ADVANCING EVIDENCE-BASED PRACTICE FOR CHILDREN WITH AUTISM: STUDY AND APPLICATION OF VIDEO MODELING THROUGH THE USE AND SYNTHESIS OF SINGLE-CASE DESIGN RESEARCH

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ABSTRACT

KAITLYN P. WILSON: Advancing evidence-based practice for children with autism: Study and application of video modeling through the use and synthesis of single-case design research
(Under the direction of Linda R. Watson)

This dissertation document is composed of three separate, but interconnected articles that represent efforts across the research cycle: the first is a review of existing literature on the synthesis of single-case design research in communication sciences and disorders; the second reports results of a novel single-case design study that adds to the existing research literature on behavior modeling interventions for children with autism; and the third is an attempt to translate existing research on video-based behavior modeling into a format accessible to school-based speech-language pathologists serving students with autism. These three articles are tied together by their focus on single-case design research and communication-focused interventions for young children with autism. Through each article, conclusions and recommendations are provided to guide service delivery and future research, with the aim of adding rigor to both the study of autism interventions and the utilization of its findings.

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CHAPTER 1: Introduction

Evidence-based practice (EBP) is the careful integration of up-to-date, high quality research, professional knowledge, and preferences of the individual/family receiving services. In the field of communication sciences and disorders and related fields such as special education, EBP is the standard for service delivery (ASHA, 2005; U.S. DOE, 2007). However, in the growing body of literature that aims to bridge the gap between research and practice (i.e. translational research), investigators are finding that many empirically-supported practices are not being used in real-life settings due to a lack of practicality, resources, and buy-in (Dingfelder & Mandell, 2011; Yell, Drasgow, & Lowrey, 2005). This unfortunate fact reflects both the impetus for the EBP movement (Winton, 2006) and the ongoing need for practical clinical research that responds to the real-life needs of practitioners and those whom they serve.

The route from research to practice is a long and circuitous one, and there are many obstacles that can stand in the way of translational success. For example, many speech-language pathologists and other professionals working in educational settings have limited time to access the research literature due to increasing caseloads and decreasing planning time (Closs & Lewin, 1998; Curtin & Jaramazavic, 2001; Roberts & Barber, 2001). In addition, these professionals report that they have difficulty relating to the research literature and lack confidence in their ability to access, understand, and utilize research findings (Closs & Lewin, 1998; Curtin & Jaramazavic, 2001). This is compounded by the fact that very few research-supported practices are accompanied by accessible and practical implementation guides for professionals to use in real-life settings (Odom, Collet-Klingenberg, Rogers, & Hatton, 2010).

Incorporating EBP into service delivery for children with autism spectrum disorder (ASD) is especially difficult. In addition to the above-outlined barriers, professionals serving this population must also navigate the quickly evolving and complex nature of ASD intervention research, and the heterogeneous need and skill profiles of this growing group of children. There are additional demands associated with the need for intensive, individualized instruction for children with ASD. Finally, the high level of family involvement (Scheuermann, Webber, Boutot, & Goodwin, 2003) and increasing media representation of unproven methods (Dingfelder & Mandell, 2011) present unique challenges to professionals serving this population. In an effort to support professionals in their provision of evidence-based services to individuals with complex disorders such as ASD, researchers must not only conduct high quality research suitable for inclusion in synthesis efforts aimed at determining empirical support for interventions, but also must focus on meaningful, socially-valid outcomes that are endorsed by stakeholders (e.g., professionals, families; Dingfelder & Mandell, 2011). In addition, investigators must make efforts to translate this science into step-by-step guides for professionals interested in incorporating empirically-supported interventions into their everyday practice.

This dissertation responds to the above-outlined needs by contributing three manuscripts that share a common goal: to advance the field of EBP in ASD intervention and bridge the research-to-practice gap by highlighting and responding to contemporary issues. The first manuscript included in this document, *Synthesis of single-case design* *research in communication sciences and disorders: Challenges, strategies, and future directions*, dissects contemporary issues surrounding research synthesis strategies and EBP in the field of communication sciences and disorders. This manuscript also addresses the importance of high quality research in single-case design (SCD), a research design common to the study of interventions and meaningful outcomes for individuals with ASD. The final two manuscripts included in this dissertation focus on the empirically-supported, cost-effective, and time-efficient intervention tool, video modeling (Nikopoulos, Canavan, & Nikopoulo-Smyrni, 2009; Simpson, Langone, & Ayres, 2004; Sherer et al., 2001). The video modeling literature base is primarily composed of SCD studies; therefore, the advancement of strategies to synthesize SCD literature, as discussed in the first manuscript, is highly relevant to the comprehensive examination of video modeling's empirical evidence as an intervention strategy for children with ASD.

The second manuscript in this dissertation, *Teaching pivotal social-communication skills to preschoolers with autism: Efficacy of video vs. in-vivo modeling in the classroom*, reports the rationale, methods, results, and implications of a rigorously conducted SCD study comparing the efficacy of video modeling to the more widely used tool of in-vivo modeling in teaching key social-communication skills to preschoolers with ASD in the classroom setting. The final manuscript in this dissertation expands upon this research report by addressing the need for practical, step-by-step guides for professionals' use of research-supported interventions in ASD. This third manuscript, *Incorporating video modeling into school-based intervention for students with autism spectrum disorders*, is a tutorial outlining the discrete steps to successful implementation of video modeling, and is written specifically for school-based speech-language pathologists serving individuals with ASD. Together, the three manuscripts that constitute this dissertation reflect the direction in which ASD intervention research must head in order to affect meaningful and lasting change in the everyday services provided to children and families faced with ASD.

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CHAPTER 2 (Manuscript 1):

Synthesis of Single-Case Design Research in Communication Sciences and Disorders: Challenges, Strategies, and Future Directions

Introduction

Single-case design (SCD), also referred to as single-subject design, single-case experimental design, and individual-subject design, is an experimental research methodology rooted in applied behavior analysis (Kennedy, 2005). It is a specific class of interrupted time-series research design that uses an individual case as the unit of experimentation and analysis (and as its own control), and repeatedly measures the effects of a systematically-manipulated independent variable on one or more dependent variables (Gast, 2010). Although usually non-randomized, SCD is considered rigorous and has the strength to identify causal relationships between independent and dependent variables (Kratochwill et al., 2010; Schlosser & Sigafoos, 2008). The strength of this class of design stems largely from its high internal validity (i.e., validity of cause-effect relationship studied), established through replication of effects across phase changes (e.g., from a baseline to a treatment phase), participants, and contexts, as well as through planned reversals of behavior and lags in treatment initiation (Parker & Hagan-Burke, 2007b).

Because of its focus on individuals, socially-valid outcomes (i.e., those that reflect socially-important changes for stakeholders), and the *process* of behavior change (over time and systematic alteration of conditions), SCD is well-suited to fields where individual variability is of special interest, including psychology, special education, and allied health disciplines such as communication sciences and disorders (Beretvas & Chung, 2008; Kavale, Mathur, Forness, Quinn, & Rutherford Jr., 2000; Kratochwill et al., 2010). SCD is also highly suited to study of low-incidence populations and complex treatments, both of which can be costly and challenging to include in larger group comparison studies (Kratochwill et al., 2010; Van den Noortgate & Onghena, 2008). In addition, unlike large-*n* group studies, which often mask individual variability in their examination of group means (Kavale et al., 2000), SCD allows for examination of variations between individuals (Kratochwill et al., 2010) in highly heterogeneous populations such as persons with autism spectrum disorders (Beretvas & Chung, 2008). As such, SCD is most prominent in fields in which individuals from complex, low-incidence populations are often served (Beretvas & Chung, 2008; Kavale et al., 2000; Kratochwill et al., 2010). It follows, then, that SCD is a widely used research method in the field of communication sciences and disorders, wherein individuals from heterogeneous populations (e.g., individuals with autism spectrum disorders, aphasia, or multiple disabilities) require individualized and scientifically-based treatment options. As evidence-based decision making has become the professional standard in communication sciences and disorders (ASHA, 2005), researchers and clinicians are in need of practical and accurate methods to synthesize the available research, much of which is rooted in SCD methodology.

Need for Assessment and Synthesis of SCD Findings

Troubling gaps between research and practice have spurred a recent movement in health- and education-related fields toward creation of increasingly objective and reliable research and use of more scientifically-sound practice (Parker, Hagan-Burke, & Vannest, 2007). Originating in the medical field of Great Britain in the early 1990s (Parker & Hagan-Burke, 2007b), this evidence-based practice (EBP) movement was later accompanied by such American legislations as No Child Left Behind (NCLB, 2001) and the Education Sciences Reform Act (ESRA, 2002) (Parker et al., 2007). Still, years after the onset of the EBP movement, practicing professionals in fields such as communication sciences and disorders are encountering numerous barriers in their efforts to determine and implement EBP in clinical settings (O'Connor & Pettigrew, 2009). In order to identify empirically-supported practices for use in applied settings, the EBP movement calls for evaluation and synthesis of findings across primary research efforts (Wolery, Busick, Reichow, & Barton, 2010). In their endeavor to support the EBP movement by evaluating practices in terms of their accumulated evidence, researchers have sought methods to integrate research findings across studies in transparent, precise, and functional ways (Kavale et al., 2000; Schlosser & Sigafoos, 2008; Wolery et al., 2010).

The integration of research findings has been undertaken for many decades as a central means of knowledge acquisition and development (Kavale, Mathur, Forness, Quinn, & Rutherford Jr., 2000). Contingency tables, narrative reviews, and other forms of qualitative synthesis were some of the most utilized research integration methods prior to the 1970s (Kavale et al., 2000; Wolery et al., 2010). In response to scientific advances and potential for inefficiency and bias in these early methods, the 1970s brought quantitative methodology to the forefront as a more objective, precise, and confirmable means of synthesizing the literature (Kavale et al., 2000; Schlosser & Sigafoos, 2008). Later termed 'meta-analysis,' this statistical aggregation tool became a key method for assessing, analyzing, comparing (e.g., examining moderating variables), and quantifying findings from primary research studies (Allison & Gorman, 1993; Wolery et al., 2010). With its intricate process of stipulating inclusion criteria, locating appropriate studies, coding study elements, calculating outcomes, and statistically analyzing data, meta-analysis became viewed by many as a precise decision-making tool, ideal for supporting the EBP movement that has taken hold over the past two decades (Kavale et al., 2000). In the current EBP climate, the role of meta-analysis in decision-making is growing, with many respected journals now requiring reports of effect size to accommodate more straightforward interpretation and aggregation of findings across studies (Olive & Smith, 2005; Parker & Hagan-Burke, 2007a, 2007b).

In 2008, a special issue of *Evidence-Based Communication Assessment and Intervention* (EBCAI) focused on issues and scientific progress in the field of SCD meta-analysis. Considering the growing attention to this area of inquiry, and the recent publication of an expert panel-authored technical document of design and evidence standards for SCD (Kratochwill et al., 2010), the current article continues this important conversation. Specifically, this article provides an unbiased and updated ‘state of the science’ in the field of SCD meta-analysis, while also continuing and refining the call for further research in quantification methods for SCD.

Meta-Analysis of SCD Research: Theoretical & Pragmatic Challenges

While early meta-analytic efforts focused mainly on evaluation of findings from large-*n* group comparison studies (Beretvas & Chung, 2008), more recent efforts have sought to include the sizeable body of relevant SCD literature as well. Noting the overall exclusion of SCD research from meta-analyses (Allison & Gorman, 1993; Parker &

Hagan-Burke, 2007a; Scruggs & Mastropieri, 1994; Van den Noortgate & Onghena, 2008), SCD proponents have identified some of the underlying reasons for this omission. Primarily, SCD studies have been excluded due to a lack of accepted statistical methods for synthesizing SCD research (Shadish, Rindskopf, & Hedges, 2008). In addition, the sub-par methodology (e.g., non-rigorous design, incomplete analysis) employed by many SCD researchers has been cited as a reason for SCD's absence from most meta-analytic efforts (Parker & Hagan-Burke, 2007a). Many researchers, SCD and non-SCD alike, are unsettled by the exclusion of SCD from meta-analyses in areas (e.g., behavioral intervention for preschoolers with severe disabilities) where the SCD literature is as extensive as the group comparison literature (Allison & Gorman, 1993; Kavale et al., 2000; Parker, Hagan-Burke, & Vannest, 2007; Scruggs & Mastropieri, 1994), and in cases where less rigorous large-*n* group studies (e.g., non-equivalent comparison group designs) are included while more rigorous SCD studies are not (Shadish et al., 2008).

Some contend that meta-analysis is not compatible with SCD's philosophy and procedures, and that with its inclusion of poor quality studies and bias toward published, significant results, it is a flawed process (Kavale et al., 2000). Yet, many others support the inclusion of SCD research into the EBP meta-analysis movement (Shadish et al., 2008) despite considerable controversy over how this should occur (Parker et al., 2007). The debate over whether, and how, to synthesize SCD literature is not new, and arguments raised in the 1980s remain divisive and relevant today (Allison & Gorman, 1993; Wolery et al., 2010). Rising from both camps, arguments surrounding quantitative synthesis (i.e., meta-analysis) of SCD results highlight the theoretical and pragmatic challenges inherent in this enterprise.

Theoretical Challenges: The Value of Visual Analysis

Those with a theoretical, or ideological, aversion to quantifying SCD findings point to the underlying purpose of SCD to identify ‘useful’ outcomes, as opposed to statistically significant effects (Baer, 1977). This group is generally populated by proponents of visual analysis, the traditional means of determining the presence and magnitude of functional relationships between independent and dependent variables in SCD (Kratochwill et al., 2010; Parker et al., 2007). When using visual analysis, the magnitude of an effect must be large to be detected (Beretvas & Chung, 2008), which is a limitation in the eyes of some (Parker & Hagan-Burke, 2007a), but the theoretical heart of SCD (i.e., clinical importance) in others’ estimation (Baer, 1977). Using visual analysis to determine clinically important effects reduces the probability of drawing a false conclusion about the functionality of a variable (i.e., Type 1 error), and thus produces conclusions that are dependable and clinically robust (Baer, 1977). Abandoning visual analysis for the allure (e.g., increased chance of publication, increased acceptance by scientific community) of statistical aggregation and meta-analysis may reduce the occurrence of Type 2 error (i.e., claiming a variable is not functional when it is) in SCD; however, this shift would also threaten to reduce the impact of SCD results and undermine the ideological foundations of this unique research approach (Baer, 1977). For researchers wishing to avoid such pitfalls, other options include more structured, systematic visual analysis methods (see Fisher, Kelly & Lomas, 2003; Gast, 2010).

An additional theoretical challenge to the meta-analysis of SCD results is tied to the nature of the populations and outcomes studied using this methodology. SCD is commonly utilized in the study of individuals with severe, low-incidence disabilities (i.e., the outliers) in fields such as psychology, education, and communication sciences and disorders, where individual variability is of special interest (Beretvas & Chung, 2008; Kavale et al., 2000; Kratochwill et al., 2010; Van den Noortgate & Onghena, 2008). Because of SCD's intended focus on individual variability and the *process* of behavior change, traditional visual analysts and others are theoretically opposed to using a single number (as is common in meta-analysis) to characterize the complex SCD findings that emerge across heterogeneous participants and studies (Kavale et al., 2000).

Pragmatic Challenges: SCD Meets Effect Size

In addition to the theoretical challenges inherent in meta-analysis of SCD findings, there are a number of practical complications cited by traditional visual analysts, as well as by proponents of SCD quantification. For instance, individuals on both sides of the debate cite the fact that combining findings across SCD studies with different characteristics (e.g., dependent and independent variables, participant profiles, measures) results in unreliable and illogical conclusions (Kavale et al., 2000). Other practical challenges to the use of meta-analysis in SCD lie in the employment of quantification methods (i.e., effect sizes, overlap methods) within a methodology that often produces imperfect (e.g., floor/ceiling effects) or insufficient data, and that inherently violates the underlying assumptions of most statistical methods (Olive & Smith, 2005). Furthermore, data patterns seen commonly in SCD research (i.e., extinction bursts, learning curves) are not accounted for when using existing quantification methods. Many of these obstacles are outlined in the following section on quantification approaches; however, special attention is drawn below to the difficulties in using statistical effect size to quantify SCD results.

Effect size is the basic statistical metric used in combining large-*n* group studies for meta-analysis (Allison & Gorman, 1993; Kavale et al., 2000; Parker & Hagan-Burke, 2007a, 2007b). It is an index of the magnitude of the effect of one variable on another, and is commonly calculated as the ratio of the difference between two group means to a measure of standard deviation (Kavale et al., 2000). Effect size does not indicate causality, but allows researchers and others to look at standardized treatment-related changes across studies with different (but related) samples, measures, designs, and analyses (Allison & Gorman, 1993; Parker & Hagan-Burke, 2007a, 2007b). The limitations of visual analysis (e.g., poor inter-rater reliability), combined with the impetus of the EBP movement, spurred a subset of SCD researchers to adapt this existing statistical aggregation tool into a more rigorous and parsimonious means of analyzing findings across SCD studies. Increased emphasis on the use of effect size in SCD and large-*n* group design is highly intertwined with the EBP movement and its focus on rigor, accountability, and research synthesis in education-related fields (Parker & Hagan-Burke, 2007a, 2007b).

In addition to practical concerns for maintaining the credibility of SCD in the EBP movement, arguments for the use of effect size in SCD also point to its objectivity, reliability, precision (e.g., allowing confidence intervals), and ability to detect smaller effects (Beretvas & Chung, 2008; Parker & Hagan-Burke, 2007a). Although many are in favor of using effect size in SCD, there is heated debate within this group over which effect size metric, or other quantification tool, is most suitable to SCD designs

(Campbell, 2004; Olive & Smith, 2005). In a recent editorial on effect size developments in SCD, Schlosser & Sigafoos (2008) assert that there is no question that effect size is needed in SCD research, but that the real search is for a suitable metric. A mere 13% of published SCD studies through 2006 employed effect size metrics (Parker & Hagan-Burke, 2007b), a clear indication of the practical challenges that stand between SCD and this meta-analytic tool (Kavale et al., 2000; Kratochwill et al., 2010).

Certain issues can compromise the use of effect size with any type of research, even large-*n* group design studies (e.g., incomplete data, inadequate statistical information; Allison & Gorman, 1993); however, many more practical challenges arise specific to the use of effect size in SCD. The biggest obstacle is the serial dependence, or autocorrelation, of data in SCD (Campbell, 2004; Haardorfer & Gagne, 2010; Kavale et al., 2000; Olive & Smith, 2005; Wolery et al., 2010). In SCD, participants' residuals are correlated across time, violating the assumption of independence that underlies most statistical tests of significance (Campbell, 2004; Haardorfer & Gagne, 2010; Kavale et al., 2000). Additionally, the data trends and small number of data points common to SCD studies can confound effect size measures and lead to non-meaningful results (Beretvas & Chung, 2008; Campbell, 2004; Kavale et al., 2000). Non-randomized sampling in SCD also violates the statistical assumptions of normality and homogeneity of variance (Olive & Smith, 2005). In order to circumnavigate these pragmatic challenges, researchers and statisticians have proposed a variety of metrics for quantifying SCD's complex results, drawing on both parametric (i.e., assume data are drawn from a probability distribution) and non-parametric (i.e., make fewer assumptions regarding data being drawn from a probability distribution) methods.

Major Approaches to Quantifying SCD Research

Many options have been proposed for quantifying results of SCD studies, with a recent influx of ideas (Schlosser & Sigafoos, 2008); however, little consensus has emerged as to which option is most appropriate (Allison & Gorman, 1993; Beretvas & Chung, 2008), or whether a combination of approaches is optimal (Beretvas & Chung, 2008; Parker & Hagan-Burke, 2007a). The existing options include both non-parametric and parametric methods, with the non-parametric options largely consisting of 'overlap methods' that do not rely on statistical assumptions and are not actually effect size estimates, and the parametric effect size options primarily based on linear regression (Campbell, 2004). Much of the effect size debate in SCD has centered on the different strengths and weaknesses of these two categories of quantification methods, each of which is reviewed below.

Non-Parametric Approaches

In a recent review of 25 SCD meta-analyses, the most widely-used approach to quantifying findings was the calculation of percentage of non-overlapping data (PND; Beretvas & Chung, 2008), or the percentage of data points in the treatment phase above/below (depending on goal) the highest/lowest baseline data point (Scruggs, Mastropieri, & Casto, 1987). Proposed by Scruggs et al. in 1987, PND was the first non-parametric alternative to visual analysis, and has since inspired development of many overlap methods for quantifying SCD findings (Shadish et al., 2008). Major drawbacks apply to overlap methods that determine the amount of data variability around a center point (Parker et al., 2007) or compare the response distributions across phases (e.g., baseline and treatment) (Shadish et al., 2008). Arguments against use of overlap methods are that they are: (1) confounded when there are floor/ceiling effects, or trends in baseline data (Allison & Gorman, 1993, 1994; Beretvas & Chung, 2008; Kavale et al., 2000; Kratochwill et al., 2010; Olive & Smith, 2005; Parker et al., 2007; Wolery et al., 2010); (2) dependent on the number of data points, with PND systematically approaching zero as the number of data points increases (Allison & Gorman, 1994; Kavale et al., 2000; Shadish et al., 2008); (3) limited in their validity due to unknown sampling distributions and inability to calculate confidence intervals or *p*-values (Beretvas & Chung, 2008; Parker & Hagan-Burke, 2007a; Parker et al., 2007); (4) lacking published standards for interpretation in all but PND (Olive & Smith, 2005; Wolery et al., 2010); (5) susceptible to human error when hand calculation is used (Parker & Vannest, 2009); and, importantly, (6) not actually effect sizes, or related to any effect size, so not accepted by the wider research community (Parker & Hagan-Burke, 2007a; Parker et al., 2007).

As the original overlap method, PND carries the burden of all the above-outlined flaws, and has endured additional criticism due to its reliance on extreme data points and its inability to discriminate between different data profiles that are 100% non-overlapping (Allison & Gorman, 1993, 1994; Parker et al., 2007; Scruggs & Mastropieri, 1994). To assess the prevalence of this latter issue, further research is needed to indicate the number of 100% non-overlapping data profiles in PND meta-analyses. Still, this method is the most widely-utilized in SCD meta-analyses (Parker & Hagan-Burke, 2007a), and is positively regarded as meaningful, simple to calculate and interpret, useful across design types, and unaffected by autocorrelation and non-linearity (Beretvas & Chung, 2008; Kavale et al., 2000; Scruggs & Mastropieri, 1994; Shadish et al., 2008; Wolery et al., 2010). PND is cited as an especially useful method for examining data within and across

SCD studies when the goal is to make ‘local’ (vs. broad or universal) clinical decisions (Kratochwill et al., 2010; Parker et al., 2007). In response to PND’s drawbacks, other overlap methods were developed, including, but not limited to, percentage of zero data (PZD), percentage of all non-overlapping data (PAND), non-overlap of all pairs (NAP), pairwise data overlap squared (PDO^2), percentage of data exceeding the median (PEM), percentage of data exceeding the median trend (PEM-T), and mean baseline reduction (MBLR).

PZD is an adaptation of PND that looks at the percentage of zero data points in the treatment phase (Allison & Gorman, 1993; Campbell, 2004), and is often combined with PND (Beretvas & Chung, 2008), as the methods measure related yet distinct aspects of SCD outcomes (Campbell, 2004). For example, PZD is a stronger tool than PND for analyzing studies where behavior suppression is the goal and examination of moderating variables is desired (Campbell, 2004). Still, PZD suffers from many of the same weaknesses as PND (Allison & Gorman, 1993; Van den Noortgate & Onghena, 2008). PAND is a more recent alternative to these earlier overlap methods that draws upon all data points, not just extreme values (Parker et al., 2007). In this method, all between-phase overlapping points are removed and the percentage of remaining data points is calculated (Parker et al., 2007). This estimator is appropriate for studies with a larger number of data points (i.e., at least 20 in baseline), provides a synthesis metric with confidence intervals, and is easily translated to the parametric *Phi* statistic (Parker & Hagan-Burke, 2007a; Parker et al., 2007). Yet, PAND requires more complex calculations, is still prey to ceiling/floor effects, uses a questionable algorithm, and does not control for baseline trends (Parker & Hagan-Burke, 2007a; Parker et al., 2007;

Shadish et al., 2008). In 2009, Parker and Vannest proposed NAP as a superior option to PND and PAND. NAP pairs all baseline and treatment data points to determine the percentage of non-overlapping pairs (Parker & Vannest, 2009). Initial study of NAP shows better discrimination of results, more objective procedures, more precise confidence intervals, and greater correlation with the accepted R^2 effect size (Parker & Vannest, 2009); however, more work investigating this new metric is needed. Randomization tests have been proposed as another, more rigorous non-parametric option for use with SCD data; however, use of these procedures requires random assignment of treatments to participants and time points, which is contrary to general SCD procedures and ideals (Haardorfer & Gagne, 2010).

Wolery et al. (2010) compared PND and three additional overlap methods (i.e., PEM, PEM-T, and PDO^2) to visual analysis judgments made by a panel of experts, concluding that none had acceptable error percentages (i.e., PEM-T lowest at 13.2%). PDO^2, a method which uses all baseline data points to determine non-overlap, was previously cited by Parker and colleagues as a better-quality method than both PND and PEM; however, it showed the highest (23%) disagreement with visual analysis in the comparison (Wolery et al., 2010). PEM, which uses the median (vs. extreme) baseline point to gauge non-overlap, had the advantage of avoiding floor/ceiling effects, while PEM-T was the only overlap method that took baseline trend into account (Wolery et al., 2010).

MBLR is an additional nonparametric approach for quantifying results in SCD. Instead of using extreme or median data points as reference, MBLR calculates percentage reduction from baseline by comparing averages of the last three data points from baseline and treatment phases (Campbell, 2004; Olive & Smith, 2005). MBLR was found to be the third most utilized method for quantifying SCD in meta-analyses (Beretvas & Chung, 2008), and is the only overlap method that assesses the magnitude of effect of an independent variable. However, there are no standards for its interpretation (Olive & Smith, 2005). The general lack of published interpretation guidelines for non-parametric approaches is a serious limitation to this class of methods. An additional obstacle to the use of non-parametric methods is the lack of a statistical procedure to quantitatively synthesize these indices. Clearly, despite their widespread use in SCD, continued work is needed to bring non-parametric quantification methods to the level of stringency required by the increasingly-rigorous scientific EBP community.

Parametric Approaches

In their commentary on the 'state of the science' in SCD meta-analysis, Shadish et al. (2008) predict that parametric methods "will be one of the dominant and most statistically sound approaches in [the field]" (pg. 191). However, they also state that decades of refinement are needed to these still-primitive meta-analytic methods (Shadish et al., 2008). The majority of parametric methods are regression-based, using linear estimation with outcome as the dependent variable and time as the independent variable (Olive & Smith, 2005). Their ability to model data trends (i.e., detrend data) allows for examination of *both* level and slope, and overall, these methods produce easily interpreted effect size statistics that are comprehensive in their use of all data points, and precise in their provision of confidence intervals (Allison & Gorman, 1994; Beretvas & Chung, 2008; Campbell, 2004; Kratochwill et al., 2010). Parametric effect sizes are commonly used to evaluate and synthesize large-*n* group studies, and so are accepted by the scientific community as powerful and rigorous metrics.

Despite their power, though, parametric options are criticized for their impracticality when used with SCD data. Compared to non-parametric options, they are more difficult to calculate and generally require more data points (i.e., 25+) to produce accurate effect sizes (Allison & Gorman, 1993; Kavale et al., 2000; Parker et al., 2007). Still, their major flaws are related to their violation of underlying statistical assumptions of linearity and independence of residuals when used with SCD studies, which inherently involve autocorrelated (i.e., serially dependent) data (Allison & Gorman, 1994; Beretvas & Chung, 2008; Olive & Smith, 2005; Parker et al., 2007; Wolery et al., 2010). Although some have proposed models and programs (e.g., ITSACORR) for dealing with autocorrelation in SCD quantification, these often require exceedingly large numbers of data points (e.g., 50+ per phase) (Beretvas & Chung, 2008), have insufficient power to detect small effects (Crosbie, 1993), and/or become inaccurate with a baseline trend (Beretvas & Chung, 2008). A more flexible, multi-level modeling approach has recently been proposed as a promising extension of the ordinary regression model that can estimate and adapt to autocorrelation and trends in SCD data (Shadish et al., 2008; Van den Noortgate & Onghena, 2008). In addition, a generalized least squares (GLS) approach that similarly models autocorrelation has recently been proposed (Swaminathan et al., 2010) and examined in a preliminary study (Maggin et al., 2011). Further examination of these methods will determine their utility.

In addition to the many regression-based effect size approaches being honed for use with SCD data, standardized mean difference (SMD) is a non-regression-based parametric approach that is the second most utilized method across SCD meta-analyses (Beretvas & Chung, 2008). SMD uses phase means (or the mean of the last three data points per phase) to produce a *d* statistic effect size (Beretvas & Chung, 2008). Although easier to calculate than other parametric options, SMD violates the statistical assumption of independence and loses the ability to account for data trend (Beretvas & Chung, 2008), making it a questionably-effective option. As noted by Shadish and colleagues (2008), much work remains to be done in honing parametric effect size measures to suit the nature of SCD data, while maintaining their power and standardizing their meaning across large-*n* and single-*n* design categories.

Combining SCD & Large-n Effect Size

Although integration of SCD and large-*n* effect sizes is the ultimate goal of many SCD researchers who wish to participate in determination of EBP, such combination is ill-advised at this point (Beretvas & Chung, 2008; Kavale et al., 2000; Kratochwill et al., 2010; Van den Noortgate & Onghena, 2008). Aside from the different participant selection procedures (i.e., non-random vs. random) employed by SCD and many large-*n* designs, there is a more fundamental and burdensome difference in their effect size scales: SCD effect size measures variance *within an individual*, while large-*n* group design effect size examines variance *among individuals* (Allison & Gorman, 1993). Because of the smaller variance within an individual, SCD effect sizes tend to be much larger than their large-*n* counterparts, placing them on a different scale and, thus, making them incomparable. At this stage, it is recommended that, instead of combining SCD and large-*n* effect sizes, SCD effect sizes be used to rank treatments, make 'local' decisions, and supplement large-*n* meta-analyses until further developments have been made

(Kavale et al., 2000; Kratochwill et al., 2010; Van den Noortgate & Onghena, 2008). However, for researchers who are more concerned with the combination of findings *across SCD studies* (e.g., in fields examining interventions for individuals with severe, low-incidence populations), conclusions and recommendations are offered below.

Conclusions and Recommendations

What can SCD researchers and practitioners in fields such as communication sciences and disorders take from this quagmire of information in their effort to make informed choices about what, if any, technique is suitable for identifying effective interventions for individuals with severe, low-incidence, or heterogeneous disabilities? The recommendations of published experts in the field further complicate the issue, as most articles begin and conclude with statements regarding the large amount of work needed before any acceptable metric is defined for quantifying SCD results. Interestingly, the most consistent advice offered is the combination of more than one effect size or overlap method, and in many cases, triangulation of those methods with traditional visual analysis (Beretvas & Chung, 2008; Kratochwill et al., 2010; Olive & Smith, 2005; Parker & Hagan-Burke, 2007a). In a similar vein, the 2010 What Works Clearinghouse document on SCD standards (Kratochwill et al., 2010) recommends the use of effect size calculations only if: (1) visual analysis of graphed data indicates a moderate or strong treatment effect; and (2) the research design meets quality standards for SCD. For data that meet these criteria, Kratochwill and his expert panel (2010) suggest use of a (non-specific) regression-based effect size metric, supplemented by a non-parametric estimator other than PND.

At this point, *neither the SCD nor the quantification literature base is adequately advanced to support an endorsement of any one meta-analytic strategy for synthesis of SCD results*. It follows, then, that some experts advise utilization of all options (i.e., visual analysis, parametric effect size, and non-parametric methods) for quantification of SCD findings (Kratochwill et al., 2010). Until a widely-accepted metric is developed that addresses the theoretical and practical challenges of SCD meta-analysis, quantification decisions will have to be made by each researcher or practitioner on the basis of ideological stance and study/data characteristics (e.g., research question, number of data points, trends). Triangulation of multiple quantification methods that best accommodate the theoretical and practical challenges of each synthesis effort is one possible course. Alternatively, researchers and practitioners may choose to rely on more qualitative syntheses until the quantitative methods are improved. For example, one option for synthesizing SCD findings in a way that is accessible and clinically meaningful involves the following steps: (1) separating high quality studies (i.e., adequate data points, experimental control, measurement of intervention fidelity) from those of inadequate quality; and (2) examining the high quality studies, outlining the effectiveness of the intervention, the population(s) for which it is effective, the conditions under which it is effective, and the social validity of the study's procedures, goals, and outcomes. With both of these synthesis options, an initial process of quality control allows SCD researchers to retain the dependability and power of their conclusions, and produce syntheses of only the most clinically useful findings. This important step responds to a key barrier noted by practitioners in communication sciences and disorders, 62.5% of whom cited inadequate research methodology as a significant barrier to their use of EBP

(O'Connor & Pettigrew, 2009). The idiosyncratic approaches proposed above are inadequate in the long run, however, and it is important that we continue to develop our thinking and methods surrounding incorporation of SCD findings into EBP decision-making.

In order to identify the most effective treatment options for individuals with communication disorders (e.g., autism spectrum disorders, aphasia), priority must be shifted toward production of high quality SCD studies that can be more easily digested by practitioners and researchers alike. For example, future SCD studies should address the issue of inconsistent and inadequate numbers of baseline data points (Kratochwill et al., 2010), provide more complete participant information (e.g., assessment scores, language level, inclusion status, and history of services), and outline clear plans for measurement of intervention fidelity and social validity of goals, procedures, and outcomes, as well as maintenance and generalization of effects. Recent reviews of the SCD intervention literature have found these areas to be sorely lacking (Campbell, 2003; Flippin et al., 2010; Odom et al., 2003) and practitioners in communication sciences and disorders have reported study quality and data presentation as significant barriers to their use of EBP (O'Connor & Pettigrew, 2009). With a renewed focus on producing quality SCD results, we will not only reduce the practical challenges facing practitioners and researchers seeking to synthesize SCD findings, but will also further the literature on intervention for low-incidence and heterogeneous populations that constitute a large portion of those with communication disorders. Throughout this process, we must strive to retain and protect the distinctive, clinically-relevant role of SCD research as a methodology that has as its primary goal to "solve social and personal problems" (Baer, 1977, p. 171).

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CHAPTER 3 (Manuscript 2):

Teaching Pivotal Social-Communication Skills to Preschoolers with Autism: Efficacy of Video vs. In-vivo Modeling in the Classroom

Introduction

Children with autism have significant social-communication deficits (Rogers, 2000; Kanner, 1943) that commonly persist into school-age and impede academic and social success. Indeed, persistent deficits in social interaction and communication are argued to be the defining traits of autism (Scattone, 2007; Constantino et al., 2003) and include such varied skills as play, use of social language, and initiation of social interactions. For individuals with autism, development of early social-communication skills is an integral step toward reaching the academic and social potential that their families, and potentially they, envision (McDuffie, Yoder, & Stone, 2006; Sigman & McGovern, 2005). Since many young children with autism spend the majority of their days in educational settings, practical, efficient, and empirically-supported classroom intervention tools are vital to addressing the pivotal social-communication needs of these young students (Bellini & Akullian, 2007).

The need for cost-effective, innovative treatments that target the core symptoms of autism early on has been highlighted by the United States Department of Health and Human Services' 2010 Strategic Plan, put forth by its Interagency Autism Coordinating Committee (United States Department of Health and Human Services, 2010). With the myriad social opportunities present in early education settings, the preschool classroom is an ideal setting for targeting early social-communication skills that may impact critical lifelong abilities such as establishing friendships, participating in educational activities, and enjoying employment or recreational undertakings. However, with the limited time, funding, and support provided to most classrooms, the task of identifying practical evidence-based intervention strategies is immense and daunting to educators (Browder & Cooper-Duffy, 2003). Furthermore, the additional resources required for intervention training and implementation are often unavailable (Scheuermann, Webber, Boutot, & Goodwin, 2003; Jacobson & Mulick, 2000). As such, educators are in need of practical, time-efficient, and empirically-supported intervention options that require minimal training.

Rooted in Bandura's (1977) work on social learning theory, behavior modeling has been established as an effective tool for creating lasting change in a variety of behaviors. Video behavior modeling emerged in the 1990s as a variation of in-vivo (or live) modeling, a commonly used strategy for teaching children with autism (see Charlop, Schreibman, & Tryon, 1983). In earlier research, the impact of in-vivo modeling was termed "observational learning." With the increasing accessibility and affordability of digital technology, video-based behavior modeling has become an effective and practical option for use in classrooms serving young students with autism (Charlop-Christy, Le, & Freeman, 2000).

Video modeling can be defined as the presentation of a model enacting target behaviors through video-based technology. It is an innovative tool that capitalizes on the relative visual processing strengths of individuals with autism (Minshew, Goldstein, & Siegel, 1997), as well as their often-intense interest in electronic screen media (Mineo, Ziegler, Gill, & Salkin, 2009). More than two decades of video modeling research has shown its efficacy in teaching and changing a variety of behaviors in children with autism, including functional living skills, noncompliant behaviors, and social-communication skills (Nikopoulos, Canavan, & Nikopoulo-Smyrni, 2009; Simpson, Langone, & Ayres, 2004; Sherer et al., 2001). With increasing attention to the far-reaching impact of social-communication deficits on individuals and families faced with autism (Sigman & McGovern, 2005), recent studies have utilized video modeling to improve such early social-communication skills as play-related statements, toy play, and social initiations (Nikopoulos & Keenan, 2003; Taylor, Levin, & Jasper, 1999). With as few as three video modeling sessions, social-communication gains have been shown to generalize across settings, people, and stimuli, and to maintain over a period of as many as three months (Nikopoulos & Keenan, 2004). In 2003, in an article reviewing evidence-based practices for individuals with autism, Odom et al. deemed video modeling a 'probably efficacious' practice for targeting core deficits in children with autism. The subsequent influx of video modeling studies has only added credence to the empirical support of this intervention tool.

Adding to the appeal of video modeling is its practicality and efficiency of use. Very few resources are required for implementation (Gena, Couloura, & Kymissis, 2005), and a single video-based model can be easier to create than a static picture cue (Alberto, Cihak, & Gama, 2005). In addition, video modeling interventions facilitate independence (Hume, Loftin, & Lantz, 2009) and can be readily individualized to students' needs, which is highly important when serving a population as heterogeneous as children with autism. Furthermore, in contrast to the less consistent and more time-intensive tool of in-vivo modeling (Gena, Krantz, McClannahan, & Poulson, 1996), implementation of video modeling promotes consistency and requires very little time, money, and training. In fact, when compared to in-vivo modeling, video modeling takes a fraction of the time for preparation and implementation, and costs about a third less in materials and research time per participant (Charlop-Christy et al., 2000). With the time, fiscal, and personnel constraints limiting educational practitioners, video modeling has great potential to modernize and streamline social-communication intervention in classrooms serving students with autism.

More than two decades of research has established video modeling as a successful, cost-effective, and time-efficient (in terms of training, preparation, and implementation) intervention tool for children with autism (Nikopoulos, Canavan, & Nikopoulo-Smyrni, 2009; Simpson, Langone, & Ayres, 2004; Sherer et al., 2001). Despite its clear promise, however, video modeling is not widely used in classrooms serving students with autism, and has never been compared to other intervention approaches in the school setting. In addition, very few video modeling studies have focused on supporting the emerging, pivotal social-communication skills of preschool-aged students with autism. Therefore, there is a critical need to determine the relative efficacy of video modeling versus other, more established classroom-based intervention tools for improving pivotal social-communication skills in preschoolers with autism. Such information has the potential to aid educational practitioners in choosing the most appropriate empirically supported intervention option for their individual students with ASD (i.e., evidence-based practice).

Two published studies have compared video modeling to in-vivo modeling, examining the relative efficacy of these tools in improving a variety of developmental skills in home and clinic settings (Gena et al., 2005; Charlop-Christy et al., 2000), with differing findings. A home-based study (Gena et al., 2005) found that video and in-vivo modeling facilitated similar learning of appropriate affective behaviors in preschoolers with autism, whereas a clinic-based study (Charlop-Christy et al., 2000) revealed faster acquisition of a variety of skills (including social-communication) when using video modeling with school-aged children with autism. This literature represents initial examinations of the comparative effectiveness of video versus in-vivo modeling in clinic and home settings, but neglects the study of the relative efficacy of these interventions in classroom settings. That gap, as well as the contrasting findings of the two comparative studies, point to the need for more research in this area.

The present study addresses this research gap by examining the relative potential of video and in-vivo modeling as classroom-based social-communication interventions for preschoolers with autism. In order to explore the relative potential of these two interventions, this study was designed to address three research aims: (1) to compare the efficacy of video modeling to that of in-vivo modeling in increasing pivotal social-communication skills of preschoolers with autism in the classroom setting; (2) to compare preschool participants' visual attention to the two model types, allowing for greater insight into the learning process and individual preferences of the participants; and (3) to assess participating educational practitioners' attitudes toward video and in-vivo modeling as potential intervention tools for classroom use (i.e., social validity). Based on findings that adults and peers are equally effective models (Shukla-Mehta, Miller, & Callahan, 2010), and due to consistency- and feasibility-related issues inherent in using preschool-aged peer models, this study employed adult models.

Method

Participants & Setting

With approval from the University of North Carolina at Chapel Hill's Institutional Review Board, five preschool-aged children with autism spectrum disorder (ASD) diagnoses consistent with the Diagnostic and Statistical Manual of Mental Disorders (DSMIV-TR; American Psychiatric Association, 2000) criteria were recruited from local preschool classrooms, and parental consent was obtained. However, one child was withdrawn from the study during the pre-participation assessment process due to behavioral outbursts and extreme difficulty complying with assessment procedures. The child's teacher initiated his withdrawal from the study due to concerns that the interventions would be similarly difficult for him to tolerate, and would disrupt his progress in the classroom. Therefore, four children participated in the entirety of this study. Study data were collected over the course of two academic years, with each individual participant's data collected during one academic year.

Inclusion criteria for participation were: (1) an existing diagnosis of ASD assigned by a licensed psychologist or physician; (2) school-based service provision under the category of autism; (3) vision and hearing acuity within normal or corrected-normal ranges, according to teacher report; (4) ability to visually attend to a video for three minutes, as demonstrated during a pre-participation trial; (5) basic imitation skills, as exhibited during pre-participation assessment; and (6) enrollment in a local public preschool program. Efforts were made to recruit diverse participants in terms of race, ethnicity, and gender.

Autism diagnoses and imitation skills were confirmed prior to study participation using the *Autism Diagnostic Observation Schedule* (*ADOS*; Lord, Rutter, DiLavore, & Risi, 1999). Participants' initial profiles (i.e., language, communication, motor, perceptual, and adaptive behavior skills) were then assessed using standardized assessment tools including the *Vineland Adaptive Behavior Scales*, 2nd Edition (*Vineland-II*; Sparrow, Cicchetti, & Balla, 2005), the *Mullen Scales of Early Learning* (*MSEL*; Mullen, 1995), and the *Preschool Language Scale*, 4th Edition (*PLS-4*; Zimmerman, Steiner, & Pond, 2002). These tools were chosen based on their recommended and successful use in assessing and describing children with autism (Paul & Wilson, 2009; Corbett, Carmean, & Fein, 2009).

The final four participants were recruited from two local preschool classrooms, each housed in a different public elementary school. Each classroom was staffed by a lead teacher and two teaching assistants, and served students with a range of developmental disabilities. Each class was composed of five to six preschool-aged students, with two to three students with ASD diagnoses per class. Both classrooms followed the same instructional format (i.e., five days per week, four hours per day), with similar structure throughout the day (e.g., breakfast, center time, circle time, recess). In order to promote ecological validity, all intervention and data collection took place in participants' classrooms using classroom materials. Throughout this article, pseudonyms are used for child participants.

Isaac, an Asian-American male, was aged 5 years, 4 months at the start of the study. Isaac was diagnosed with autism at 2 years of age. At the time of this study, he was enrolled in a public preschool program for children with developmental disabilities and received speech-language and occupational therapy services at school. Administration of the *ADOS* confirmed Isaac's diagnosis of autism and showed he had deficits in directed vocalizations, gestures, initiation of joint attention, quality of social overtures, and use of stereotyped phrases. Across additional measures, Isaac scored below the level expected for his age, falling in the 13-24 months age range for visual reception, fine motor, and receptive and expressive language skills. Visual reception and fine motor skills were relative strengths for Isaac, placing him at the 24 months age level according to the *MSEL*. However, expressive and receptive language were areas of relative weakness, as Isaac scored in the 13-18 months age range across the *MSEL* and *PLS-4*. Through the *Vineland-II* parent interview, Isaac's parent reported that some of his best language skills included listening to and following simple instructions and using first names to refer to familiar people. In interpersonal relationships, Isaac's parent reported that he was able to imitate complex actions of others, show affection for familiar people, and play simple interaction games. Observations of Isaac in the classroom by research staff showed him to be a child who smiled often and used delayed echolalia, jargon, eye contact, and non-word vocalizations to communicate (i.e., mainly to request highly desired objects/activities). Additional observations were that Isaac enjoyed jumping, physical contact (e.g., being tickled), and music. Isaac's teacher reported that he experienced a regression in his language and attention skills following a recent break from school.

Selena, an African female adopted by Caucasian-American parents, was aged 4 years, 8 months at the start of the study. She was enrolled in the same public preschool classroom for children with developmental disabilities as Isaac. She was diagnosed with autism at 4 years of age, and was also diagnosed with microcephaly and metopic craniosynostosis at 5-6 months of age. Selena received speech-language and occupational therapy services at school and attended outside therapy sessions three to four times per week. Administration of the *ADOS* confirmed her diagnosis of ASD and documented Selena's deficits in her use of eye contact, shared enjoyment, and quality of social overtures. Across additional measures, Selena scored below the level expected for her age, falling in the 10-27 months age range for visual reception, fine motor, and receptive and expressive language skills. Receptive language was a relative strength for Selena, placing her in the 25-27 months age range across the *MSEL* and *PLS-4*. However, expressive language was an area of relative weakness, as she scored in the 10-14 months age range across the *MSEL* and *PLS-4*. Through the *Vineland-II* parent interview, Selena's parent reported that expressively, Selena was able to use signs and words to label objects, answer questions, and express single-word requests (with occasional phrase speech). In terms of social skills, Selena's parent reported that Selena had a best friend, imitated relatively complex behaviors hours after watching the actions performed, and used actions to show happiness or concern for others. Observation of Selena in the classroom showed her to be a happy child who communicated (mainly requests and joint attention) through manual signs, gestures, vocalizations, and single words. She was also observed to attend well to adult-led activities and show enjoyment (although rarely shared with others) during reading, play, and physical activities such as jumping.

Nicholas, an African-American male, was aged 3 years, 9 months at the start of the study. He was enrolled in a public preschool program for children with developmental disabilities (at a different school than Isaac and Selena), and received speech-language and occupational therapy services at school. He attended outside therapy sessions one to two times per week. Administration of the *ADOS* confirmed his diagnosis of autism and showed Nicholas' deficits to include limited use of gestures (i.e., showing), eye contact, vocalizations, and facial expressions to communicate with others. Across additional measures, Nicholas scored below the level expected for his age, falling in the 8-26 months age range for visual reception, fine motor, and receptive and expressive language skills. Visual reception and fine motor skills were relative strengths for Nicholas, placing him in the 26 months age range on the *MSEL*. However, expressive language was an area of relative weakness, as he scored in the 8-13 months age range across the *MSEL* and *PLS-4*. Through the *Vineland-II* parent interview, Nicholas' parent reported that expressively, Nicholas was able to say his name when asked, identify body parts, attempt to repeat words, and use pointing and pulling to direct others' behavior. Regarding social skills, Nicholas' parent reported that he was able to imitate simple and complex actions and show affection for familiar people. In the classroom, research staff observed Nicholas to be a happy child who learned routines quickly, enjoyed dancing and watching videos, but rarely interacted with his peers. He also was observed to have difficulty attending to adults during group activities, but to check in with adults after performing an undesired behavior.

Sarah, a Caucasian female, was aged 4 years, 3 months at the start of the study. She was enrolled in the same classroom as Isaac and Selena, but during a different school year and with a different teaching assistant. Sarah received speech-language and occupational therapy services at school and attended outside therapy sessions three to four times per week. Administration of the *ADOS* confirmed her diagnosis of autism and showed Sarah's deficits to include limited use of eye contact, gestures, vocalizations, and facial expressions to communicate with others. Across additional measures, Sarah scored in the 13-20 months age range for visual reception, fine motor, and receptive and expressive language skills. Visual reception and fine motor skills were relative strengths for Sarah, placing her in the 20 months age range on the *MSEL*. However, receptive and expressive language were areas of relative weakness, as she scored in the 11-13 months (receptive) and 15-16 months (expressive) age ranges across the *MSEL* and *PLS-4*. Through the *Vineland-II* parent interview, Sarah's parent reported that expressively, Sarah was able to label objects, and occasionally use single words or gestures to make requests or answer questions. Sarah's parent also reported that she showed happiness, concern, and affection for others, and imitated simple actions like waving goodbye. Research staff observed Sarah to be a driven, anxious child who communicated in the classroom through sounds, gestures, and negative behaviors such as hitting and pulling hair. She also was observed to enjoy adult attention and affection, play social games initiated by an adult, and engage in solitary, repetitive, but at times functional, play. By teacher and parent report, Sarah started taking anxiety medication at the start of baseline data collection.

Adult Participants

Two lead teachers (i.e., models) and three teaching assistants (i.e., interaction partners and activity facilitators) participated in the interventions compared in the present study. Isaac, Selena, and Sarah had the same lead teacher, but Sarah had a different teaching assistant participate as her facilitator due to a staffing change between school years. Nicholas attended a different school, so a separate teaching team participated in his interventions. All adult participants were Caucasian, four were female, and one was male (a teaching assistant). All participating teachers held bachelor's degrees, and teaching assistants were either working towards completion of an associate's degree or held a bachelor's degree. Adult participants had a range of 2-16 years' experience working with students with autism. Participating teaching teams reported incorporating technology into their classrooms multiple times per week (using tablet PCs and laptop projection, in addition to the present study's procedures) and focusing primarily on communication in their instruction.

Design

Single-case design (SCD) is a rigorous and systematic methodology that examines the causal relationship between actively manipulated independent variables and socially significant dependent variables (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005). SCD, unlike large group designs, allows for detailed examination of the *process* of skill acquisition in individuals, which is especially important in efficacy studies that serve to inform later effectiveness trials (Kratochwill et al., 2010). SCD is a methodology well suited to identification of evidence-based practices for heterogeneous, low-incidence populations such as individuals with autism (Kratochwill et al., 2010; Van den Noortgate & Onghena, 2008). The present study utilizes a multi-element design with baseline and replication across participants to determine comparative effects of video and in-vivo modeling. This design allows for both within- and between-participant comparisons and represents a behavior analysis methodology specifically intended for comparing effects of two treatments.

Procedure

Determination of Target Behaviors*:* A target social-communication behavior was determined and operationally-defined for each child using semi-structured assessment procedures and a corresponding social-communication skill hierarchy, both of which were used successfully in a previous intervention development study targeting pivotal social-communication skills in preschoolers with autism (see Dykstra, Boyd, Watson, Crais, & Baranek, 2012). These tools are based on research with typically developing children and children with autism. Importantly, this method of identifying goals allowed targeting of behaviors that lead to development of pivotal social-communication skills (e.g., joint attention) suggested to form early foundations upon which later social-communication skills are built. The semi-structured assessment was completed by the author and a trained research assistant, and involved (1) 30 minutes of naturalistic classroom observation of the child participating in multiple small group contexts (e.g., free play, snack time) and (2) adult-facilitated participation in one-on-one play scenarios (e.g., action toys, book, physical games), structured to allow the child opportunities to display various social-communication skills in areas of joint attention, requesting, and social interaction. The research team used accompanying worksheets to record and score the child's displayed skills and a corresponding social-communication skill hierarchy to identify an appropriate target behavior for each participant. Once a social-communication target was identified for a child, research staff consulted with the child's teacher and parent to confirm whether they endorsed the target behavior as an appropriate and meaningful goal for the student (i.e., to determine social validity of goals).

Determination of Intervention Contexts*:* To determine intervention contexts and materials for each child, the research team used a multiple-stimulus preference assessment procedure found to identify confirmable and stable preferences in young children with autism (Carr, Nicolson, & Higbee, 2000). This procedure involved three identical sessions in which the child was shown eight stimuli and instructed to choose preferred items until all were selected. In this way, stimuli were ranked from highest preference to lowest preference and used to identify motivating and preferred materials (e.g., book, crayons) and related contexts (e.g., reading center, art center). For each child, the interventions were then randomly assigned to two different contexts of comparable preference (i.e., within five percentage points), so that each intervention was provided in an independent but functionally similar context.

Adult Participant Training*:* Modeling conditions consisted of the teacher and teaching assistant interacting with one another while the child observed. Each participating teacher/model was trained by the author to accurately and consistently perform the student's target behavior in the in-vivo and video modeling conditions. Each participating teaching assistant/facilitator was trained to perform in his or her role, which involved providing materials and giving semi-structured opportunities for the targeted social-communication behavior, but not modeling the target behavior. Adult participants were given semi-structured scripts and immediate feedback to guide sessions.

Video Model Recording*:* Following training of the adult participants, the author recorded a three-minute video model for each child, with the child's teacher serving as the model and teaching assistant as the facilitator of the activity through which the modeling took place. Video and in-vivo interventions were matched for length (i.e., three minutes), number of models given (i.e. 11 models), and general setting characteristics (e.g., in the classroom, free of excessive distractions). Interventions were generally provided while other children were in the classroom, and all adult actions included in the modeling interventions were performed at a natural (vs. slower than normal) pace.

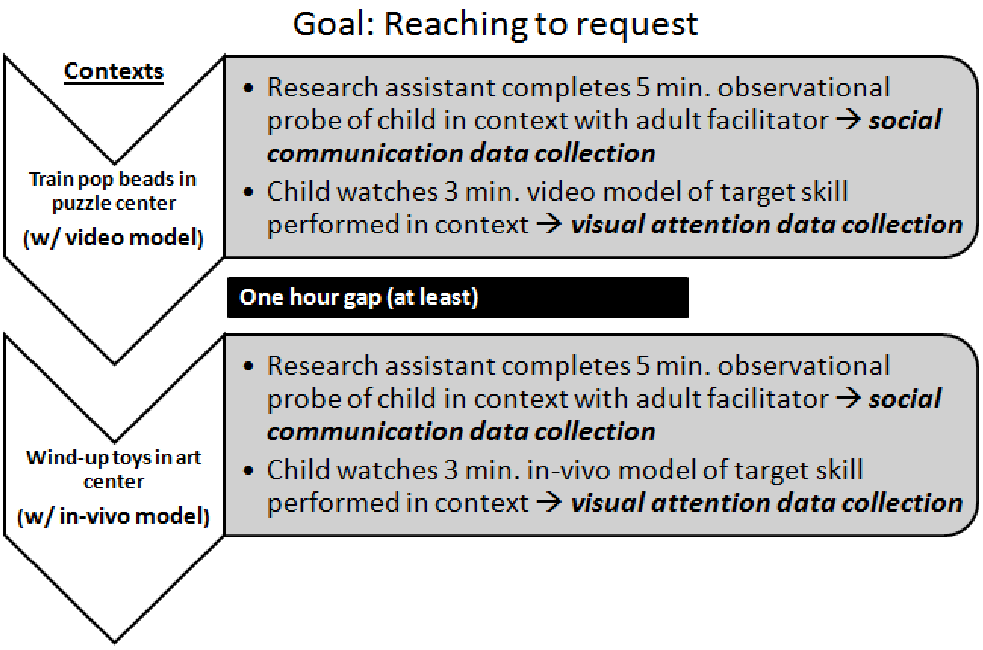
Data Collection*:* All observational data were collected by trained research assistants blind to the study's hypotheses, using pen and paper protocols for both social-communication and visual attention data collection, and an automated interval indicator (that provided a beep through headphones every five seconds) for the visual attention data collection, as described below.

Baseline measures of each child's target social-communication behavior were taken in each context (i.e., pre-determined activity/materials, with facilitation by teaching assistant) approximately three times per week during five-minute observational probes for a minimum of five data points or until responses stabilized (Kratochwill et al., 2010). In Selena's case, however, a stable baseline was especially difficult to achieve in one context, and the school calendar (i.e., approaching end of school year) made it imperative that we move forward with treatment before a predictable trend was revealed. Following baseline, the teacher/teaching assistant team provided each treatment to the child for three minutes, an average of three times per week, for a minimum of five sessions (Kratochwill et al., 2010) and a maximum of fifteen sessions, with the length of actual data collection dictated partially by the school calendar, participant availability, and participant performance (e.g., extending data collection due to delayed response to intervention).

Both treatments were provided on each day of data collection, with at least one hour between treatments, and with the order of treatments randomized by the author daily to reduce order effects. A binomial test examining treatment order and outcome data confirmed that the order of treatments was not significantly related to social-communication outcomes.

During treatment delivery, the research assistant used momentary time sampling to record presence or absence of visual attention to the model based on the child's attention state every five seconds (36 times) during the three-minute treatment session. Gestural and verbal prompts were given to the child to attend to each model as needed (i.e., when not visually attending) during treatment sessions. To examine the effects of the intervention, the same research assistant conducted a five-minute observational probe to assess the child's retention of learning, with these probes conducted each day of treatment prior to each treatment session in the same context as that used for the treatment (i.e., modeling). Conducting this observation prior to the corresponding treatment (vs. following the treatment) allowed the research team to measure learning over time, as opposed to direct imitation. During the five-minute observational probes, the research assistant recorded the number of occurrences of the target behavior. See Figure 3.1 for an example of a daily enactment of the intervention and data collection procedures.

Figure 3.1 Example of Daily Study Procedures



Approximately two to three weeks following the final treatment session (which occurred on the second to last day of treatment data collection), a research assistant followed the same observational procedure (i.e., five-minute observational probes in each context) for two days to assess maintenance of any treatment effects; however, no visual attention data were captured during this follow-up phase, as no modeling treatments were being provided during these sessions.

Intervention Rating: Following treatment, participating teachers and teaching assistants independently completed the *Intervention Rating Profile* (*IRP-15*; Witt & Martens, 1983), indicating their impressions of the acceptability and practicality of both video modeling and in-vivo modeling as classroom-based intervention procedures (i.e., to determine social validity of procedures). The *IRP-15* has an internal consistency of .98 and offers general guidelines for interpretation (Witt & Martens, 1983). Adult participants also completed a brief questionnaire with demographic questions related to training and experience. This questionnaire also asked questions related to classroom practices, perceived outcomes of each intervention (i.e., social validity of outcomes), and the likeliness of using each intervention following the end of the study. After completion of the study, each participating classroom received a miniature digital camcorder with USB connector as compensation for participation, and as a means of promoting sustainability of the video modeling intervention method, if desired.

Target Behaviors & Contexts

As described above, each participating child's target behavior was determined based on assessment results, observation, and consultation with the child's teacher and parent. The intervention contexts were based on the preference assessment results, with the child exhibiting equivalent preference for the two contexts randomly assigned to the two interventions. Attempts were made to choose contexts through which the child exhibited similar baseline frequencies of the target social-communication behavior, and this was achieved for three of the four participants. For each child, the two contexts were characterized by different settings and sets of materials. Information regarding each child's target behavior and intervention contexts is presented in Table 3.1.

Table 3.1 Participants' Target Behaviors and Intervention Contexts

Child	Target Behavior	Operational Definition	Video Modeling Context (Setting)	In-vivo Modeling Context (Setting)
Isaac	Reaching for an out-of-reach object to show wanting that	Extending hand toward an object without clear intent to grab the object (i.e., must pause, retract	Wooden car chute with colored toy cars that roll back and forth down	Bingo board game with cards picturing different colored bears and bingo

	object (i.e., as a request)	hand, and not touch the object)	the chute (table in puzzle center)	boards (floor in reading center)
Selena	Pointing to a nearby object/ picture while vocalizing to share interest with another person	Forming a clear point (i.e., index finger extended) and directing the point to a nearby object/picture with coinciding vocalization, and clear intent to share interest with another person (i.e., not a request for an action or object)	Illustrated story book with a predictable structure (bean bag chair in reading center)	Clear plastic jar with screw-on lid, containing many different colored wooden blocks in the shape of balloons (floor in free play center)
Nicholas	Using a gesture to indicate wanting more after a brief adult-initiated pause in the activity	Indicating desire for more materials or for an activity to continue through use of one of the following gestures: signing 'more,' reaching for materials without grabbing (i.e., hand stays open; retracted), or pointing to materials	Wooden car chute game with three different colored cars and a button to send them down the track (table in independent work area)	Large rubber (exercise) ball for kicking and bouncing back and forth with a partner (floor in teacher work area)
Sarah	Using a gesture to indicate wanting more after a brief adult-initiated pause in the activity	Indicating desire for more materials or for an activity to continue through the use of one of the following gestures: reaching for materials without grabbing (i.e., hand stays open and is retracted), or pointing to materials	Different colored pop beads in the shape of vehicles (table in puzzle center)	Clear plastic jar with screw-on lid, containing many small, colorful wind-up toys in the shape of different animals (table in art center)

Intervention Fidelity

This study measured treatment fidelity of both video and in-vivo modeling interventions. Measuring the fidelity of both treatment conditions adds procedural validity to the study's findings and allows for more accurate replication. Fidelity of in-vivo modeling (e.g., length, setting, number of models) was assessed by research staff through direct real-time observation during 26% of treatment sessions using a pre-established checklist. In-vivo modeling fidelity averaged 96% across the four participants. As suggested by Delano (2007), for video modeling, two independent raters assessed the accuracy and quality of each videotaped depiction of a target behavior prior to implementation using a pre-established checklist (checklists available from the author upon request). Videos were re-recorded or edited if the average fidelity score fell below 90%. Two videos were edited to enhance the audio quality and increase its fidelity, and the average fidelity of the final videos used in the study was 96%.

Interobserver Agreement

Interobserver agreement was calculated for social-communication data for each participant during baseline (28% of sessions), treatment (30% of sessions), and maintenance (50% of sessions), with 92% agreement across participants (range from 86% to 100%). Interobserver agreement was calculated for visual attention data taken during 23% of sessions during the treatment phase, with 93% agreement across participants (range from 90% to 95%). The author served as the second observer during all sessions through which interobserver agreement was calculated.

Results

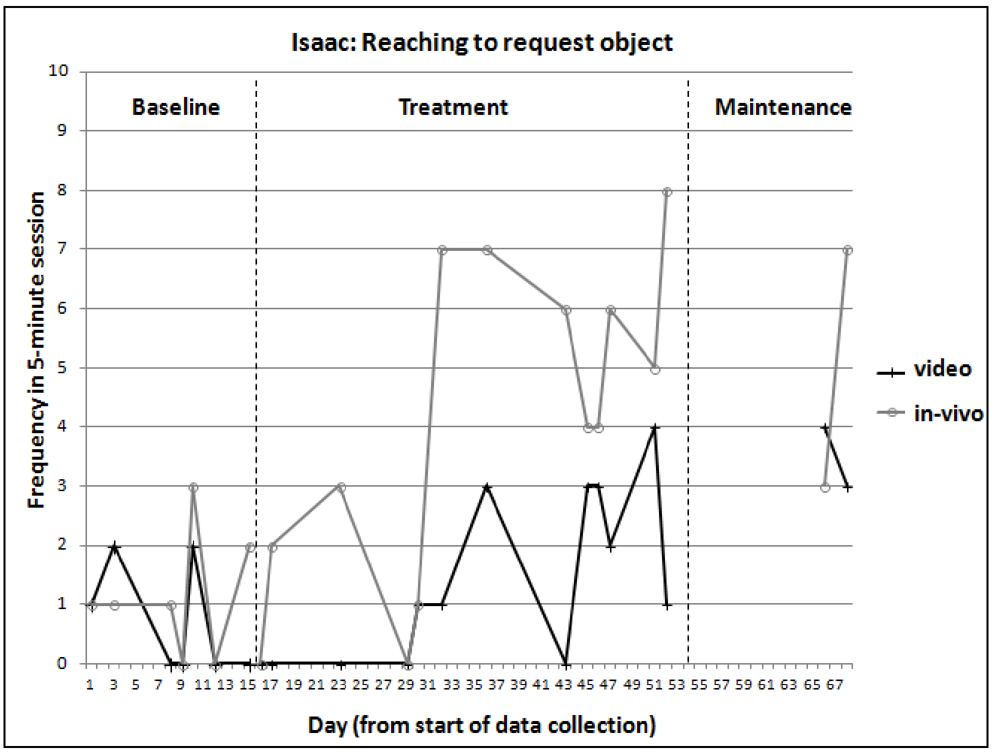
Social-Communication

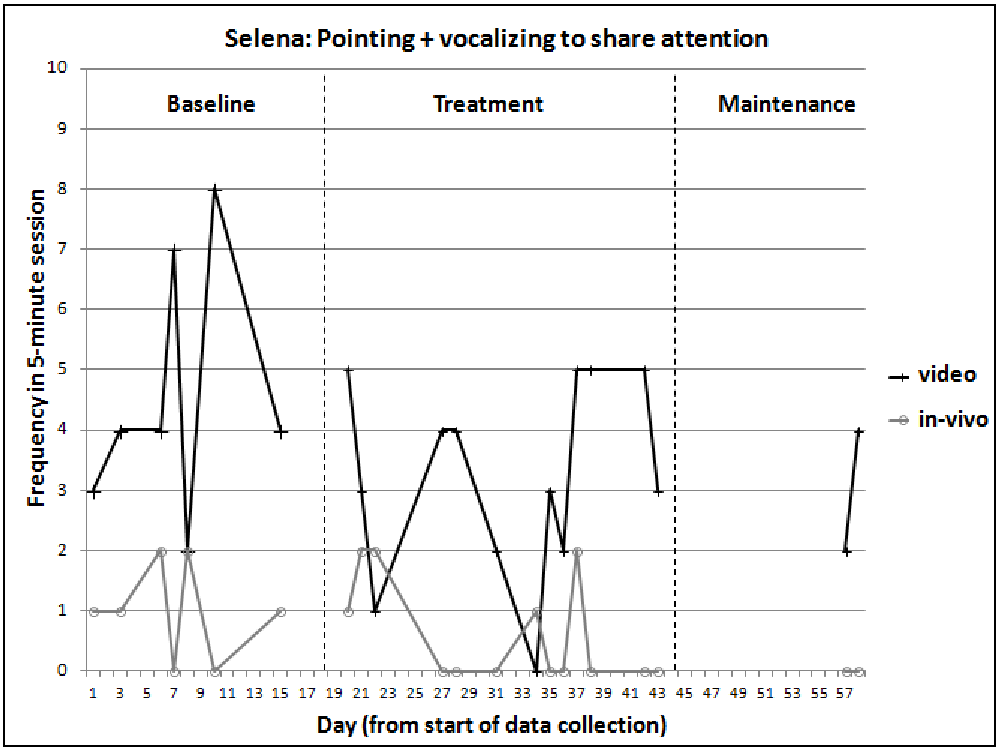
Social-communication data are organized into time-series graphs for each participant (see Figure 3.2), with time (i.e., session number across baseline, treatment, and maintenance phases) represented on the x-axis and frequency measurement of outcome variables represented on the y-axis. Time-series graphs were analyzed using visual analysis of level, trend, variability, and immediacy of effect. In cases where visual analysis provided evidence of a causal relation between one or both of the treatments and the outcome variable, calculations were conducted to compare each participant's baseline and treatment data for each intervention, providing a numerical index for comparison (Kratochwill et al., 2010). Because this study, along with most SCD studies, has too few data points to satisfy the underlying statistical assumptions of parametric effect size metrics (i.e., linearity and independence of residuals; Allison & Gorman, 1994; Beretvas & Chung, 2008; Olive & Smith, 2005; Parker et al., 2007; Wolery et al., 2008), a non-parametric data overlap method was utilized: non-overlap of all pairs (NAP; Parker & Vannest, 2009).

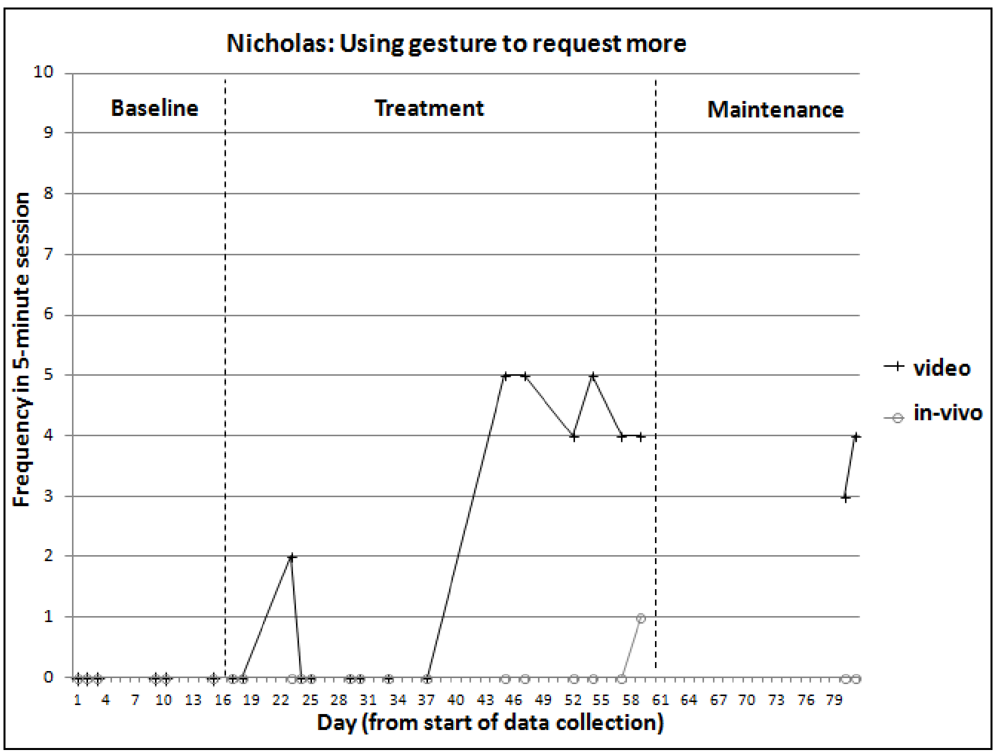
NAP is a quantification method that has been field tested to indicate higher precision and discriminability than other overlap methods. Similar to other existing overlap quantification (e.g., Percentage of All Non-overlapping Data, Percentage of Non-overlapping Data, Percentage of data Exceeding the Median) and traditional visual analysis methods, NAP defines non-overlap as a phase B (treatment phase in this study) data point being *higher than* a phase A (baseline in this study) data point in studies where increased target behavior is the goal (Parker & Vannest, 2009). Thus, non-overlap reflects improvement from one phase to the next (Parker, Vannest, & Davis, 2012). Different from other overlap methods, NAP pairs each (vs. highest or median) baseline data point with each treatment data point, assigning one point for an overlap (i.e., treatment data point is lower than baseline data point), zero points for non-overlap (i.e., treatment data point is higher than baseline data point), and half a point for a tie (i.e., treatment data point is equal to baseline data point). The final percentage of non-overlapping data pairs is then calculated by determining the number of comparison pairs showing no overlap (or partial overlap, i.e., a tie) and dividing by the total number of comparisons. The total number of comparisons is determined by multiplying the number of data points in baseline times the number of data points in treatment (e.g., 7 x 13=91). Results offer a percentage of non-overlapping pairs, with a higher percentage of non-overlap indicating a greater effect. In cases where data points in baseline and treatment phases are equal, the NAP is equal to 50% (Parker & Vannest, 2009). NAP can be calculated through computerized statistical analysis tools using a receiver operator characteristic curve (ROC) module or a Mann-Whitney *U* test, or through simple hand calculations (Parker, Vannest, & Davis, 2012), as it was in this study. Based on comparisons to expert visual analyses, Parker and Vannest (2009) offer tentative guidelines for interpretation of NAP, with 0%-65% non-overlap reflecting weak effects, 66%-92% medium effects, and 93%-100% strong effects.

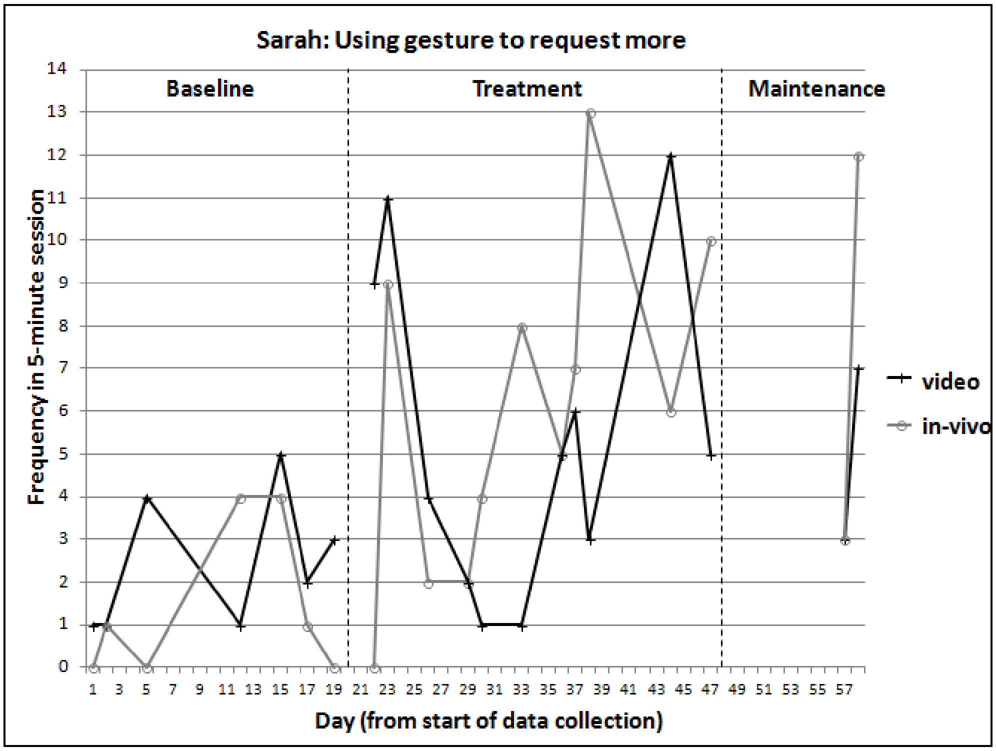
The NAP percentages allow for useful juxtaposition of treatment effects both within and across participants, with an additional method used to test for statistically significant differences between video and in-vivo data sets for individual participants. A non-parametric binomial test was used first to determine whether baseline frequencies of a participant's target social-communication behavior in the two treatment contexts were non-signficant. If this desired non-significant result was obtained for the baseline, then a binomial test was used to indicate whether, following the onset of the two treatments, a participant's two social-communication data series were significantly different, approaching significance, or non-significant.

Figure 3.2 Social-Communication Target Behavior Graphs




Selena: Pointing + vocalizing to share attention
Baseline
Treatment
Maintenance
Frequency in 5-minute session
Day (from start of data collection)
video
in-vivo


Nicholas: Using gesture to request more
Baseline
Treatment
Maintenance
Frequency in 5-minute session
Day (from start of data collection)
video
in-vivo



Isaac’s social-communication graph shows predictable patterns in baseline data for both the video and in-vivo modeling contexts. In the video modeling context, the initiation of the treatment resulted in an upward trend, slightly increased level, and increased variability in Isaac’s use of a reach to request. The effects were not immediate, however, and reflect questionable effectiveness due to eight of thirteen data points overlapping between the baseline and treatment phase in this context. Following the onset of the in-vivo modeling treatment, Isaac’s use of reaching to request similarly increased in level, trend, and variability; however, these effects were more immediate, to a greater degree, and resulted in only five overlapping data points between the baseline and treatment phases. Intervention effects were maintained after two weeks without treatment. Overlap analyses were completed for both treatments using the NAP procedure, with the following results: 63% non-overlap, confirming a weak effect for video modeling consistent with the visual analysis, and 81% non-overlap for in-vivo modeling, falling in the upper portion of the medium effect range. The binomial test further indicated that there was no significant difference in baseline data across treatments, but that there was a significant (p=.011) difference in Isaac's use of reaching to request during the treatment phase, favoring the in-vivo modeling treatment.

Selena's social-communication graph shows a predictable pattern in the baseline data for the in-vivo modeling context, but not for the video modeling context. In addition, the onset of the treatments resulted in no positive change in level or trend for her use of pointing and vocalizing to initiate joint attention. In addition, all treatment data points overlapped with baseline data points in both contexts. Due to the lack of a visually detectable functional relationship between either of the treatments and the outcome variable, and a significant difference between baseline measures of the target behavior across the two contexts, no further analyses were completed on Selena's social-communication data.

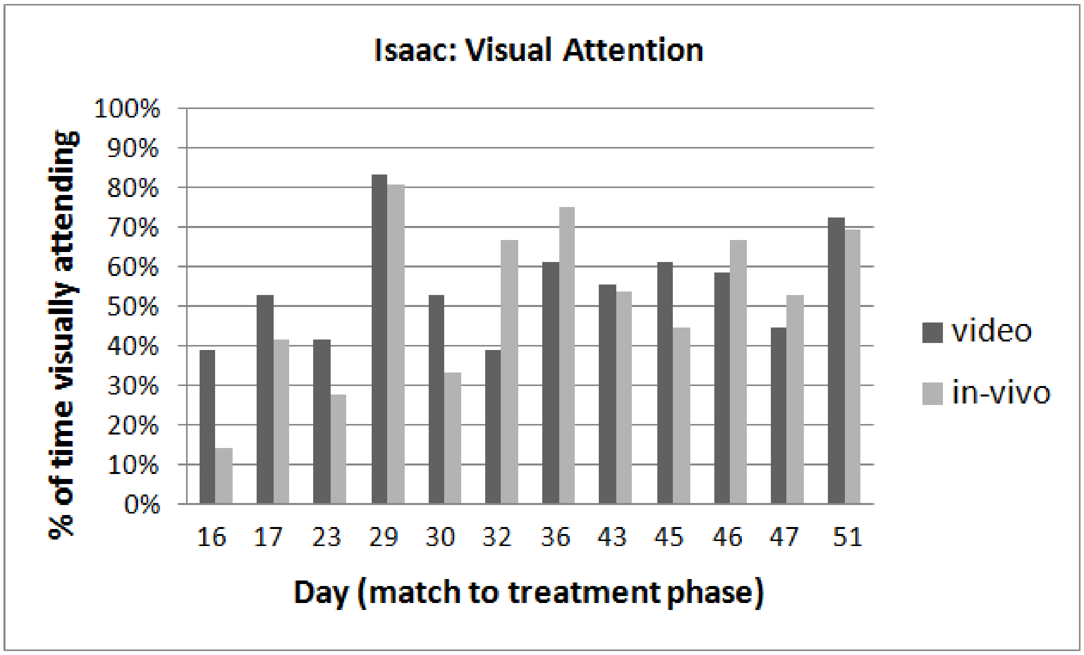
Nicholas' social-communication data show a predictable baseline pattern, followed by a delayed response to the video modeling treatment. In the video modeling context, following eight treatment sessions, Nicholas showed an upward trend, increased level, and increased variability in his use of gestures to request more, and intervention effects were maintained after three weeks without treatment. Because the effects were not immediate, seven of the first eight data points in the video modeling treatment phase overlap with baseline data. In contrast, virtually all treatment data in the in-vivo modeling context overlap with the baseline data (the last treatment session showed a slight increase), with baseline and treatment data points largely falling at 'zero' in this context. Overlap analyses were completed for both treatments using the NAP procedure, with the following results: 73% non-overlap for video modeling, indicating a medium effect and 53% non-overlap for in-vivo modeling, indicating virtually no effect. It is important to note that with all baseline data points falling at zero, the minimum NAP percentage possible was 50%, as 0.5 point is assigned to each 'tie' and clearly, no data could fall below the baseline data points to reflect true overlap. Binomial test results show no significant difference between Nicholas' baseline data across contexts, and a trend toward significance ($p=.059$) in the comparison of his response to the two treatments. If data collection had been extended in the treatment phase, this difference may have moved from approaching significance to significance; however, we can only note a trend toward significance in favor of video modeling, given the data collected for the present study.

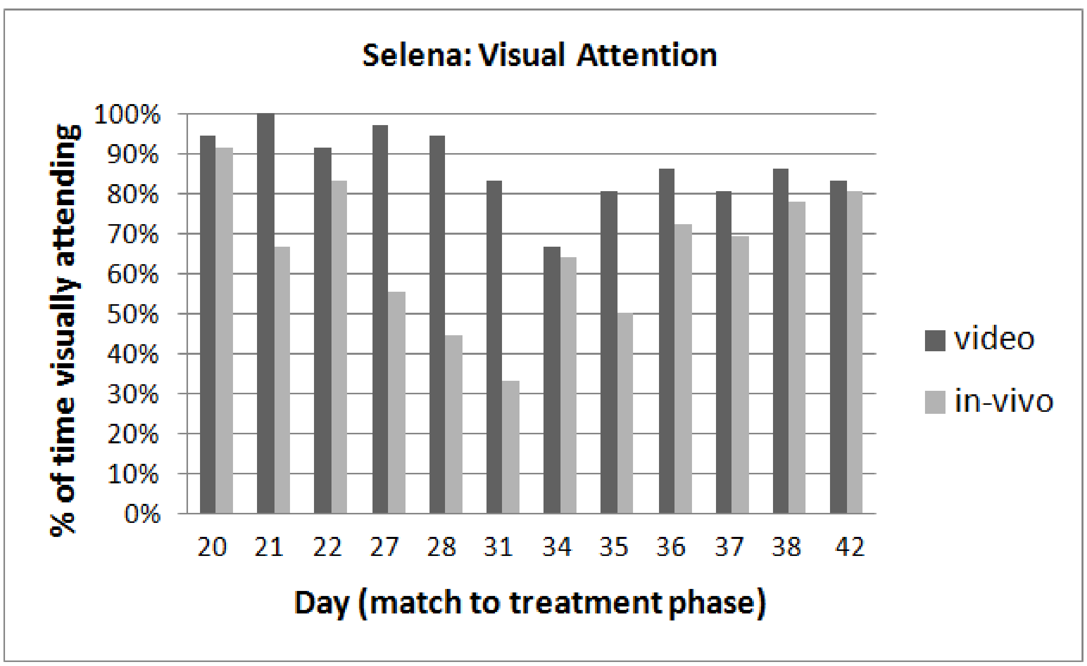
Sarah's social-communication data show predictable baseline patterns for both the video and in-vivo modeling contexts, with the binomial test showing no significant difference between baseline data across contexts. The onset of the two treatments resulted in an upward trend in the data, which was more immediate in the in-vivo modeling context than in the video modeling context. The increased variability seen in both data series was more pronounced in the in-vivo modeling context, with the video modeling data showing a more steady increase in level and a more pronounced upward trend. When compared to the baseline data, Sarah's treatment data show low percentages of overlap with baseline data points in either context, with an NAP of 80% for video modeling and 86% for in-vivo modeling. These NAP values indicate both treatments produced effects in the upper portion of the medium effect range. Although the in-vivo modeling data had a greater percentage of non-overlapping pairs between baseline and treatment phases, indicating a greater effect, the binomial test showed no significant difference between video and in-vivo data during the treatment phase. Overall, visual analysis and NAP calculations evidence a meaningful response to both treatments, with the binomial test indicating that Sarah's response to both treatments was equally positive. Follow-up data taken about two weeks following the last treatment session showed marginal maintenance of skills, with one data point within baseline range and one greater than the highest baseline data point for each context.

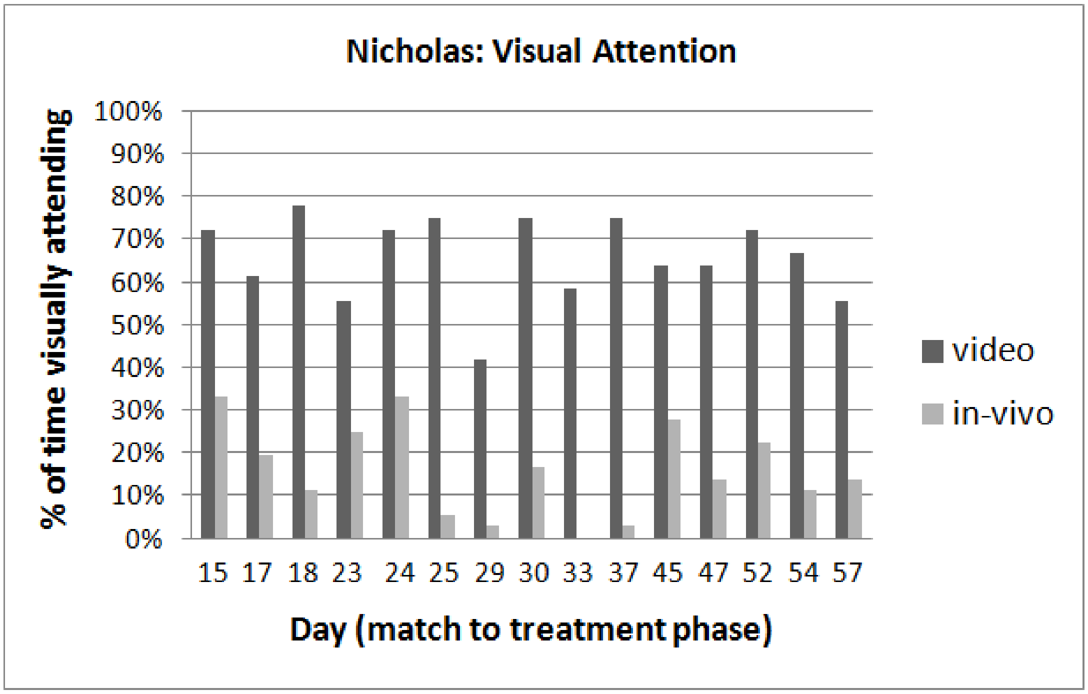
Visual Attention

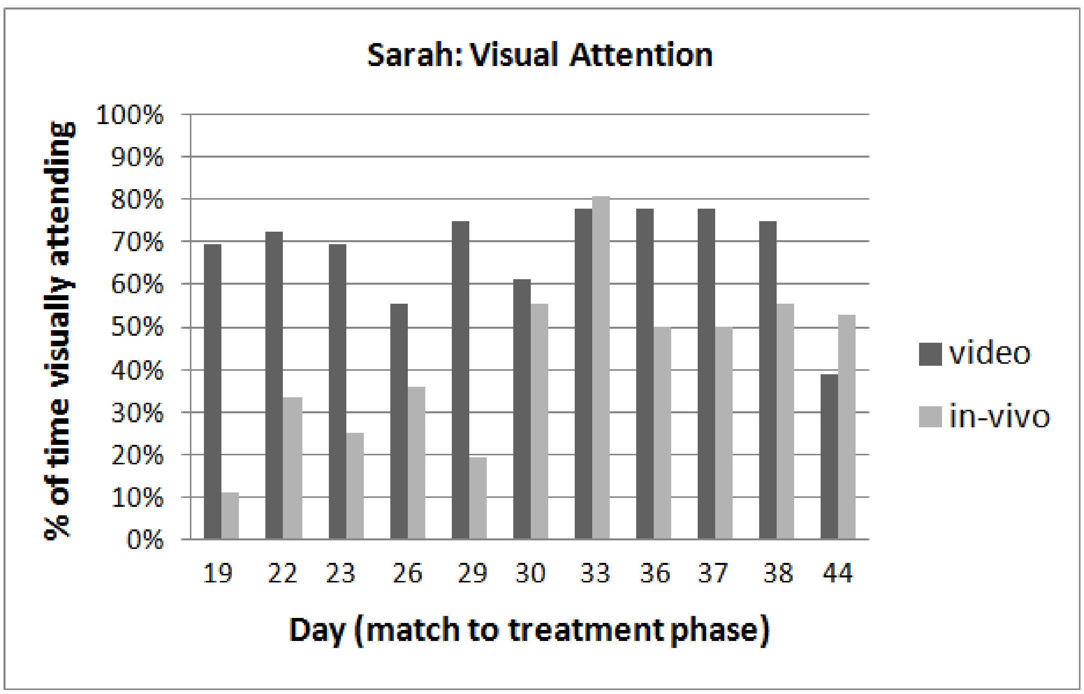
Data reflecting participants' visual attention to the video and in-vivo models are presented in Figure 3.2 as a series of percentages reflecting the proportion of intervals during which each participant attended to the particular model type (i.e., video or in-vivo) on each day of treatment. Days on the x-axis correspond to the days elapsed since the start of study participation, as indicated on the social-communication graphs. These data are used to illustrate variability in participants' attention to the video and in-vivo model types, and to inform differences in the social-communication outcome data. Statistical analysis of the visual attention data for each participant was conducted using a non-parametric Wilcoxen signed rank test for related samples, with the purpose of identifying statistically significant differences in visual attention to the two different model types.

Figure 3.2 Visual Attention Graphs









Isaac's visual attention data show similar mean levels of attention to the two model types across treatment sessions (video: 55%, in-vivo=52%), with a Wilcoxen test showing no significant difference (p=.410). However, visual examination of his data reveals that a shift in his visual attention preference corresponded to the initiation of his positive response to the treatments, especially to the in-vivo modeling. During the first five treatment sessions, Isaac showed greater visual attention to the video model by a margin of 14%. However, during the remaining treatment sessions, when he responded most positively to the in-vivo model by showing greater frequency of reaching to request in that context, he also showed greater visual attention to the in-vivo model by 5%, a shift of nearly 20%.

Selena’s visual attention data show significantly greater visual attention to the video model (p=.002), with mean visual attention of 87% and 66% for the video and in-vivo models, respectively. The difference between her visual attention to the video and in-vivo models ranged from less than 3% at the start and end of the treatment phase to as much as 50% in the middle of the treatment phase. Despite the lack of functional relationships in Selena’s social-communication outcome data, her visual attention data reveal interesting patterns of preference and attention.

Nicholas’ visual attention data show significantly greater visual attention to the video model (p=.001), with mean visual attention of 65% and 18% for the video and in-vivo models, respectively. Across all treatment sessions and with no discernible pattern, Nicholas’ visual attention was 30-69% greater for the video model than the in-vivo model.

Sarah’s visual attention data show significantly greater visual attention to the video model (p=.010), with mean visual attention of 68% and 43% for the video and in-vivo models, respectively. Sarah attended to the video model more than the in-vivo model on nine out of eleven days of treatment; however, the data show a gradual increase in her attention to the in-vivo model over the course of her participation. As evidence of that trend, Sarah's visual attention to the video model was, on average, 43% greater than her visual attention to the in-vivo model over the first five treatment sessions, while it was, on average, only 11% greater over the last six treatment sessions.

Intervention Rating

Total scores from the *IRP-15* were averaged across educational practitioners to determine a mean index of acceptability for video modeling and in-vivo modeling. The *IRP-15* is scored with 15 as the lowest possible rating and 90 as the highest, with 52.5 as a suggested minimum index of intervention acceptability (Von Brock & Elliot, 1987). Across participating educational practitioners, the mean *IRP-15* score for video modeling was 82 (range: 76-90) and for in-vivo modeling was 79 (range: 60-89).

Additional questionnaire data collected from participating educational practitioners revealed that five out of six perceived the video modeling treatment to be more effective during the course of the study (all but Isaac's teaching assistant). In addition, all participating practitioners reported that they were likely to use video modeling following the completion of the study, while only four out of six reported that would likely use in-vivo modeling (all but Nicholas' teacher and teaching assistant).

Discussion

The present study compared the efficacy of video modeling and in-vivo modeling as classroom-based interventions aimed at increasing pivotal social-communication skills in preschoolers with ASD. Comparisons between the two interventions were made through examination of students' social-communication outcomes, their visual attention to the two model types, and the attitudes of participating educational practitioners regarding the acceptability and practicality of each intervention. Across these three areas, results of the present study provide similar levels of support for both modeling interventions, with varied outcomes across individual participants that raise interesting questions for future research. Findings are discussed in greater detail below, as they pertain to each of the study's three research aims.

Social-Communication Outcomes

Three of the four study participants (Isaac, Nicholas, and Sarah) increased their use of individualized social-communication target behaviors in response to one or both modeling interventions. Of the three participants who responded to intervention, one participant responded to both the in-vivo and video modeling treatments (Sarah), another responded to the video modeling treatment only (Nicholas), and a final participant responded to the in-vivo modeling with weak response to the video modeling (Isaac). All treatment effects were maintained at least two weeks following treatment, although Sarah's maintenance data show one data point at baseline level and one above. This study's findings add to the extensive body of literature evidencing the effectiveness of behavior modeling as an intervention option for addressing the social-communication needs of young students with ASD; however, the comparative efficacy of these two interventions was the principal focus of this study. Interestingly, then, of the three participants who responded to one or both treatments, outcomes favored video modeling in one case and in-vivo modeling in another case, while treatments were equally effective in the final case. These results are not entirely consistent with the current literature, which has shown video modeling to be as effective (Gena et al., 2005) or more effective (Charlop-Christy et al., 2000) than in-vivo modeling in affecting a variety of behaviors in children with ASD. Although the video modeling literature points to the overall effectiveness of this intervention for children with ASD, the present study suggests that some students with ASD may learn more efficiently through in-vivo modeling, or possibly even a combination of modeling modalities.

In this study, the research staff devoted considerable effort to assessment and observation of the child participants prior to the beginning of intervention in order to provide rich quantitative and qualitative information on each child. Although patterns in participants' standardized assessment scores or observed classroom behaviors do not appear to offer explanations for their varied responses to the modeling interventions, systematic efforts to provide thorough participant descriptions across SCD studies may aid in generating hypotheses about child variables predicting response to different modeling treatments as results are synthesized across studies (Wilson, 2011). In order to develop empirically-supported practice guidelines for the use of classroom-based modeling interventions (video and in-vivo), future research must strive to identify which children will learn best from video modeling, from in-vivo modeling, or even from a combination of these treatment methods. Working from the many literature reviews and meta-analyses of the video modeling literature, future researchers could develop hypothesis-driven studies to examine potential pre-treatment skills and characteristics (e.g., visual reception skill level, interest in social interaction, desire for sameness) that will help educational practitioners match students with the modeling intervention likely to be most effective for each one, based on students' respective profiles.

Factors other than child characteristics may be relevant to interpreting the heterogeneity in child responses to modeling interventions in the present study. One consideration that may be specific to classroom-based (vs. clinic- or home-based) comparison of the interventions is that the highly structured and consistent in-vivo modeling used in the present study may not reflect the typical classroom-based use of this treatment strategy. Perhaps the consistency of the in-vivo modeling, paired with students' association of live classroom-based instruction with learning (vs. videos with leisure) contributed to the effectiveness of this strategy for certain participants.

In addition, the present study illustrates a case when modeling interventions were not effective for a young student with ASD. Selena's complex medical diagnoses may have contributed to her lack of response to these treatments, or possibly she represents a subset of children with ASD for whom modeling interventions are not effective. Publication bias toward positive results may be providing an inflated expectation that video modeling, in particular, will prove effective for children with ASD. More research and representative publication in this area will clarify that point, and the future directions described above will similarly work toward identifying which children learn best through behavior modeling, whether video-based or in-vivo.

Viewing Selena's social-communication data from a methodological standpoint offers additional implications for future research in this area. Although a baseline phase is not always conducted when using certain types of multi-element designs (Kazdin, 2011), Selena's case points to the utility of collecting such initial data. Without baseline data identifying a pre-existing difference in Selena's use of the target behavior across the two intervention contexts, interpretation of her treatment data would have been inaccurate and misleading, as the intervention phase in isolation would suggest a better response to video modeling than in-vivo modeling. With the baseline data collected during the present study, it is clear that Selena did not respond positively to either treatment. Future researchers utilizing multi-element designs can increase the rigor and strengthen the accuracy of the implications of their research by collecting baseline data.

Visual Attention

The visual attention data captured during each child participant's individualized video and in-vivo modeling treatments show overall visual preference for the video model, with a margin of 3% to 48% greater attention to the video model across sessions and participants. For three of the four participants, the Wilcoxen test showed significantly greater visual attention to the video model, and across those participants, there were only two sessions when visual attention was greater to the in-vivo model than to the video model. Thus, a clear finding of the present study is the overwhelming visual preference for video-based models over in-vivo models in participating preschoolers with ASD. This finding offers unique evidence to support the potential for video as a teaching modality, as the present study showed video models to be generally preferred over the same instruction provided live.

The relationship between individual participants' visual attention and social-communication outcomes is less overwhelmingly evident; however, some interesting associations can be noted. Specifically, for Isaac, a shift in visual preference from the video to the in-vivo model coincided with a marked increase in his use of the target social-communication behavior in the context assigned to the in-vivo modeling treatment. Sarah was the only participant for whom both video and in-vivo modeling interventions produced clear effects; therefore, it is interesting that Sarah's early visual preference for the video model by a 43% margin lessened midway through the treatment phase to only an 11% margin. For Nicholas, a more general association can be made between his consistent and significant visual preference for the video model (66%) over the in-vivo model (18%) and his eventual response to the video modeling intervention only. Combined, these results suggest that the video model was initially more appealing than the in-vivo model; however, participants who eventually learned from in-vivo modeling (solely or in addition to video modeling) showed an increase in their visual attention to the in-vivo model, more closely matching their visual attention to the video model over time.

Interestingly, when compared to her fellow participants, Selena showed the greatest visual attention to both model types, but she did not increase her use of the modeled social-communication behavior in either context. The basic visual attention data captured in the present study could not indicate specific areas of fixation within the modeling situation, and perhaps Selena was attending to non-salient aspects of the models (e.g., clothing, ears). Future research could build on the present study by using eye tracking technology to determine precisely what children are attending to while viewing a video or in-vivo model. This line of research could not only illustrate the fixation patterns that are most predictive of learning, but could also identify the types of behaviors that may most effectively be taught through each modeling intervention. For example, one study used eye tracking to examine fixation patterns during viewing of film clips, and showed adolescents with autism fixated significantly less on the eye region of faces than their typically-developing peers, and significantly more on objects and other areas of the body (Klin, Jones, Schultz, Volkmar, & Cohen, 2002). With further study involving younger children and more naturalistic, relevant situations (e.g., individualized video models), such work may inform hypothesis-driven research on the types of behaviors that young students with ASD will most effectively learn through video modeling (e.g., those related to objects and actions vs. facial expressions). The same line of research could be undertaken to examine in-vivo modeling, and to further compare these two intervention approaches.

Intervention Rating

Intervention rating data from the *IRP-15* showed both treatments exceeded the minimum rating for acceptability. This finding reflects the social validity of both interventions' procedures in classrooms serving young students with ASD. Additional data from the researcher-created questionnaire provide more specific information about adult participants' impressions and preferences regarding the two interventions. For example, the only teacher/teaching assistant team who reported they were unlikely to use in-vivo modeling following the end of the study was Nicholas' team. Nicholas was the only participant who responded to video modeling, but not at all to in-vivo modeling. Because Nicholas was the only child in his classroom enrolled in the study, his teaching team was not exposed to any children who showed a different pattern of response to the two interventions. In addition, the only adult participant who indicated in-vivo modeling as more effective during the course of the study was Isaac's teaching assistant, who was present for each data collection and treatment session and witnessed Isaac's clear response to this intervention modality. Isaac was the only participant for whom the in-vivo modeling intervention had a significantly greater effect. Given these findings, it is clear that the adult participants' buy-in for the two treatments was highly influenced by their students' outcomes, reflecting the fact that practitioners value treatment options through which they have observed positive results.

In the present study, practitioner ratings of the two modeling interventions suggested overall similarity in their acceptability as preschool classroom interventions. These results contrast somewhat with previous research citing video modeling as a more practical intervention than in-vivo modeling (Charlop-Christy et al., 2000); however, results from the Charlop-Christy et al. study were based on time- and cost-efficiency measures collected by the research team, and not on practitioners' impressions of practicality. Also, data from the present study showing adult participants' high fidelity of in-vivo modeling implementation suggest they were able to master the procedures with minimal training and support. Future research could further describe the social validity of these two interventions by including simple measures of practitioner buy-in and intervention ratings.

Limitations

There are several limitations to the current study. First, the potential for multiple treatment interference, or carryover effects, is a limitation inherent in the use of an multi-element designs (Kennedy, 2005). In the present study, the use of different contexts (i.e., materials and settings), combined with the different treatment modalities (i.e., video-based and live), was anticipated to maximize discriminability and control for the possibility of carryover effects to the extent possible. However, despite these controls, there remains the possibility of carryover of learning from one treatment context to the other.

A second potential limitation inherent to the manner in which the multi-element design was employed in the present study is the difficulty of matching the two treatment contexts (materials/settings) for participant preference. An empirically-supported preference assessment procedure was used at the start of each student's participation in order to match the contexts in terms of preference; however, the preferences of preschool-aged children likely change over time. In addition, the dynamic use of the contexts during treatment may alter the child's preferences. Future researchers using this design may wish to conduct preference assessments at multiple intervals during the treatment phase in order to document any changes in child preference and discuss those changes in relation to the outcome data. In addition, due to the nature of the present study's design, the contexts (i.e., materials and settings) are a potentially confounding factor as they are linked to a particular treatment. Future research could avoid this limitation by adding a phase wherein the more effective treatment is applied to the other context, or set of materials (i.e., those used with the less effective treatment), to more rigorously isolate the effects of the treatment.

Another limitation specific to this study's research design is the difficulty of assessing generalization of gained skills from each treatment context to other settings, people, or materials. This is due to the fact that it is impossible to determine with certainty whether generalized skills were gained through one treatment or the other, or both combined. However, in the present study, anecdotal evidence from teacher report and direct researcher observation points to generalization of target skills through the modeling interventions as a whole. For example, for those students who responded to one or both of the interventions, classroom staff and related service professionals working with the children stated that the target behavior was being used with greater frequency in other settings/situations (e.g., occupational therapy sessions, meal times). We cannot determine whether the skills were learned through video modeling, in-vivo modeling, or the combination of both treatments, but this anecdotal evidence points to the utility of modeling interventions in general.

Additional limitations inherent to classroom-based research affected this study. One of those limitations is the difficulty providing treatment on an extended and ongoing basis when school closings, vacations/holidays, absences, and special occasions (e.g., assemblies) limit the span of time when treatment can be provided in a consecutive, consistent manner. Similarly, when conducting ecologically valid research that employs classroom staff as interventionists and facilitators, the additional factor of staff attendance and availability has the potential to interrupt treatment and data collection. These factors limited the length of data collection for the present treatment study, reducing the number of data points and the subsequent ability to draw firm conclusions in some cases.

Finally, participants were recruited based on ASD diagnoses, as confirmed by researcher-conducted *ADOS* evaluations. However, following initial recruitment, additional diagnosed and undiagnosed difficulties became evident in certain participants. For example, Selena's additional diagnoses of microcephaly and metopic craniosynostosis (see Fombonne, Rogé, Claverie, Courty, & Frémolle, 1999 for discussion of these comorbidities), and Sarah's initiation of medical interventions for anxiety, were revealed throughout the course of their participation. The majority of children and adolescents with ASD have additional diagnoses (Simonoff, Pickles, Charman, Chandler, Loucas, & Baird, 2008) and many receive medical interventions, so the participants in this study likely reflect the heterogeneity expected among preschool-aged children with ASD diagnoses served under the category of autism; however, this study cannot determine the effects of these additional challenges on the participants' outcomes.

Conclusions

Despite these limitations, the present study adds to the literature on modeling interventions by offering a rigorous single-case design study suitable for replication and inclusion in synthesis efforts. This study exceeds the standard for within-study replication of three participants, and surpasses past research practice (i.e., average of 2.8 participants) in studies using SCD methodology with children with autism (Odom et al., 2003). This study also provides a stringent assessment of learning by conducting observational probes prior to treatment sessions on each day of data collection, assessing retention of learning versus direct imitation. In addition, this is the first comparative study to assess the treatment fidelity of both the video and in-vivo modeling treatments, as suggested by Delano in a 2007 review of the video modeling literature. The use of NAP (Parker & Vannest, 2009) and binomial tests expands on traditional visual analysis of the data and offers means for comparing and combining this study's results with the results of other similar studies.

Results of the present study offer classroom-based researchers and professionals evidence of the efficacy of modeling interventions, both video and in-vivo, for young students with ASD. Educational practitioners may take note of the promising effects of video modeling, as well as the clear effects of structured and consistent in-vivo modeling on the learning of some children with ASD. In order to increase the feasibility of in-vivo modeling outside of a research situation, teachers may wish to incorporate related service providers into classroom-based utilization of this treatment, working as a team to build more structure into their use of this strategy. This study's findings also reveal the need for focused research examining characteristics or skills that may predict what type of modeling, if any, is most appropriate for individual students with ASD. In addition, the study's results show visual attention and visual preference to be a potential consideration for assessing students' ability to learn from different modeling interventions. Finally, and importantly, the results point to the acceptability of the procedures for both video and in-vivo modeling, as perceived by actual educational practitioners, pointing to the social validity of both types of modeling as classroom-based intervention tools.

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CHAPTER 4 (Manuscript 3):

Incorporating Video Modeling into School-Based Intervention for Students with Autism Spectrum Disorders

Introduction

Autism spectrum disorder (ASD) is a set of complex developmental disorders that involve impairments in social interaction and communication, and patterns of repetitive behaviors and/or restricted interests (American Psychiatric Association, 2000). Between 1996 and 2005, American classrooms saw a threefold increase in the percentage of school-aged students with ASD served under the Individuals with Disabilities Education Act (U.S. Department of Education, 2010). The varied skill and need profiles of this still-increasing population of students make educational programming and provision of services challenging, necessitating the use of individualized evidence-based strategies. However, educational professionals, including speech-language pathologists (SLPs), have reported feeling underprepared to work with their students with ASD (Schwartz & Drager, 2008). Furthermore, although the American Speech-Language-Hearing Association (ASHA) urges its members to find and critically evaluate current literature for use in clinical practice (ASHA, 2005), school-based SLPs, among other educational professionals, have cited a lack of time for accessing research due to large caseloads, understaffing, and insufficient planning time (Closs & Lewin, 1998; Curtin & Jaramazavic, 2001; Roberts & Barber, 2001). As such, school-based SLPs could benefit from tutorials drawn from the research literature that outline clear, step-by-step instructions for the use of practical, research-based intervention strategies for their students with ASD.

This tutorial focuses on the cost-effective, practical, and empirically-supported intervention strategy of video modeling (Nikopoulos, Canavan, & Nikopoulo-Smyrni, 2009; Simpson, Langone, & Ayres, 2004; Sherer, Pierce, Paredes, Kisacky, Ingersoll, & Schreibman, 2001). Video modeling is the presentation of a model performing a target skill through the use of video technology (Cihak, Fahrenkrog, Ayres, & Smith, 2010; Nikopoulos & Keenan, 2007). Video modeling is a form of behavior modeling that spans the theoretical frameworks of behaviorism (Watson, 1997) and social cognitive theory (Bandura, 1977). In terms of its behavioral and social cognitive roots, video modeling can be illustrated by the concepts and strategies outlined in Table 4.1.

Table 4.1 Theoretical Roots of Video Modeling

Concept or Strategy ***(Theoretical Root)***	**Relation to Video Modeling**
Manipulable and measurable setting event *(Behaviorism)*	The child is exposed to a desired behavior in order to influence later responses
Antecedent behavioral strategy of priming *(Behaviorism)*	The child's sensitivity to a particular situation is increased by viewing the model
Vicarious reinforcement *(Social Cognitive Theory)*	The child observes another person's success
Observational learning *(Social Cognitive Theory)*	The child learns through observing and imitating others' behavior

There are multiple variations of video modeling, including traditional video modeling (i.e., video model depicts another person performing the target skill) and video self-modeling (i.e., video model depicts the child him/herself performing the target skill through video editing). Another variant called point-of-view modeling, wherein the video depicts a situation from the child's point-of-view but does not actually provide a model, will not be discussed in this tutorial but is nicely described in a study by Hine and Wolery (2006) and in a review by McCoy & Hermansen (2007).

Through over three decades of study, video modeling has been demonstrated to be an empirically-supported intervention for children with ASD (Hitchcock, Dowrick, & Prater, 2003; Bellini & Akullian, 2007). Video modeling has been used to successfully affect a range of skills in individuals with ASD, including social, communication, adaptive, and play skills (Shukla-Mehta, Miller, & Callahan, 2010). Reducing problem behaviors (e.g., crying, difficulty transitioning, off-task behavior) has also been targeted with video modeling, particularly through the use of video self-modeling (e.g., Coyle & Cole, 2004) or point-of-view modeling (e.g., Schreibman, Whalen, & Stahmer, 2000). Studies of video modeling's effectiveness with individuals with ASD have spanned a broad range of ages (i.e., 3-20 years) and settings (i.e., school, clinic, community, and home), with some studies combining video modeling with other strategies such as instructional prompts or tangible reinforcers (Shukla-Mehta, et al., 2010; Bellini & Akullian, 2007).

Individuals with ASD have been shown to possess relative strengths in visual processing (Minshew, Goldstein, & Siegel, 1997). Along with this underlying propensity, the effectiveness of video modeling in changing the behavior of children with ASD has been attributed to the reduced attention and language demands of the intervention (Sherer et al., 2001), and a fascination with screen media that is common to individuals with ASD (Mineo, Ziegler, Gill, & Salkin, 2009). Another potential explanation for the success of this intervention with persons with ASD is video modeling's ability to instruct without the face-to-face interaction that may be aversive to some individuals with ASD (Corbett & Abdullah, 2005). Finally, review of the extant video modeling literature suggests that various combinations of these factors may also serve to increase the child's motivation and, thus, their attention to the intervention (Bellini & Akullian, 2007).

Given the social and communicative needs of children with ASD, and SLPs' need for empirically-supported interventions for this population, video modeling may be an ideal option for some students. Based on the existing literature, video modeling is a promising intervention for addressing the following goal areas in the SLP's scope of practice: play (individual and reciprocal), social initiation, conversation/greetings, adaptive/functional skills (e.g., cleaning, purchasing), and perspective-taking (Ayres & Langone, 2005; Bellini & Akullian, 2007; Shukla-Metha, Miller, & Callahan, 2010). With expertise in addressing social and communication skills, and the flexibility of their modes of service delivery, SLPs are in a unique role to individualize students' intervention and incorporate video modeling into one-to-one or consultative services. This tutorial focuses on the use of video modeling within the framework of school-based speech-language pathology services for students with ASD, offering a rationale for its use and step-by-step instructions for implementation.

Rationale for Use of Video Modeling

School-based SLPs interested in incorporating video modeling into their practice may wish to inform themselves, their educational teams, and/or their administrators about the many advantages of its use. In addition to the research evidence supporting its effectiveness (as outlined above), some additional advantages are increased child independence, easy individualization, low cost, consistent implementation, and efficient use across professionals and settings.

Increased Child Independence. Video modeling has been cited as one of the few interventions for students with ASD that fosters independence (Hume, Loftin, & Lantz, 2009). Video modeling encourages independence by shifting the intervention stimulus away from adult instruction and toward a medium that requires very little, if any, adult prompting. In this way, the situation or context of the modeling itself becomes the stimulus to elicit the desired or modeled behavior from the student, rather than the adult. In addition, although the student may require some assistance and instruction during the initiation of the intervention, over time, viewing of the video model can become a completely independent task initiated by the student. With a growing emphasis on promoting the autonomy of students with ASD (National Research Council, 2001), video modeling presents a promising strategy for SLPs seeking to increase students' independence while addressing their social and communication needs.

Easy Individualization. Since each video model can be designed and recorded for an individual student, video modeling can be easily individualized to students with a broad range of ages, cultures, interests, and functioning levels. Factors that can be manipulated include the video model's setting, content/materials, length, focus, number of participants, and model type. When providing services to older students, SLPs will find it is not only important, but also simple to incorporate age-appropriate content and preferences into the video model (Delano, 2007). Across age groups, preference assessment procedures (e.g., Carr, Nicolson, & Higbee, 2000) can be used to determine the optimal materials and reinforcers for each individualized video modeling intervention. In addition, the SLP's and other team member's knowledge of the student's preferences can guide this process.

Low Cost. With the reduced cost and increased efficiency of video technology, schools are increasingly providing tools such as USB-ready video cameras for staff use, thus increasing the potential for use of video modeling. Furthermore, one study found that the cost of implementing video modeling (in terms of training, implementation, and materials) is one half the cost of the same modeling delivered live (Charlop-Christy, Le, & Freeman, 2000). As such, SLPs with large caseloads and minimal time may be interested in incorporating this time- and cost-efficient intervention option into their practice.

Consistent Implementation. Video modeling also allows a student's educational team to provide consistent teaching of a target skill throughout the school day, and with minimal demands on team members (Ayres & Langone, 2005). Since video modeling allows for repeated exposure to the same context and modeled behavior, the stimulus becomes predictable, allowing students to focus on the model's behavior. Such consistency may be important for some students with ASD who become distracted by the unpredictable, less consistent, and multi-modal nature of live instruction. In addition, as the student learns to use the modeled behavior, the video model can be adapted to expand the student's skills to handle more complex contexts and behaviors.

Efficient Use Across Professionals/Settings. With minimal training (Charlop-Christy, Le, & Freeman, 2000) and little to no disruption to the daily routine, classroom-based team members (i.e., teachers, teaching assistants, and program aides) can easily incorporate video modeling into the regular classroom routine. Similarly, family members and professionals who provide after-school services can incorporate SLP-made video models into daily routines to ensure consistent intervention across a student's entire day. A video model can be shared through a USB flash drive; however, it is important to pay special attention to the legal and ethical concerns that accompany such video sharing if the SLP decides to utilize a peer model (McCoy & Hermansen, 2007) or to share the video outside of the school context.

With these advantages in mind, SLPs can advocate for the incorporation of video modeling into their clinical practice with students with ASD. The following section outlines step-by-step instructions for the implementation process, from the beginning preparatory phase to final considerations about monitoring student progress and determining next steps for intervention.

Video Modeling Implementation: A Five-Phase Process

Implementation of video modeling is a process that requires consideration of multiple factors, resulting in an intervention procedure that is individualized to each student. There are five overall procedural phases outlined in this tutorial: (1) preparation; (2) recording the video model; (3) implementing the video modeling intervention; (4) monitoring the student's response to the intervention; and (5) planning next steps. The various tasks associated with each of these phases are outlined below in an easy-to-use guide for SLPs serving students with ASD.

Phase 1: Preparation

The preparation phase consists of a series of steps aimed at determining whether video modeling is an appropriate intervention strategy for a particular student, and if so, what the video model will look like. This latter stage of the preparation process involves a series of decisions regarding the video model's target skill, model type, setting, and scripted features.

Assessing Related Skills. In order to determine whether video modeling is an appropriate clinical practice for a particular student, SLPs should first assess specific skills and preferences of that student. Skills linked to success with video modeling and suggested criteria are provided in Table 4.2, and are supported by published reviews of the video modeling literature (Shukla-Metha, et al., 2010; Delano, 2007; Rayner, Denholm, & Sigafoos, 2009).

Table 4.2 Related Skills and Suggested Criteria

Related Skill	**Suggested Criteria**
Visual attention	Exhibits ability to attend to a video for at least one minute (several minutes of attention may be an even better indicator)
Imitation	Exhibits basic imitation skills (e.g., motor or verbal, depending on target skill)
Visual and hearing acuity	Within normal or corrected-normal limits

Visual information processing and comprehension	Higher skill levels may be related to better outcomes with video modeling (functioning level should be considered when determining length and complexity of video)

When assessing the student's ability to attend to a video for a period of time, it is recommended that trials be completed with a video that depicts real people (vs. animation), as that is the type of video SLPs will be using during this intervention. The remaining skills included in Table 4.2 can be assessed through classroom observation or targeted assessment procedures. Some standardized instruments recommended for use with students with ASD include the current editions of the *Clinical Evaluation of Language Fundamentals* (*CELF*; Semel, Wiig, & Secord, 2003) for syntax, semantics, and morphology; the *Peabody Picture Vocabulary Test* (*PPVT*; Dunn & Dunn, 2007) for receptive and expressive vocabulary; the *Children's Communication Checklist* (*CCC*; Bishop, 2003) for all aspects of communication, including speech, language, and pragmatics (e.g., nonverbal communication, social relations); and the *Social Responsiveness Scale* (*SRS*; Constantino, 2002) for reciprocal social interaction, social processing, and social anxiety.

Choosing an Appropriate Target Skill. Not all social and communication skills are appropriate targets when using video modeling as an intervention tool. Target skills must be those that can be clearly modeled and easily observed. As such, 'internal' skills that fall under categories such as receptive language (e.g., comprehending vocabulary words) or social understanding (e.g., recognizing others' emotions) are not appropriate targets for video modeling unless they can be linked to observable correlate behaviors (e.g., identifying corresponding pictures, objects, or words). Instead, observable, ‘external’ skills such as offering greetings, using gestures, requesting, taking turns in play, or initiating interactions represent the most appropriate skills to target through video modeling. A target skill can be chosen for a student based on the student’s Individualized Education Plan (IEP) or other apparent or documented needs; however, careful assessment of existing skills in the chosen domain (e.g., requesting, social interaction) should be conducted for multiple reasons. First, developmental sequences can be considered to assess the student’s potential to achieve the target skill. For example, the student may show the more basic social interaction skill of attending to others during interactions before exhibiting a higher-level social interaction skill such as combining gestures and eye contact to initiate an interaction. However, it is important to note that not all students will follow the same developmental patterns. Second, careful assessment will allow the SLP to determine the student’s potential to gain the target skill by determining whether the target skill is emerging (Wert & Neisworth, 2003). A skill that is emerging, or can be elicited through prompting, is an ideal target, as it lies within the student’s zone of proximal development, a concept developed by Vygotsky (1978) that refers to a child’s range of ability when provided with adult support (i.e., not independent).

Finally, assessment and consultation with the student’s team (including caregivers) can aid the SLP in determining whether the student is failing to exhibit a skill due to lack of ability or lack of motivation. Consultation with the team will also allow the SLP to assess the social validity of the goal/target skill (i.e., endorsement by stakeholders as meaningful and appropriate for the student). Together, this information will inform the

SLP’s and the team’s decision regarding whether or not to target a certain skill, and may also affect the choice of materials, setting, and/or model type.

Choosing a Model Type. Options for model types broadly include ‘self’ and ‘other’; however, within the ‘other’ category, several options exist. For example, the ‘other’ model may be a sibling, peer, parent, teacher, or SLP, may be familiar or unfamiliar, and may be typically-developing or atypically-developing. Research has not documented any difference between the effectiveness of video modeling when conducted with ‘self’ or ‘other’ as the model (Sherer et al., 2001; Bellini & Akullian, 2007) and the intervention has been proven effective using all types of models including peers, adults, and self (McCoy & Hermansen, 2007). As such, consideration of an individual student’s traits and preferences, as well as the nature of the target skill, will dictate the characteristics of the person modeling the target skill in a video model.

Considerations involved in choosing a model type may include the student’s age, gender, race/ethnicity, and preferences, as well as any logistical barriers to the recording process. For example, when serving a preschool-aged student with ASD, there are viable concerns regarding the time required (for the SLP and for the model) to adequately train a peer model (Bellini & Akullian, 2007). Bandura’s early work on behavior modeling posited that social factors (e.g., authority, popularity, perceived competence), as well as the motivation and characteristics of the observer determine the observer’s attention to the model (Bandura, 1969). With this in mind, SLPs using an ‘other’ model in a video may wish to choose a familiar, preferred/respected peer, or a familiar adult whom the child likely perceives as an authority. Peer models are generally matched to the student’s approximate age and gender, and are commonly typically-developing (McCoy &

Hermansen, 2007). When targeting skills in areas such as social interaction or reciprocal play, a second individual (peer or adult) may be included in the recording as a facilitator or interaction partner.

Studies of video self-modeling suggest that using ‘self’ as the model is most effective when the goal is to reduce problem behaviors or increase compliance (Sherer et al., 2001). However, the student must have the target behavior in his/her repertoire to some extent (with or without prompting) in order for the SLP to capture enough footage of the student performing the behavior (Rayner, Denholm, & Sigafoos, 2009). The amount of time the SLP may need to devote to taping the behaviors for this type of video modeling is unpredictable. The SLP then edits footage from multiple tapings/settings to produce the final video that only pictures the child performing the target behavior. If self-modeling is the chosen technique, the video editing expertise of, and/or resources available to the SLP should be considered.

Choosing a Setting. Ideally, the setting of the video model recording will be the setting in which the student is expected to perform the target skill. For example, if the SLP wants the student to point to request toys in the block center, then the video model should be recorded in the block center. This enhances the ecological validity of the intervention by picturing the real-life situation in which the target skill will be used. In addition, the real setting then becomes the stimulus to elicit the modeled behavior. Utilizing the natural setting in this way has been shown to produce greater intervention effects, as well as higher levels of skill maintenance and generalization (Bellini, Peters, Benner, & Hopf, 2007). However, within this natural setting (e.g., classroom, lunch room, playground), visual and auditory distractions should be minimized during recording so the student is able to focus on the model and the behavior(s) being modeled. For this reason, it would be best to record the video model when students (other than models) are not present (e.g., before or after school).

Just as a natural setting is important to intervention effects, all materials used in the video model should be natural, familiar, and appropriate for the behavior being modeled. Figure 4.1 pictures an example of a video model recorded in a natural classroom setting, using everyday classroom materials, and with minimal visual distractions. This video model was created to target reaching to request, with the classroom teacher (left) as the model and the teaching assistant (right) as the facilitator, or interaction partner.

Figure 4.1 Screenshot of Video Model

Scripting the Video Model. For optimal learning, a video model of 3-5 minutes is recommended (Shukla-Metha, Miller, & Callahan, 2010), although studies have produced intervention effects with videos ranging from 35 seconds to over 5 minutes (Bellini & Akullian, 2007; Nikopoulos & Keenan, 2004). The SLP may consider the student's typical attention span, or may set up a trial video viewing to determine the optimal length of the video model. In addition to choosing the length of the video, the SLP must determine how many instances of the modeled behavior will be recorded, as well as any other scripted factors (e.g., interactions, wait time, facial expressions). There is little evidence to guide the SLP in choosing the number of models per video; however, research has shown positive effects with video models showing six to fourteen instances of the target behavior (Reagon, Higbee, & Endicott, 2006; MacDonald, Sacramone, Mansfield, Wiltz, & Ahearn, 2009). When scripting video models depicting behaviors such as play or social interaction, SLPs may choose to observe typically-developing students performing the target behavior and base the video model's script on those interactions (Paterson & Arco, 2007).

There are a few additional factors the SLP should consider during the scripting process. For example, a video model may be created with or without voice-over narration and/or instructions for the student. Evidence for inclusion of narration is mixed, and for some students (e.g., those who have auditory sensitivity or processing difficulties), the inclusion of this additional processing challenge may lessen the intervention's effectiveness (Rayner, Denholm, & Sigafoos, 2009). In addition, the SLP will need to decide whether to segment the target behavior into multiple video modeling 'steps' or picture the complete behavior in one model. Additional research on the relative effectiveness of these two strategies is needed. As such, SLPs will want to consider the characteristics of the student and determine whether a task analysis approach (i.e., breaking a skill into small, manageable steps) is preferable for promoting learning, maintenance, and generalization of the particular skill.

Phase 2: Recording the Video Model

Once the SLP has determined the content and setting of the video model, the second phase of the video modeling process involves the actual recording of the video model. This phase entails decision-making regarding equipment for video recording and playing, as well as evaluation of the recorded video model's quality.

Choosing Equipment. Video recorders have become highly accessible and affordable, and are even provided to some teachers, therapists, and/or schools. Small, USB-ready video cameras range in price, with the more expensive options generally producing better video and audio quality. Some video cameras will have an input for an external microphone, and this inexpensive accessory can be used to enhance audio quality if needed. If the SLP does not have access to a tripod, a flexible, tabletop tripod can be purchased. Most USB-ready video cameras include easy-to-use software packages that allow for uploading, sharing, and, in some cases, editing of videos. More comprehensive video editing software can be purchased if, for instance, the SLP wishes to utilize video self-modeling with a student. Additional information regarding resources and equipment for professionals incorporating video modeling into their practice may be found in the user-friendly and widely accessible book, *How to Use Video Modeling and Video Prompting* (Sigafoos, O'Reilly, & de la Cruz, 2007).

In addition to the items needed to create the video model, certain equipment is needed to present the video model to the student. Video models can be played for students on a classroom computer (e.g., desktop, laptop, tablet PC), a television, or a portable computer from outside the classroom. These items are generally available to school staff and are purchased by the school. SLPs without access to the needed equipment may want to consider partnering with teachers and administrators to apply for outside grant money to purchase the needed technology. An internet search using combinations of key words such as ‘grant,’ ‘school,’ ‘education,’ ‘special education,’ ‘autism,’ and ‘technology’ will lead SLPs to a plethora of information about current grant competitions.

Evaluating Video and Audio Quality. SLPs using video models in their practice will need to evaluate the quality of a recording before presenting it to a student. Not only does the modeled behavior need to be clearly visible and the focus of the video, but also distractions should be minimized. Adults who are accustomed to ‘tuning out’ the ambient noises of a school setting may not notice distractions that seep into the video recording. For example, a loudspeaker announcement, a favorite toy visible in the background, or a child walking behind the scene is likely to reduce the effect of the intervention by distracting the student away from the salient behaviors of the model. In addition, a grainy or jumpy video may sidetrack the student and provide sensory input that similarly distracts from the modeled behavior.

For some target behaviors (e.g., simple play, gestural requests), the audio component of the video model may be less important; however, for other target behaviors, such as conversation or greetings, the quality of the audio is of utmost importance. SLPs should evaluate the quality of the video model’s audio output by playing the video on the actual device that will be used to display the video to the student. This is important because not all video players will produce the same audio, and the SLP must determine whether the student will be able to adequately hear and decipher the audio component of the video model.

Prior to implementation, SLPs may wish to create and use a checklist of items such as those listed in Table 4.3. This checklist can be used to systematically evaluate the video model's quality and adherence to the intended script (e.g., number of models, scripted phrases or actions, length) and thus can be viewed as a measure of fidelity of the intervention.

Table 4.3 Sample Checklist of Video and Audio Quality Items

Video Quality Items	Audio Quality Items
☐ Is the video clear (vs. grainy or pixelated)?	☐ Is the audio clear (vs. with echo or double sound)?
☐ Does the video play smoothly (vs. jumpy or halting)?	☐ Does the audio sync with the video (vs. with delay or mismatch)?
☐ If video editing was used, are the transitions clean/seamless (or nearly)?	☐ Is the audio easy to decipher (vs. muted or overly quiet)?
☐ Is the model the focus of the video, with his/her actions clearly visible?	☐ Is the audio free of distracting sounds (e.g., announcements, other conversation, air conditioner hum)
Overall Quality Items	
☐ Does the video model generally follow the script?	
☐ Does the length of the video model match the intended length?	
☐ Does the video model display the intended number of modeled behaviors?	
☐ Are the setting and materials used in the video model natural to the student and the target behavior?	

Phase 3: Implementing the Video Modeling Intervention

Once the video model has been recorded and evaluated for adherence to quality and fidelity guidelines, the SLP is ready to implement the video modeling intervention. Phase 3 involves decision-making surrounding the details of the video modeling implementation, including determination of the setting, frequency, and timing of video viewing, as well as the person(s) who will implement the determined plan.

Determining Setting and Frequency of Viewing. Before implementing the video modeling intervention, the SLP will need to determine an appropriate setting in which the student will watch the video model. As much as possible, this setting should be free of distractions (e.g., loud noises, other children, music). The SLP may find that his/her office is the ideal location for the student to view the video model; otherwise, a desk in a quiet corner of the classroom, the hall, another empty classroom, or the library may work well. The student may wear headphones to reduce auditory distraction; however, some students with ASD may find the sensation of headphones aversive.

Similarly, the SLP will want to determine the frequency of video model viewing for each student. This guideline may be altered along the way using the SLP's clinical judgment, but determining the expected frequency up front may help to structure and schedule the intervention amidst the student's many other classroom and therapy commitments. Research shows that repeated viewing (e.g., two to four times per session) of a video model increases intervention effects for some children with ASD (Shukla-Metha, Miller, & Callahan, 2010); however, the length of the video and attention span of the student can guide the SLP in determining the optimal frequency of viewing.

Determining Timing of Viewing. The goal(s) of the intervention and the characteristics and skills of each student will guide the timing of the video model viewing. For example, SLPs may wish to show the video model to some students immediately prior to the event during which the student is expected to use the modeled behavior. As stated in the introduction, this can be conceptualized as a type of priming, since exposure to the video model will hopefully alter the student's response to the later stimulus. Some even refer to video modeling as 'video priming' (Cihak et al., 2010; Odom et al., 2003), whereas others similarly conceptualize video modeling as a setting event for the target behaviors (Simpson et al., 2004). Alternately, or maybe later in the intervention process, the SLP may wish to show the video model to a student at a time that is temporally removed from the situation when the behavior is expected. This method may be preferable if the SLP wishes to target learning, as opposed to immediate imitation, of the modeled behavior, or if the SLP is assessing the student's potential for maintenance and generalization of the skill.

Determining Who Will Implement the Intervention. Once a video model is created, the implementation is straightforward. The SLP will have previously determined the student's ability to sit and attend to a video without behavior problems. Since the determined timing of the viewing may preclude the SLP from implementing the intervention, s/he may consult with the adult who implements the intervention regarding instructions for the timing and location of viewing, the number of repetitions of viewing in one sitting, and whether/how the adult should prompt/redirect the student to attend to the video as needed. With these instructions and basic knowledge of the equipment used (e.g., computer, headphones), any classroom staff member (e.g., teaching assistant, teacher, program aide) or caregiver should be able to implement the video modeling intervention with minimal time commitment or training (Delano, 2007).

Phase 4: Monitoring Students' Response to the Video Modeling Intervention

During and following video modeling implementation, the SLP will want to monitor each student's progress in response to the intervention. Thus, Phase 4 involves planning for data collection, including monitoring of generalization and maintenance of gained skills.

Choosing Methods of Data Collection. School-based SLPs utilize varied means of data collection in order to monitor student progress. In line with their overall responsibility to monitor progress collaboratively with other professionals and, when appropriate, the student (ASHA, 2010), SLPs will need to develop a plan for collecting data on the effectiveness of the video modeling intervention. This progress monitoring plan may include standardized or non-standardized assessment procedures, allowing for pre-, mid-, and post-treatment comparisons. The assessment of progress should be tailored to the outcomes that the video modeling is designed to impact; however, one consideration in planning progress monitoring is that few standardized tests will be sensitive to changes in specific targeted behaviors over a short period of time. If scores from a standardized instrument are deemed appropriate as criteria to monitor progress, the SLP must be cognizant of the frequency of administration recommended for each assessment (e.g., once every 6 months due to potential testing effects), which is generally stated in the assessment manual. Another option for data collection is behavioral observation (Kennedy, 2002). SLPs may use a predetermined criterion to gauge progress based on a student's developmental level and goals, and they may ask others on the educational team to assist in observational data collection. Observational data collection forms can be created indicating the student's target behavior and any other instructions necessary to ensure team members collect data in a consistent manner (see Appendix A for a sample observation form). Observations should occur in natural contexts during times when the target behavior is appropriate and expected, and should be conducted over multiple days to ensure the representativeness of the student's performance.

If appropriate, the student may play a role in the data collection process by self-monitoring their use of the target behavior (see example in Strain, Kohler, Storey, & Danko, 1994). For example, a middle school student with ASD may apply a sticker to a chart on the wall each time s/he initiates an interaction with a peer. In this way, data collection can become a reinforcer for the student while also promoting the student's independence. As a final consideration for data collection, SLPs may wish to assess the impressions of the educational team in regard to the intervention. Tools such as the *Intervention Rating Profile* (*IRP-15*; Witt & Martens, 1983) are quick and easy to use, and can assess team members' impressions of video modeling's acceptability and practicality as a school-based intervention. Sample items from the *IRP-15*, rated on a six-point Likert-type scale, include: 'I would be willing to use this intervention in the classroom setting'; 'this intervention would be appropriate for a variety of children'; and 'I would suggest this intervention to other professionals.'

Evaluating Maintenance and Generalization of Skills. Maintenance refers to the student's retention of a learned behavior over time, while generalization refers to their ability to use the skill in different settings, with different people, and with different materials/stimuli. Video modeling has been shown to produce effects that are maintained and generalized by individuals with ASD (Bellini & Akullian, 2007). With as few as three video modeling sessions, gains have been shown to generalize across settings, people, and stimuli (Nikopoulos & Keenan, 2004). In addition, acquired skills have been found to maintain for as many as 15 months following the video modeling intervention (Charlop & Milstein, 1989). SLPs will want to evaluate their students' maintenance and generalization of skills following a break in the video modeling treatment. This can be done through follow-up assessment and/or structured observation, and will allow the SLP to determine whether the student has effectively incorporated the target behavior into their skill repertoire.

Phase 5: Planning Next Steps

After evaluating the effects of the video modeling intervention on a particular student, the SLP will be ready to make decisions regarding next steps for intervention. Such decisions must be made whether the student responds well to the intervention or does not respond as expected to the video modeling intervention.

Next Steps if Video Modeling is Effective. If a student responds to the video modeling intervention by showing gains in the target skill, the SLP may wish to expand on the current target skill by recording a new video model with similar characteristics. For example, if the student responded to the first video model by gaining the target skill of requesting by pointing, the subsequent video model could target the combination of vocalization and pointing to request. In this way, the SLP could continue to utilize video modeling to build the student's skills in small, developmental steps. Alternatively, if the student gained the target skill, but had difficulty generalizing the skill to different contexts or interaction partners, a next step could be to record a video model that targets the same skill, but pictures a different context, set of materials, or interaction partner.

Alternative Options if Video Modeling is Not Effective. If video modeling proves an ineffective or inappropriate intervention strategy for a student, there are other supplementary intervention options the SLP and educational team can explore. Additional interventions that are practical and that promote independence in students with ASD include self-monitoring strategies and individual work systems (Hume, Loftin, & Lantz, 2009). Other intervention strategies that have been found to increase socialization in school-aged children with ASD include Social Stories ™ (Gray & Garand, 1993), peer mediation strategies (e.g., peer tutors, circle of friends), and social skills groups (Rogers, 2000). Finally, if a student seems to be unresponsive to the video component of the video modeling intervention (e.g., becomes uninterested over time, seems to focus only on non-salient features), a live version of the modeling could be attempted to determine whether that intervention is better suited to the particular student.

Summary and Conclusions

The everyday challenges faced by school-based SLPs are many, and video modeling speaks to those challenges in the following ways: (1) video modeling meets evidence-based practice requirements as empirically-supported; (2) video modeling requires very little training and proficiency to implement; (3) video modeling can be used with great consistency across settings, materials, and team members; (4) video modeling is rewarding to many students with ASD and, thus, may curb behavior problems; and (5) video modeling is affordable, with creation of one video model costing less in time and resources than creation of a simple picture cue (Charlop-Christy, Le, & Freeman, 2000).

This tutorial outlines the rationale for school-based SLPs' use of video modeling with students with ASD, and provides clear, systematic instructions for implementation. By following these steps and incorporating the supplemental intervention strategy of video modeling into their practice when appropriate, school-based SLPs can have great potential to affect lasting change in their students with ASD.

Appendix A. Sample Observational Data Collection Form

Student's name:______________ Date:________ Time:________ **Observer:_________** **Goal**: During preferred games/routines, after a brief pause, the child will use a gesture to indicate that s/he wants the game to continue. **Operational definition**: After a brief (adult-created) pause in a game/routine, the student will indicate his/her desire for the game/routine to continue through the use of one of the following gestures: signing 'more', reaching (without grabbing, so hand stays open and is retracted), or pointing. **Instructions**: During a **5 minute observation**, the observer should place a check in successive boxes for each observation of the behavior defined above.

Context:_____________________	**Context**:_____________________
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20

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