional strategies met criteria for evidence-based practices. In addition, qualitative reviews of the literature do not allow researchers to make relative comparisons of treatment effectiveness across different intervention strategies. Therefore, it is difficult to determine how the effectiveness of video modeling and VSM compare to other educational and clinical practices. A quantitative synthesis of studies utilizing video modeling and VSM would add a substantial amount of information to our existing knowledge regarding the effectiveness of these procedures.

PURPOSE OF THE STUDY

The purpose of this study was to provide a synthesis of existing research studies on video modeling interventions for children and adolescents with ASD and to examine the outcomes of these studies. The meta-analysis examined intervention, maintenance, and generalization effects of video modeling and VSM interventions across three categories of dependent variables: (a) social-communication skills, (b) functional skills, and (c) behavioral functioning. A final purpose of the study was to determine whether video modeling interventions meet the criteria for evidence-based practices as outlined in Horner et al. (2005).

METHOD

LOCATING STUDIES

Studies included in the meta-analysis were located by conducting a search of journal articles published from 1980 to 2005 utilizing the Educational Resources Information Center (ERIC) and PsycINFO databases using a combination of the following descriptors: autism, autism spectrum disorder, ASD, pervasive developmental disorders, PDD, Asperger's, Asperger's syndrome, video modeling, videotape modeling, video self-modeling, videotape self-modeling, VSM, self-modeling, video technology, and video feedforward. We conducted an ancestral search of studies using the reference lists of each study located via ERIC and PsychINFO, in addition to the Ayres and Langone (2005) review, in an effort to locate addi-

tional studies that were not captured by the initial database search, and also performed manual searches of the journals *Focus on Autism*, *Journal of Autism and Developmental Disorders*, and *Exceptional Children*. The abstract or Method section of each article was examined to determine whether the article met inclusion criteria. Of all, 29 studies were located that examined video modeling or video self-modeling in school-aged children and adolescents with ASD between the ages of 3 to 21.

Each study was reviewed by the two authors to determine inclusion eligibility based on eight criteria.

1. Participants must have been identified as having an ASD. Three studies included a combination of participants with ASD and other developmental disabilities (e.g., Mechling, Pridgen, & Cronin, 2005; Norman, Collins, & Schuster, 2001; Thiemann & Goldstein, 2001). In these cases, data were analyzed only for participants with ASD.
2. The study must have utilized outcome measures that targeted behavioral functioning, social-communication skills, or functional skills. Studies examining academic outcomes were excluded (e.g., Kinney, Vedora, & Stromer, 2003).
3. The study must have assessed the efficacy of video modeling or VSM interventions alone, or in combination with other intervention strategies, such as reinforcement or self-monitoring. Interventions that did not depict a video representation of "self" or "other" as a model were excluded (i.e., studies involving visual priming, visual cueing, or in-vivo modeling).
4. The study must have utilized a single-subject research design that demonstrates experimental control, such as multiple-baseline, reversal, or alternating treatment designs.
5. Studies that included dichotomous dependent variables (e.g., yes/no, correct/incorrect) with fewer than three probes or questions per data point were excluded from the analysis because they could not be logically and/or intuitively interpreted by the metric employed in the meta-analysis (i.e., percentage of nonoverlapping data points). In two cases, this resulted in

the exclusion of an entire study (e.g., Charlop-Christy & Daneshvar, 2003; LeBlanc et al., 2003). In other cases it resulted in the exclusion of a single participant or dependent variable (e.g., Charlop-Christy, Le, & Freeman, 2000).

6. The study must have presented data in graphical displays that depicted individual data points rather than aggregated data (such as bar charts), as these graphical displays were critical to the determination of intervention effectiveness (see Analysis subsection). This criterion led to the exclusion of one study from the percentage of non-overlapping data points (PND) analysis (e.g., Biederman, Stepaniuk, Davey, Raven, & Ahn, 1999).
7. Based on recommendations provided by Horner and colleagues for determining evidence-based practices (2005), the meta-analysis included only studies published in peer-reviewed journals.
8. Only studies published in English were included in this review, resulting in the exclusion of two studies published in Japanese (e.g., Inoue, Iizuka, & Kobayashi, 1994; Inoue & Kobayashi, 1992).

Twenty-three studies met all these criteria and were included in the quantitative analysis. Six additional studies that examined video modeling or VSM with children with ASD but did not meet inclusion criteria were excluded from the quantitative analysis. A narrative summary of four of these studies is included in the results section (the two studies published in Japanese were not included in the qualitative analysis).

CLASSIFICATION

We analyzed the 23 studies using a coding system adapted from Mastropieri & Scruggs (1985–1986) and modified based on the criteria outlined by Horner et al. (2005). Each study was analyzed across the following categories: (a) participant characteristics, including number of participants, diagnosis, and age; (b) intervention description, including setting, number of treatment sessions, and length of video clips; (c) description of independent variable(s); (d) research design; (e) description of the targeted skills and dependent

variables; (f) intervention effectiveness, including intervention, maintenance, and generalization effects as measured by PND; (g) confirmation of experimental control through the introduction or withdrawal of the independent variable across three points in time; (h) for video modeling only, type of model (peer or adult); (i) for VSM only, method of recording (scripted or naturalistic); (j) confirmation of whether the study measured interobserver reliability, intervention fidelity, and social validity; and (k) authors, including geographical location of first author (name of state or foreign country).

To establish interrater reliability for the coding procedure and the PND analysis, the two authors independently coded each study and compared results. Interrater agreement was obtained by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100. Interrater agreement for study features was 98% (range 96%–100%). Given the fact that PND calculations are more complex than the recording of study features, a separate procedure was employed for ensuring the accuracy of PND calculations. Both authors initially computed PND scores for 10 studies and then compared their calculations. For these first 10 studies, interrater agreement was 70%. Discrepancies were resolved through discussion and further inspection of the graphed data points. PND scores were independently recalculated by the two reviewers, resulting in an interobserver agreement of 100%. PND was then independently calculated for the remaining 13 studies and, again, interrater agreement was 100%. In addition, one independent reviewer (a graduate student trained in the coding system and PND calculations) coded 13 randomly selected studies using the same procedures. The mean interrater agreement between the independent reviewer and the authors was 100% for both study features and PND calculations.

ANALYSIS

PND provides a measure of intervention effectiveness and a method for systematically synthesizing single-subject research studies (Mastropieri & Scruggs, 1985–1986). It is determined by calculating the percentage of intervention data

points that do not overlap with the highest baseline data point. Scruggs and Mastropieri (2001) argue that the use of PND is preferable to the use of a conventional effect size (ES) in synthesizing single-subject research for two primary reasons. First, ES computations are derived theoretically from procedures used in inferential statistics. This is problematic because the data derived from single-subject research is nonindependent, thereby violating a primary assumption of inferential statistics, independence. Second, many single-subject studies include relatively few data points which may inflate the ES, thus making interpretations difficult at best. Scruggs and Mastropieri (1998) suggest that PND scores above 90 represent very effective intervention scores; scores from 70 to 90 represent effective interventions; scores from 50 to 70 are questionable; and scores below 50 are ineffective. Scruggs, Mastropieri, and Casto (1987) provide a comprehensive discussion of procedures for calculating and interpreting PND scores.

PND scores were calculated for each participant and across all dependent variables measured in each of the 23 studies. PND scores were calculated for intervention effects, maintenance effects, and generalization effects. Maintenance effects were measured by calculating PND between baseline and the maintenance or reversal phase. Generalization effects were calculated for studies that measured intervention effectiveness across persons, settings, or skills/behaviors that were either not displayed on the video or were not the primary target of the intervention. Mean PND scores (M PND) were calculated for each study and aggregated for the entire data set. Separate M PND scores are reported for the subset of video modeling studies and the subset of VSM studies. Mean PND scores are reported across the three categories of dependent variables included in the analysis: (a) behavioral functioning, (b) social-communication skills, and (c) functional skills. Behavioral functioning included studies addressing a reduction in problem behaviors and off-task/on-task behaviors. Social-communication skills included (a) conversational skills, (b) play skills, (c) social initiations, and (d) social responses. Functional skills included (a) purchasing behaviors, (b) hygiene, and (c) other self-help skills. Four studies (Buggey, 2005; Charlop-

Christy et al., 2000; Hagiwara & Myles, 1999; Haring, Kennedy, Adams, & Pitts-Conway, 1987) measured more than one of these categories of dependent variables. In these cases, M PND scores were calculated for the overall study and for each of the outcome variables.

Given the nonparametric nature of PND, we used the Kruskal-Wallis procedure to test for significant differences in PND between intervention procedures (video modeling vs. VSM), across dependent variables (social-communication skills, functional skills, and behavioral functioning), across age groups (6 and younger, 7–12, and 13 and older), and between studies that documented both intervention fidelity and experimental control and those studies that did not document these features. The Kruskal-Wallis procedure is a nonparametric test that allows for the comparison of multiple independent samples (Hinkle, Wiersma, & Jurs, 1994). Statistical significance was established at the .05 level.

RESULTS

OVERALL STUDY CHARACTERISTICS

Twenty-three studies published between 1987 and 2005 were included in the meta-analysis. A total of 73 participants were included in these studies. Studies were conducted by 20 primary researchers across 13 states and 4 countries. The participants' ages ranged from 3 to 20. Twenty-two studies utilized a variation of a multiple baseline or probe design and 1 study utilized a reversal design. Of the 22 studies using a multiple baseline or probe design, 16 used a multiple baseline only design, 3 studies used a multiple baseline and changing conditions design, 2 used a multiple baseline and alternating treatment design, and 1 study used a multiple baseline and reversal design. Interventions were conducted in school, home, clinical, and community settings, with school being the most common setting ($n = 14$). Interobserver reliability was reported in 22 studies. Nine studies measured intervention fidelity and only 4 studies measured social validity. Twenty-two studies demonstrated experimental control through the introduction or removal of the independent variable across three or more points in time. Intervention sessions ranged in

length from 4 to 33 sessions ($Mdn = 9.5$ sessions). Duration of video clips ranged from 30 s to 13.5 min ($Mdn = 3$ min).

INTERVENTION, MAINTENANCE, AND GENERALIZATION EFFECTS

Tables 1 and 2 present an overview of the 23 studies included in the quantitative synthesis. Based on the recommendations of Scruggs and Mastropieri (1998) for interpreting the magnitude of PND scores, the results indicate that video modeling and VSM interventions are effective strategies for targeting social-communication skills, functional skills, and behavioral functioning. Results indicate a moderate intervention effect for the studies included in the meta-analysis ($n = 22$, $M PND = 80\%$, range 29–100). One study (Charlop & Milstein, 1989) did not report individual data points for the intervention phase of the study; therefore, intervention PND was not calculated for this study. Results also indicate moderate effects for both maintenance and generalization. Eighteen studies measured maintenance effects ($M PND = 83\%$, range 35–100), and 7 studies collected and graphed data on generalization effects ($M PND = 74\%$, range 22–100). The Kruskal-Wallis procedure was performed to test for significant differences across age groups (6 and younger, 7–12, and 13 and older). None of the differences reached the .05 level of significance.

DIFFERENCES ACROSS DEPENDENT VARIABLES

PND scores were calculated across three categories of dependent variables: (a) social-communication skills, (b) functional skills, and (c) behavioral functioning. Sixteen studies targeted social-communication functioning, 8 targeted functional skills, and 3 targeted behavioral functioning. The highest intervention effects were found for functional skills ($n = 8$, $M PND = 89\%$, range 43–100); followed by social-communication functioning ($n = 15$, $M PND = 77\%$, range 29–98); and then behavioral functioning ($n = 3$, $M PND = 76\%$, range 42–95). Maintenance effects were also moderate to high across the three outcome variables with the highest

PND observed for functional skills ($n = 6$, $M PND = 100\%$); followed by behavioral functioning ($n = 2$, $M PND = 82\%$, range 63–100); and then social-communication ($n = 12$, $M PND = 78\%$, range 35–100). Generalization effects were moderate for the outcome variable of social-communication skills ($n = 6$, $M PND = 70\%$, range 22–100) and high for the outcome variable of functional skills ($n = 2$, $M PND = 97\%$, range 94–100). No studies measured generalization effects for the outcome variable of behavioral functioning. The Kruskal-Wallis procedure revealed no statistically significant differences across dependent variables. However, all comparisons across outcome variables should be interpreted with caution given the small subsamples and, thus, their vulnerability to extreme scores.

DIFFERENCES BETWEEN VIDEO MODELING AND VSM

Fifteen studies examined video modeling interventions and 7 studies examined VSM. One study (Sherer et al., 2001) examined both video modeling and VSM. In this case, PND was calculated for the entire study and for both the video modeling interventions and the VSM interventions. Moderate intervention effects were found for both video modeling ($n = 15$, $M PND = 81\%$, range 29–100) and VSM ($n = 8$, $M PND = 77\%$, range 43–96). Similarly, moderate maintenance effects were observed for video modeling ($n = 12$, $M PND = 88\%$, range 50–100) and VSM ($n = 7$, $M PND = 71\%$, range 35–100). Moderate generalization effects were found for video modeling ($n = 5$, $M PND = 82\%$, range 22–100) and low generalization effects were found for VSM ($n = 3$, $M PND = 65\%$, range 25–94). The Kruskal-Wallis procedure revealed no statistically significant differences in the intervention, maintenance, and generalization effects between video modeling and VSM. A comparison of the generalization effects between video modeling and VSM should be made with caution given the small number of studies that collected and graphed generalization data.

TABLE 1
Video Modeling Interventions

<i>Study</i>	<i>Participants With ASD</i>	<i>Setting</i>	<i>Type of Model</i>	<i>Targeted Skills</i>	<i>Dependent Variable</i>	<i>Intervention PND</i>	<i>Maintenance PND</i>	<i>Generalization PND</i>
*Alcantara (1994)	3 children ages 8-9	School and Community	Adult	Functional skills: purchasing behaviors	Number of correct steps in purchasing tasks	99%	100%	N/A
*Apple, Billingsley, & Schwartz (2005)	5 children ages 4-5	School	Peer and adult	Social-communication skills: compliments and social initiations	Number of compliments	71%	58%	N/A
Charlop & Milstein (1989)	3 children ages 6-7	Home and Clinical	Adult	Social-communication skills: conversational skills	Number of correct conversational responses and questions	N/A	100%	87%
*Charlop-Christy, Le, & Freedman (2000)	5 children ages 7-11	Clinical	Adult	Functional skills: brushing teeth and washing face Social-communication skills: conversational speech, spontaneous greetings, and play behavior	Number of correct responses in task; percentage of correct intervals of play behavior and expressive labeling	Overall study: 82% Social-communication skills: 73% Functional skills: 100%	N/A	Overall study: 100% Social-communication skills: 100% Functional skills: 100%
D'Areno, Mangiapanello, & Taylor (2003)	1 child age 3	School	Adult	Social-communication skills: play behavior	Number of motor responses and verbal statements	92%	N/A	22%

continues

TABLE 1 (Continued)

Study	Participants With ASD	Setting	Type of Model	Targeted Skills	Dependent Variable	Intervention PND	Maintenance PND	Generalization PND
Haring, Kennedy, Adams, & Pitts-Conway (1987)	3 adolescents ages 20	School and community	Peer	Functional skills: purchasing behaviors Social-communication skills: social responses	Percentage of correct operational and social responses in purchasing task	Overall study: 97% Social-communication skills: 94%	Overall study: 100% Social-communication skills: 100%	N/A
MacDonald, Clark, Garrigan, & Vangala (2005)	2 children ages 4 and 7	School	Adult	Social-communication skills: scripted verbalizations and play behavior	Number of scripted verbalizations and play actions	98%	Functional skills: 100% 100%	N/A
*Mechling, Pridgen, & Cronin (2005)	1 adolescent age 17	School and community	Adult	Functional skills: purchasing behavior	Percentage of correct verbal and motor responses in purchasing task	100%	100%	N/A
Nikopoulos & Keenan (2003)	7 children ages 9-15	School	Peer and adult	Social-communication skills: social initiations and play behavior	Latency to social initiations and duration of appropriate play	29%	80%	100%
Nikopoulos & Keenan (2004)	3 children ages 7-9	Clinical	Peer	Social-communication skills: social initiations and reciprocal play	Latency to social initiations and mean time engaged in reciprocal play	71%	100%	N/A

continued

TABLE 1 (Continued)

Study	Participants With ASD	Setting	Type of Model	Targeted Skills	Dependent Variable	Intervention PND	Maintenance PND	Generalization PND
*Norman, Collins, & Schuster (2001)	1 child age 12	School	First-person	Functional skills: cleaning glasses and using zipper	Percentage of correct steps in task	74%	100%	N/A
Ogletree & Fischer (1995)	1 child age 5	Clinical	Animated	Social communication skills: gaze, verbal responding, and topic maintenance	Percentage of appropriate behavior	59%	67%	N/A
Sherer et al. (2001)	5 children ages 4-11	Home and clinical	Peer	Social communication skills: conversation skills	Percentage of correct engagement in conversation	Overall study: 78% Video modeling: 76%	Overall study: 54% Video modeling: 50% 100%	Overall study: 88% Video modeling: 100% N/A
Shipley-Benamou, Lutzker, & Taubman (2002)	3 children ages 5	Clinical	First-person	Functional skills: mailing a letter, setting a table, pet care, and squeezing orange juice	Percentage of correct steps in task	92%	N/A	N/A
*Simpson, Langone, & Ayres (2004)	4 children ages 5-6	School	Peer	Social communication skills: sharing with others, complying with teacher directions, and social greetings	Number of unprompted social behaviors	97%	N/A	N/A
Taylor, Levin, & Jasper (1999)	2 children ages 6 and 9	Home	Sibling and Adult	Social communication skills: play-related statements	Percentage of correct scripted and unscripted statements	84%	N/A	N/A

Note. * = Studies that measured intervention fidelity and demonstrated experimental control.

TABLE 2
Video Self-Modeling (VSM) Interventions

Study	Participants With ASD	Setting	Type of Recording	Targeted Skills	Dependent Variable	Intervention PND	Maintenance PND	Generalization PND
Buggey (2005)	5 children ages 5-11	School	Scripted and naturalistic	Social-communication skills: social initiations, and responses to questions Behavioral functioning: pushing and tantrums	Number of social responses to behaviors; duration of tantrums	Overall study: 87% Social-communication skills: 84% Behavior: 91%	Overall study: 100% Social-communication skills: 100% Behavior: 100%	N/A
Buggey, Toombs, Gardner, & Cervetti (1999)	3 children ages 7-12	Home	Naturalistic	Social-communication skills: verbal responses	Percentage of appropriate verbal responses	75%	44%	N/A
*Coyle & Cole (2004)	3 children ages 9-11	School	Naturalistic	Behavioral functioning: off-task behavior	Duration of off-task behavior	95%	63%	N/A
Hagiwara & Myles (1999)	3 children ages 7-9	School	N/A	Functional skills: washing hands Behavioral functioning: on-task behavior	Percentage of completion: duration of on-task behavior	Overall study: 43% Functional skills: 43% Behavior: 42%	N/A	N/A

continues

TABLE 2 (Continued)

Study	Participants With ASD	Setting	Type of Recording	Targeted Skills	Dependent Variable	Intervention PND	Maintenance PND	Generalization PND
Lasater & Brady (1995)	2 adolescents ages 14-15	Home	Naturalistic	Functional skills: shaving, making a sandwich, hanging clothing, and making bed	Fluency of task completion	95%	100%	94%
Sherer et al. (2001)	5 children ages 4-11	Home and clinical	Scripted	Social-communication skills: conversation skills	Percentage of correct engagement in conversation	Overall study: 78% VSM: 79%	Overall study: 54% VSM: 58%	Overall study: 88% VSM: 75%
*Thiemann & Goldstein (2001)	4 children ages 6-12	School	Naturalistic	Social-communication skills: initiating comments and requests, securing attention, and contingent responses	Number of target behaviors	48%	35%	25%
*Wert & Neisworth (2003)	4 children ages 3-6	School and home	Naturalistic	Social-communication skills: spontaneous requesting	Number of spontaneous requests	96%	100%	N/A

Note. * = Studies that measured intervention fidelity and demonstrated experimental control.

OUTCOMES OF STUDIES THAT MEASURED INTERVENTION FIDELITY AND DEMONSTRATED EXPERIMENTAL CONTROL

Nine studies measured intervention fidelity and also demonstrated the adequate experimental control recommended by Horner et al. (2005); these studies are noted in Tables 1 and 2. Eight of the 9 studies measured intervention effects (M PND = 85%, range 48–100). Seven of these studies measured maintenance effects (M PND = 79%, range 35–100) and 2 studies collected and graphed data on generalization effects (M PND = 63%, range 25–100). The Kruskal-Wallis procedure did not reveal statistically significant differences between the outcomes of these 9 studies and the outcomes of the other 14 studies included in the meta-analysis (i.e., studies that did not measure intervention fidelity and demonstrate experimental control).

STUDIES TARGETING SOCIAL-COMMUNICATION SKILLS

Social Skills and Play Behavior. A number of studies examined the efficacy of video modeling and VSM interventions in teaching social skills and play behaviors to children and adolescents with ASD. Wert and Neisworth (2003) examined the effectiveness of VSM in teaching young children with ASD to make spontaneous verbal requests in school settings. During structured play sessions with peers, the children were prompted to make requests for play items. The video was then edited to remove all adult prompts so that when the children watched the video, they observed themselves responding spontaneously and independently. The VSM intervention led to substantial increases in spontaneous verbal requests in all 4 children participating in the study and gains were maintained at intervention levels throughout the follow-up phase. Only 1 child failed to show immediate gains in requesting behaviors after the introduction of the intervention, though he did eventually make gains commensurate to the other participants. The researchers noted that this child showed no interest in watching the video or seeing himself in the video. Buggey, Toombs, Gardener, and Cervetti (1999) examined the effects of VSM on the acquisition

and maintenance of play-related verbal responses in school-aged children with ASD. The researchers recorded the children answering questions while engaged in play behaviors. The child then watched the videos, which depicted successful verbal responding and included intermittent verbal praise. Similar to the Buggey (2005) study, the videos included an audio introduction of what behaviors the child would see on the video. Participants showed a marked increase in verbal responses after the introduction of the VSM intervention. All 3 participants nearly doubled their rates of appropriate responding to questions during play situations; however, minimal maintenance effects were observed.

Nikopoulos and Keenan (2003, 2004) conducted two separate experiments that examined the effects of video modeling on the social initiations and reciprocal play behaviors of children with ASD. The later study (2004) demonstrated a marked increase in initiation skills and reciprocal play behaviors for all 3 participants following the peer modeling intervention, and skills were maintained at 1- and 3-month follow-up. The researchers concluded that the video viewing may have increased the reinforcing properties of the toys featured on the video. The earlier study (2003) led to substantial increases in social initiation and appropriate play behavior in 4 out of 7 participants; the 3 remaining participants showed no increases. PND calculations reveal high maintenance and generalization effects for this study; however, these scores are inflated by the fact that the researchers only measured maintenance and generalization effects for the 4 participants who showed gains during the intervention phase. The researchers concluded that 2 of the children engaged in disruptive behaviors that did not allow them to adequately attend to the video. They also noted that the failure of 3 children to initiate a social interaction may be attributed to the fact that none of these children knew how to play with the play items featured in the video. Finally, it is noteworthy that Nikopoulos and Keenan (2003) implemented a video self-modeling procedure for 1 participant after the child did not respond to the video modeling intervention. The addition of the VSM phase for this participant was ineffectual.

Three studies examined the benefits of video modeling in teaching play behaviors to children with ASD. D'Ateno, Mangiapanello, and Taylor (2003) examined the effects of a video modeling intervention in teaching play behaviors to a preschool child with autism. The child viewed a video depicting an adult model playing alone with a toy. The adult model spoke to the play item (e.g., a doll) and manipulated it according to a script. Children were then required to play with the same play item featured in the video. Video modeling led to rapid acquisition of both scripted verbal statements and modeled motor responses for all play sequences. However, results indicated that gains were not generalized across verbal responses and motor behaviors that were not featured on the video (i.e., novel responses). The researchers attributed this to the fact that the study included only one video exemplar. They suggested that the use of multiple video vignettes may have produced greater generalization effects across behaviors. MacDonald, Clark, Garrigan, and Vangala (2005) extended the work of D'Ateno et al. by teaching children to engage in longer play sequences involving pretend play. Participants watched adult models act out scripted sequences of pretend play. The procedure led to rapid acquisition of both scripted verbal statements and scripted motor actions for all play sequences. However, similar to the results of D'Ateno et al., the intervention did not lead to an emergence of unscripted play behaviors. Similarly, Taylor, Levin, and Jasper (1999) examined the effects of video modeling in increasing play-related statements in children with ASD. Participants watched videos depicting scripted and unscripted dialogue between sibling and adult models. Participants were then provided with the same play stimuli featured in the video. The intervention led to increases in scripted comments for both children. However, only 1 of the 2 children exhibited an increase in unscripted comments.

The use of video modeling and VSM in combination with other strategies (i.e., as part of an intervention package) yielded conflicting results on the outcome variable of social-communication skills. Apple, Billingsley, and Schwartz (2005) conducted two experiments that focused on teaching compliment-giving responses and initiations via video modeling. In the first experi-

ment, video modeling was used alone and in combination with reinforcement for performance of the target behavior. Videos featured adult models demonstrating compliment-giving initiations and responses in addition to providing explicit instructional rules for when and how to provide compliments. The second experiment examined the effectiveness of video modeling in combination with a self-management strategy in increasing compliment-giving behaviors. Video modeling alone led to an increase in compliment-giving responses, but not initiations. Compliment-giving initiations increased only after the addition of tangible reinforcement. When the video modeling and reinforcement was withdrawn, initiations decreased to baseline levels while responses maintained intervention levels. The second study demonstrated that the inclusion of a self-management strategy increased compliment-giving initiations, and levels were maintained after the video was withdrawn. Simpson, Langone, and Ayres (2004) examined the effectiveness of video modeling in combination with a computer-based instructional package to teach social skills to 4 students with ASD. The computer-based program presented picture cards and information (e.g., a declarative statement and definition) about the target behaviors, followed by a video clip of peers displaying examples and nonexamples of the targeted social skills in a natural environment. All participants showed rapid improvements in targeted social skill activities following video viewing.

Based on the PND analysis, one study failed to demonstrate the effectiveness of VSM in combination with other strategies in teaching social skills to children with ASD. Thiemann and Goldstein (2001) investigated the effects of written text and pictorial cuing, social stories, a social activity group, and video feedback on the social-communication skills of 4 participants identified with ASD. Immediately following the 10-min social activity group, the participants viewed a video of their interaction and were required to note whether or not they performed a target behavior (e.g., "I started talking"). The videos were not edited to portray predominantly positive behaviors. When the target behavior was not performed, the video was paused and the children were given an opportunity to watch a peer

demonstrate the behavior. Low intervention, maintenance, and generalization effects were observed for this study.

Conversation Skills. The results of the meta-analysis demonstrate the utility of video modeling and VSM in promoting conversation skills. Charlop and Milstein (1989) examined the maintenance and generalization effects of a video modeling intervention on the conversation skills of children with ASD. The videos depicted familiar adults engaged in a scripted conversation while holding specific stimuli (e.g., a toy). Maintenance and generalization probes across persons and settings were performed after the participants met specific performance criterion. The researchers concluded that the video modeling procedure was effective in teaching conversation skills to the children with ASD in the study. High maintenance and generalization effects were observed for all participants. Intervention data points were not provided, precluding calculation of intervention PND.

Charlop-Christy et al. (2000) compared the effectiveness of video modeling versus in-vivo modeling for teaching communication skills and functional skills to children with ASD. Participants watched adult models perform various tasks at an exaggeratedly slow pace. Prompting and reinforcement were not delivered during the treatment phase of this study. As compared to in-vivo modeling, video modeling led to faster acquisition of skills and larger generalization effects across persons and settings. The researchers attributed the effectiveness of video modeling to the fact that video modeling may compensate for children's stimulus overselectivity, is less anxiety provoking than interacting with a live person, and leads to increased motivation to attend to the model. This study was the only study that investigated time and cost efficiency of video modeling procedures. Results indicated that video modeling was less costly and less time consuming than live modeling.

Sherer et al. (2001) conducted the only study comparing the effectiveness of "self" as model versus "other" as model. Participants watched videos that alternated between "other" and "self" models. Videos depicted a scripted conversation between a peer model and a teacher. Results were variable across participants. Three of the 5 partici-

pants performed at levels of mastery (100% accuracy) following the intervention. The remaining 2 participants failed to reach acquisition on tasks in either condition. The researchers noted that the 2 participants with the highest level of performance had the greatest preference for visual stimuli. They hypothesized that the success of video modeling might be contingent upon the visual learning capabilities of the learner. The researchers concluded, and the PND analysis confirms, that there were no overall differences between video modeling and VSM.

One study documented low intervention and maintenance effects for the outcome variable of communication skills (Ogletree & Fischer, 1995). The study was unique in that it was the only experiment that used animated characters as models, as opposed to peer, adult, or self models. During video viewing, the participants were asked to discriminate between positive and negative examples of the target behaviors. The participants role-played the target behavior following the video viewing. This study also failed to demonstrate experimental control as defined by Horner et al. (2005).

STUDIES TARGETING FUNCTIONAL SKILLS

Self-Help Skills. Three studies demonstrated the effectiveness of video modeling and VSM in promoting skill acquisition and facilitating the generalization of self-help skills for children and adolescents with ASD. Norman et al. (2001) investigated the effectiveness of a video instructional package which included video modeling and video prompting to teach three self-help skills to participants with cognitive disabilities in a small group setting, including 1 participant with ASD. The researchers filmed the activities being performed from a "first-person" perspective; that is, through the eyes of the participant. The videos portrayed the arms and hands of the model performing the task. In addition, the video included a verbal and graphic task directive at the beginning of the task sequence. After watching the model perform the complete task sequence, the verbal and visual task direction was delivered (e.g., "pick up your sunglasses"), followed by a video prompt depicting the model completing the first step of the task (i.e., picking up the sun-

glasses). The participants received verbal praise and a token reinforcer for successful task completion during the baseline and intervention phase. The video instructional package was a highly effective method for teaching functional skills to the child with ASD. High maintenance effects were also observed.

Shiple-Benamou, Lutzker, and Taubman (2002) examined the effectiveness of a video modeling procedure in teaching functional skills (setting a table, pet care, mailing a letter, and making orange juice) to three children with ASD. Similar to Norman et al. (2001), the video depicted a task being performed from a first-person perspective. The video included a 5 s animation at the beginning of the video to increase attention to the video. A narrator's voice was also heard on the video providing directions for the task. Unlike Norman et al., verbal praise and gestural cues were only provided to promote attention to the video. Again, the video modeling intervention was highly effective in promoting skill acquisition across all 3 children. In addition, skills acquisition was maintained at 1-month follow-up.

Lasater and Brady (1995) examined an instructional package that included VSM in combination with discrimination training, behavior rehearsal, and debriefing for improving task fluency of functional skills in 2 children with ASD. Participants were shown four videos depicting themselves performing the target behavior. Three of the videos were edited to portray the children independently and fluently performing the target behavior. The fourth video portrayed the children incorrectly performing the behavior. The latter video was used to teach the children to discriminate between successful and unsuccessful behavior. The video instruction package increased task fluency, and promoted generalization to other tasks not directly targeted by the training.

Purchasing Skills. Results of the meta-analysis also suggest that video modeling is an effective strategy for teaching purchasing behaviors to children and adolescents with ASD. Haring et al. (1987) examined the effectiveness of video modeling, in combination with explicit shopping training, in facilitating the transfer of purchasing skills and social behavior across various community stores. Participants received direct training in purchasing prior to watching the videos. The

video modeling intervention began after the children reached 90% accuracy on a task analysis in the training setting. The videos depicted peers making purchases in various community stores (the same sequence of behaviors that were taught to the children with ASD in the training setting). Participants were asked questions while they watched the video, such as "what store is this?" or "what is he doing?" The video modeling procedure in combination with explicit shopping training was effective in promoting the transfer of purchasing skills (taught in a training setting) to a naturalistic setting (community store). To assess changes in the dependent variables that could be attributed to the video modeling procedure, PND calculations were performed by calculating the percentage of nonoverlapping data points between the shopping training phase and the video modeling phase. That is, at least in terms of the PND calculation, the shopping training phase served as the baseline for the video modeling phase. PND calculations were not calculated in the training setting because of ceiling effects (see Scruggs et al. 1987, for a complete description of procedures and conventions for calculating PND scores). The researchers concluded that video modeling is an effective strategy for addressing purchasing behavior in individuals with ASD when paired with explicit skill instruction.

Alcantara (1994) also examined the effectiveness of a video modeling instructional package on the acquisition and generalization of children's grocery-purchasing skills, but without explicit shopping training. The study also examined the effectiveness of video modeling alone and with an in-vivo prompting procedure. Verbal prompts were provided in both conditions (including baseline) when the student failed to perform one of the steps to the task. If a step was completed successfully following a verbal prompt, it was recorded as a zero (incorrect). The videos depicted an adult model purchasing shopping items at various community stores. In addition to demonstrating purchasing behaviors, the model also provided verbal instruction related to the behaviors that they performed (e.g., "we always find eggs in the dairy section"). The intervention was effective in promoting the acquisition and maintenance of purchasing skills. Contrary to the conclusions of Haring et al. (1987), results indicate

that video modeling can be an effective technique for teaching purchasing skills without the need for explicit skill instruction.

Mechling et al. (2005) used video modeling imbedded within a computer-based instructional program to teach purchasing skills to 3 adolescents with developmental disorders, including 1 with ASD. The researchers measured verbal and motor responses during purchasing tasks at three fast-food restaurants. The computer-based instructional program depicted an adult model (and store employees) purchasing various items at the three restaurants. Students received the computer-based instruction at school on a daily basis. The computer program was designed to be interactive. For instance, the program would stop periodically and require the student to respond to the questions of the store employee (e.g., "May I take your order?"). After achieving a predetermined level of mastery on the computer-based instructional program implemented at school, students returned to the three fast-food restaurants to make purchases. Verbal praise was provided for attending to tasks and for attempts to perform the task. Results indicated that the intervention was effective in promoting the acquisition and maintenance of purchasing skills in community settings.

STUDIES TARGETING BEHAVIORAL FUNCTIONING

Only one study specifically targeted the reduction of problem behaviors, while two studies targeted off-task behavior. Buggay (2005) examined the effects of VSM across a variety of prosocial behaviors including language, social initiations, tantrums, and pushing behaviors. The various interventions involved mainly scripted role-playing procedures and in one case the recording of naturalistic behaviors. Videos included an audio introduction that identified the behavior displayed in the video. Each video ended with applause and a written description of "Good Job!" All 5 participants exhibited immediate and significant gains in social-communication and behavioral functioning. In addition, gains were maintained after the interventions were withdrawn.

The meta-analysis provides conflicting data on the effectiveness of VSM in reducing off-task behavior. Coyle and Cole (2004) examined effects

of a video self-modeling and self-monitoring intervention program on the off-task classroom behavior of 3 children with ASD. The researchers recorded the children while they engaged in classroom tasks. The video was edited to include only on-task behavior, and was then used to train the children to use a self-monitoring procedure targeting on-task behavior. After the children were trained to use the self-monitoring procedure, they were instructed to return to their classroom to use what they had learned. Prompting was provided during the intervention phase to remind children to use the self-monitoring procedure. The VSM and self-monitoring procedures led to substantial decreases in off-task behavior during the intervention phase of the study; off-task behavior increased after the first withdrawal phase of the study. When the intervention was reapplied, off-task behavior again decreased substantially, but this time results were maintained after the intervention was withdrawn. Hagiwara and Myles (1999) also targeted off-task behaviors in addition to self-help skills using a computer-based intervention that combined VSM with an interactive social story. Participants read and listened to social stories that targeted specific tasks to be performed. They then watched a brief movie clip that depicted them performing each task. The intervention had a minimal impact on the functional skills and behavioral functioning of the 3 participants.

STUDIES EXCLUDED FROM THE PND ANALYSIS

Four studies involving video modeling or VSM for children with ASD were excluded from the PND analysis because they did not meet the selection criteria detailed earlier. Charlop-Christy and Daneshvar (2003) and LeBlanc et al. (2003) examined the effectiveness of video modeling in teaching perspective-taking skills to children with ASD. Both studies utilized videos that depicted an adult model correctly performing a perspective-taking task. The adult models verbalized their problem-solving strategies and stated the correct answers. The studies differed in the fact that LeBlanc et al., provided reinforcement in the form of praise, stickers, and edible items for correct responses on the perspective-taking tasks,

whereas Charlop-Christy and Daneshvar provided no reinforcement or feedback to participants for correct or incorrect responses. Results of both studies indicate that video modeling is an effective strategy for teaching perspective-taking skills to children with ASD. In the Charlop-Christy and Daneshvar study, results were maintained over a 15-month period and generalization effects were observed across stimuli not targeted in the video. However, generalization effects were observed in only 2 of 3 participants in the LeBlanc et al. study.

Kinney et al. (2003) used video modeling to successfully teach generative spelling skills to a child with ASD. The child watched as an adult model slowly wrote a spelling word. After spelling the word, the model verbalized the word that she just wrote (e.g., "I wrote t-o-p"). The child was then asked to independently write the spelling word. As a reinforcer, the child was allowed to watch a "play video" that depicted a play action or routine unique to the word being spelled. The researchers concluded that the video modeling intervention was effective in promoting skill acquisition, maintenance, and generalization of generative spelling skills.

Biederman et al. (1999) used video modeling to teach dressing skills to 3 children with autism and 3 children with Down syndrome. The researchers demonstrated that participants performed skills better after observing models perform skills at a relatively slow pace as compared to a faster pace. This procedure was similar to the Charlop-Christy et al. (2000) study that also featured models performing behaviors at an exaggeratedly slow pace. No prompting or verbal instruction was provided to the participants during the viewing of the video. The researchers concluded that for children with developmental disabilities, video modeling is an effective instructional strategy that does not require the use of additional instructional techniques, such as verbal or physical prompting.

DISCUSSION

Results suggest that video modeling and VSM are effective intervention strategies for addressing social-communication skills, behavioral function-

ing, and functional skills in children and adolescents with ASD. Results demonstrate that these procedures effectively promote skill acquisition, and that skills acquired via video modeling and VSM are maintained over time and transferred across persons and settings. Video modeling and VSM interventions produced similar treatment, maintenance, and generalization effects, and results were also similar across outcome variables. There were no significant differences between the outcomes of studies that documented intervention fidelity and experimental control and studies that did not document these features. The studies included in the meta-analysis involved participants ranging in age from early childhood to adolescence who were diagnosed with PDD-NOS, Asperger's syndrome, and autism. Interventions were implemented successfully in a variety of settings, including school, home, community, and therapeutic clinics. Perhaps most important to time-strapped educators, video modeling and VSM are relatively brief intervention strategies. The median treatment length of the studies included in the meta-analysis was nine and a half sessions. In addition, the median duration of the video clips shown to participants was only 3 min. Results were synthesized across 23 peer-reviewed studies conducted by 20 primary researchers across 16 geographical locations, and cumulatively included 73 participants with ASD. Applying the guidelines offered by Horner et al. (2005), the results of our study suggest that video modeling and VSM meet the criteria for designation as an evidence-based practice.

WHY VIDEO MODELING AND VSM ARE EFFECTIVE FOR INDIVIDUALS WITH ASD

The effectiveness of these interventions, in part, can be attributed to the fact that video modeling and VSM integrate an effective learning modality for children with ASD (visually cued instruction) with a well studied intervention technique (modeling). This notion is supported by Sherer et al. (2001), who noted that VSM was most effective for the children in their study who enjoyed watching themselves on video, and who demonstrated prior preference for visual learning, such as video viewing and the use of visual support strategies. In addition to capitalizing on the effective-

ness of visual instruction, there are a number of other factors that make video modeling and VSM effective interventions for children with ASD. As Bandura theorized (1977), attention is a necessary component of modeling. That is, a person cannot imitate the behavior of a model if the person does not attend to the model's behavior. Some individuals with ASD exhibit overselective attention or attend to irrelevant details of the environment (Happé, 1991; Koning & Magill-Evans, 2001). The use of video modeling allows interventionists to remove irrelevant elements of the modeled skill or behavior through video editing. The removal of irrelevant stimuli allows the individual with ASD to better focus on essential aspects of the targeted skill or behavior. Charlop-Christy et al. (2000) attributed the positive gains observed in their study to the fact that children with autism attended more closely to the video model as compared to the live model. In addition, some individuals with ASD may exhibit anxiety and distress related to social interactions (Bellini, 2004). This anxiety may significantly impact their ability to attend to a learning task. Video modeling and VSM can be implemented with minimal human interaction, thereby reducing much of the distress and anxiety related to social interactions.

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Motivation could be another factor contributing to the success of video modeling and VSM interventions. Though not measured directly by the studies included in the meta-analysis, anecdotal evidence and clinical experience suggest that watching videos is a highly desired activity for many children with and without ASD, leading to increased motivation and attention to the modeled task. In VSM, motivation to watch oneself on the video may be enhanced by the portrayal of predominantly positive and successful

behaviors (Dowrick, 1999)—which may also increase attention and enhance self-efficacy (Bandura, 1997). It is important to note that one of the least effective studies included in the meta-analysis (Thiemann & Goldstein, 2001) examined a video feedback procedure that depicted the children engaging in both efficacious and nonefficacious behavior. The children did not view exclusively positive behaviors. No studies directly assessed motivation or self-efficacy, though this would present a fruitful area for future inquiry.

LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Video modeling and VSM are often combined with other therapeutic strategies, such as visual cuing and prompting, consequent strategies, and self-monitoring techniques. Though the ability to easily combine therapeutic strategies could be considered a clinical strength of the video modeling and VSM procedures, from a research perspective, it is a significant weakness of this meta-analysis. Few studies investigated the unique effects of video modeling and VSM without the use of additional intervention strategies. Other studies attempted to control for the effects of additional strategies through methodological considerations, such as alternating treatment or changing conditions design (Alcantara, 1994; Apple et al., 2005; Sherer et al., 2001). Still others attempted to control for the effects of these other strategies by including them in the baseline phase (Norman et al., 2001). It should be noted that three of the four lowest intervention effects observed in this meta-analysis involved interventions that utilized video modeling and VSM in combination with other intervention modalities (Hagiwara & Myles, 1999; Ogletree & Fischer, 1995; Thiemann & Goldstein, 2001). More research is needed to examine the effects of video modeling and VSM alone, without the use of additional intervention strategies.

Though 23 peer-reviewed studies exceeds the 5 studies recommended by Horner et al. (2005) to classify a practice as evidence-based, it still represents a small sample size for a comprehensive meta-analysis. The small number of studies included in the meta-analysis precluded a thorough analysis of covariation between participant char-

acteristics (i.e., specific diagnosis, cognitive level, language level, etc.); setting characteristics (clinical, school, home, and community); intervention features (length of intervention, number of video exemplars, duration of video clips, quality of editing, etc.) and the outcomes associated with the video modeling interventions. The small sample size also prohibited a thorough analysis of the differences between video modeling and VSM interventions. Further research is needed to elucidate the participant, setting, and procedural features that lead to the most effective intervention outcomes for children with ASD.

The present study reported PND scores across three categories of dependent variables: (a) behavioral functioning, (b) social-communication skills, and (c) functional skills (see Tables 1 and 2 for a description of the dependent variables measured in each study). Results of the PND analysis suggest that the highest intervention, maintenance, and generalization effects were observed for the outcome variable of functional skills. However, it is premature to conclude that video modeling and VSM interventions are most effective in teaching functional skills to children and adolescents with ASD. Comparisons across dependent variables should be interpreted with caution given the differences in the types of outcome measures used to assess these variables. For instance, studies targeting functional skills often used percentage of correct responses in a task sequence as the outcome measure, whereas studies measuring social skills often measured number of social behaviors during a predetermined observational period. The type of outcome measure used would seem to have a particular impact on the measurement of maintenance and generalization effects. Studies that "train to mastery" (e.g., 100% accuracy on a task sequence) during the intervention phase would likely result in higher maintenance and generalization effects than those studies that do not train to mastery; furthermore, maintenance and generalization effects might be particularly elevated in cases where participants are performing at 0% accuracy during the baseline phase. It is uncertain how differences in outcome measures impacted the effect sizes observed in the present study. Though the small sample size of the present meta-analysis precludes a thorough exam-

ination of this issue, future research should address this as a primary research question.

Few studies documented the measurement of social validity and intervention fidelity. It is important to stress that the failure to document social validity and intervention fidelity does not necessarily indicate that the intervention is not socially valid or that the procedures were not implemented with fidelity. However, these measures are essential in determining whether the intervention was implemented as intended and whether the intervention and the results were socially acceptable. This is particularly important given the need for replication and the technological proficiency required to implement a video modeling intervention. Though video modeling interventions are relatively easy to implement (i.e., showing a video), they do require a sufficient level of technical expertise to edit the video footage. This presents the potential for resistance or rejection by some educators and families who may view their lack of technological proficiency as an obstacle to successful implementation. This potential for resistance and rejection of video modeling interventions makes the measurement of social validity and intervention fidelity an imperative aspect of research, clinical, and educational interventions.

Both social validity and intervention fidelity are easy to measure and can be done by providing the implementer and/or the child's parents or teachers with a checklist that documents when and how often the video was shown, and whether any events prevented the showing of the video such as equipment failure, school fire drills, absences, or problem behaviors. These checklists should also provide space for teachers or parents to document formative and summative data such as their impressions of viewing procedures (e.g., the impact of the video on their classroom or home routines), or their impressions of the child's progress as a result of the intervention. Finally, since attention and motivation are essential to observational learning (Bandura, 1977), measures of intervention fidelity should document whether or not the child is attending to the video; measures of social validity should ask the parent, teacher, or child herself whether or not the child enjoys watching the videos.

Only seven studies measured the generalization effects of video modeling and VSM. This low number was partly attributable to the narrow definition of generalization used in this study. Generalization was defined as transfer of skills across persons, settings, or the performance of skills/behaviors that were either not displayed on the video or were not the primary targets of the intervention. This definition excluded the calculation of generalization effects for some studies that reported results for generalization. Though challenging, it was imperative to properly distinguish between intervention effects and true generalization effects. It could be argued that video modeling and VSM interventions, by their nature, involve the generalization of skills to other settings. For instance, consider the example of an intervention where a child watches a video clip at home which depicts a targeted skill being performed in a school setting. If the child performed the skill the next day at school with the same persons featured on the video, this could conceivably be considered generalization of skills. That is, the video was watched (and thus the skill was learned) at home and then transferred to a new setting (school). We chose to define this as an intervention effect as opposed to a generalization effect because the video depicted the skill being performed in the school setting and the express purpose of the intervention was to increase the skill in the school setting. Had the child performed the skill in another setting, such as a community park, or with other persons not featured in the video, it would have been defined as generalization. The vast majority of the studies included in the meta-analysis encompassed interventions involving children watching a video in a setting that was different from the setting featured in the video. As such, video modeling and VSM hold great promise in facilitating the transfer of skills across settings. However, some studies (D'Ateno et al., 2003; MacDonald et al., 2005; Taylor et al., 1999) increased scripted play behaviors that were featured on the video clips, but failed to generalize to unscripted play behaviors. MacDonald et al. attributed this lack of generalization to the fact that their study included only one video vignette, as opposed to multiple exemplars of the target behavior. Future research should examine the utility of video modeling and VSM in facilitating general-

ization, and elucidate features that improve generalization effects, such as using multiple video exemplars, training to mastery, recording naturalistic behaviors, and so forth.

IMPLICATIONS FOR PRACTICE

Video modeling and VSM provide effective options for educators and clinicians wishing to design social, communication, and behavioral interventions for children with ASD. The VSM studies included in the meta-analysis utilized two types of recording strategies: (a) the recording of scripted behavior (role playing) or the (b) recording of naturalistic behavior. The choice of which type of recording procedure to use depends on a number of factors, including the child's willingness to participate in the role-play, the probability of capturing the target behavior in a naturalistic setting, and the technological capabilities of the interventionist. Each recording procedure has strengths that should be considered. Recording scripted behaviors typically requires less footage to record, offers more procedural control, and allows for the delivery of more precise instruction. For example, the interventionist can develop a script or storyboard that precisely targets how to join in a game with peers, and then record the child engaging in the scripted behavior. Recording naturalistic behavior is typically more time-consuming and provides less procedural control, but it may provide greater ecological validity. It currently is not known which recording procedure produces the most beneficial effects for children with ASD.

According to Dowrick (1999), VSM interventions typically fall within two categories, positive self-review (PSR) and video feedforward. PSR refers to individuals viewing themselves successfully engaging in a behavior or activity that is currently in their behavioral repertoire. PSR can be used with low frequency behaviors or behaviors that were once mastered but are no longer performed. In PSR interventions, the individual is recorded while engaging in the low frequency behavior (e.g., initiating an interaction with peer) and then shown a video of the behavior being performed. PSR is a relatively simple strategy to use from a technological standpoint. However, for very low frequency behavior, extensive amounts

of raw video footage are required to capture even a small amount of the target behavior.

Video feedforward is another category of VSM interventions. In feedforward interventions, individuals observe themselves successfully demonstrating skills that are slightly above their current capability (Dowrick, 1999). Video feedforward interventions are used when the individual possesses a component of the target skill in her behavioral repertoire, or is performing the skill at a low level of mastery or autonomy. Feedforward requires additional technological capabilities as compared to PSR, but it typically requires a lesser quantity of raw video footage. The use of a "hidden support" is an example of a feedforward intervention. For instance, the child might be prompted by an adult to ask a playmate to join her in an activity, or the child might be prompted to respond to the initiations of other children. The adult prompt is then edited out (i.e., hidden) so that when the child views the video segment, she sees herself as independent and successful.

Video modeling interventions may involve peers, siblings, or adults as models. Peer modeling would be seemingly advantageous to adult modeling because children are most likely to attend to a model similar to themselves in some way (Bandura, 1977). However, recording the behaviors of child peers requires further consent from parents and additional time to train the peers to successfully perform the target behavior and to ensure their full cooperation and participation. The use of adults as models would not require additional parental consent, and training time would be minimal.

SUMMARY

There is a great need to identify quality, evidence-based practices for children with ASD. Video modeling and VSM show great promise as effective intervention strategies for addressing the social-communication skills, behavioral functioning, and functional skills of children with ASD. Results of the meta-analysis indicate that video modeling and VSM are effective for a broad age range of children and adolescents and can be implemented in a variety of settings. Future research is needed to examine both the efficacy and social validity of video modeling and VSM interven-

tions, and to examine factors that lead to the most beneficial outcomes for children with ASD.

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