EMBEDDED INTEREST INTERVENTIONS FOR INDIVIDUALS WITH AUTISM SPECTRUM DISORDER: A QUALITY REVIEW, META-ANALYSIS, AND SINGLE-CASE RESEARCH EVALUATION

A Dissertation

by

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ABSTRACT

Individuals with autism spectrum disorder (ASD) characteristically demonstrate interest in a restricted range of activities and often fail to respond to alternative environmental stimuli. These characteristics act as a barrier to learning important life skills. Strategies that motivate learners with ASD to engage in alternative activities warrant development and exploration. One such strategy is embedding interests into the learning environment to establish motivation and promote participation. While a number of studies in this area exist, the literature has yet to be synthesized. This dissertation contains two reviews and a single-case research evaluation to determine the evidence of embedding interests for individuals with ASD.

The first study is a systematic review of quality and evidence for 20 single-case and group-based research studies. Studies were gated by quality to synthesize the evidence overall and within categories of dependent variables. This review shows limited or insufficient support for use of this intervention according to one rubric and mixed but sufficient support according to an alternative rubric. The majority of research support targets social/communication skills. The quality review identifies priorities for continued research.

The second review is a meta-analysis of 18 single-case research studies on embedding interests of individuals with ASD. The literature suggests that embedding interest for learners with ASD can either be highly beneficial or highly distractible. Effects from moderator categories ranged from neutral to high, with several moderating variables identified. Threats to the internal validity of this meta-analysis are evaluated. Practitioners should take caution

when using this intervention with students that display self-stimulatory or ritualistic behaviors when their interests are present.

The third study is an original single-case research evaluation of the use of interests as receptive identification targets for children with ASD in the context of an intervention with added components. Overall outcomes demonstrate added effects of the embedded interest condition that correspond to increases in various indicators of engagement for two participants, while a third participant's data is inconclusive. The outcomes of this study have implications for sequencing educational objectives and adding intervention components to promote skill acquisition in early language learning programs for children with ASD.

DEDICATION

To all the children I worked with as I learned to teach, my most valued moments are those of connecting and growing with you.

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NOMENCLATURE

ABA	Applied Behavior Analysis
AO	Abolishing Operation
ASD	Autism Spectrum Disorder
ASRS	Autism Spectrum Rating Scales
BCBA	Board Certified Behavior Analyst
CEC	Council for Exceptional Children
DR	Differential Reinforcement
EO	Establishing Operation
FR	Fixed Ratio Schedule of Reinforcement
HP	High-Preferred
IOA	Interobserver Agreement
IRR	Interrater Reliability
L-M	Least-to-Most Prompting
LP	Low-Preferred
M-L	Most-to-Least Prompting
MSWO	Multiple Stimulus Without Replacement Preference Assessment
MO	Motivating Operation
NAP	Nonoverlap of All Pairs
PECS	Picture Exchange Communication System
ROW-PVT	Receptive One-Word Picture Vocabulary Test
RRBIs	Repetitive or Restricted Behaviors and Interests

VB-MAPP	Verbal Behavior Milestones Assessment and Placement Program
WWC	What Works Clearinghouse

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CHAPTER I

INTRODUCTION

Autism spectrum disorder (ASD) is characterized by deficits in areas of social-communication and interaction as well as the presence of restricted or repetitive behavioral patterns (American Psychiatric Association, 2013). These core deficits of ASD can function as learning barriers that reduce on-task behavior and impact numerous critical areas for development. Individuals with ASD often demonstrate interest in a restricted or narrow range of stimuli in the environment. These abnormal or intense preoccupations deter attention from important stimuli in the environment that help to facilitate learning (Bruckner & Yoder, 2007). Interventions designed to increase student motivation and engagement can be useful in addressing learning barriers commonly associated with the core deficits of ASD.

Embedding Interests

Restricted or repetitive behavioral patterns of individuals with ASD can be utilized in strengths-based approaches to intervention. One such strengths-based approach is embedding interests into the learning environment. Embedding interests is an intervention that is used to increase student engagement (Koegel, Vernon, Koegel, Koegel, & Paullin, 2012). Interventions that embed preferences or interests involve pairing identified interests (i.e., stimuli that an individual tends to interact with at their leisure) with aspects of a curriculum or activity to promote desirable behavior. Systematic evaluation of outcomes resulting from embedding interests as an independent variable can elucidate the evidence-base and theoretical-base of this intervention, which may have applied value for individuals with ASD.

The embedded interest intervention is theoretically based in the principles of applied behavior analysis (ABA). This empirical knowledge base outlines the principles of learned behavior (cf. Baer, Wolf, & Risley, 1968). Positive effects of embedding interests can be theoretically attributed to motivating operations (MOs) or motivating variables. MOs, that include establishing operations (EOs) and abolishing operations (AOs), function to alter the value of a stimulus (Michael, 1982, 1993, 2000). The EO occurs when the value of a reinforcer is greater and the AO occurs when the value of a reinforcer is lower. With embedding interests, low-preferred (LP) or neutrally preferred stimuli are replaced with high-preferred (HP) stimuli to temporarily establish or increase the value an alternative stimulation source. Embedded interests should evoke attention to the alternative stimulation source due to the EO. This process sets the occasion for alternative behaviors including social initiations (e.g., Boyd, Conroy, Mancil, Nakao, & Alter, 2007) and task engagement (e.g., Neely, Rispoli, Camargo, Davis, & Boles, 2013). Although a variety of studies demonstrate the effects of this intervention, a number of studies have neutral or negative effects (e.g., Adams, 1999; Morrison & Rosales-Ruiz, 1995).

Outcome Variability

It is unclear what might contribute to outcome variations in the embedded interest literature-base. Outcomes of embedding interests may vary by dependent variables, participant characteristics, or intervention characteristics. A variety of outcomes have been targeted with embedded interest interventions. Participant characteristics such as behavioral characteristics, age, and intellectual or adaptive functioning level could influence outcomes. Differential rates of progress exist among individuals with ASD in response to research-based skill building approaches (Ben Itzchak & Zachor, 2007). There is considerable

heterogeneity in outcomes because ASD as is a spectrum disorder. Therefore, interventions should be tailored to individual needs and modified as necessary (Pelios & Lund, 2001). Another consideration is that interests can either be embedded into free operant social situations or structured learning environments with demands in place. Identifying differences that may affect embedded interest intervention outcomes are needed to refine applications and the theoretical framework of the intervention.

Data aggregation techniques for single-case research are increasingly being applied to literature-bases. Generality of a finding is one of seven dimensions of applied behavior analysis (Baer et al., 1968). This dimension holds that a behavioral phenomenon must occur generally or regularly across organisms to be valid. External validity is the generality of results. Single-case research studies alone can often lack external validity until results across several studies are aggregated. Study aggregation based on quality indicators has made recent advancements due to demands from the education system, which is increasingly focused on data-based decision-making and evidence-based practice in schools. A large portion of educational research utilize single-case research design. Meta-analytic techniques and effect size (ES) metrics have been developed and adapted for the characteristics of single-case research data over recent years (Burns, 2012; Parker, Vannest, & Davis, 2011a). Meta-analysis adds to techniques of quality indicator analysis by measuring the magnitude of intervention effects across studies and within categories of studies to assess potential moderators (Glass, 1976; Lipsey & Wilson, 2001). Moderator analyses group effects by categories or variables and compare them to determine sources of outcome variability.

Purposes and Research Questions

This dissertation reports results from three studies related to embedding interests for individuals with ASD. A theory of change model is depicted in Figure 1. The purposes of this dissertation overall were to (a) determine the contexts in which embedding interests of individuals with ASD has evidence of effectiveness, (b) assess potential side-effects of the intervention, and (c) evaluate potential theoretical underpinnings of the intervention.

Study 1

First, the quality of the research literature on embedding interests for individuals with ASD was evaluated. Both single-case research and group-based research studies were included. Twenty studies with 79 participants were appraised according to two quality rubrics. Quality rubrics included the Council for Exceptional Children (CEC) Standards for Evidence-Based Practice in Special Education (Cook et al., 2015) and the What Works Clearinghouse (WWC) Standards for Single-Case Design and Evidence (Kratochwill et al., 2010/2014, 2013). Evidence was analyzed overall and within categories of dependent variables according to recommended guidelines. Targeted dependent variable categories included primary outcomes of social/communication skills and task-engagement/accuracy/productivity. Secondary outcomes included positive affect, self-stimulatory or ritualistic behaviors, and disruptive or off-task behavior. In study 1, research questions included:

1. What is the quality of the evidence base for embedding interests for individuals with ASD according to the CEC Standards (Cook et al., 2015) for single-case and group-based research?

2. What is the quality of the evidence base for embedding interests for individuals with ASD according to the WWC Standards (Kratochwill et al., 2010/2014, 2013) for single-case research?
3. What dependent variables (e.g., social/communication skills) are targeted and how many studies, cases, and research groups make up the support?

Study 2

Second, a meta-analysis of the embedding interests literature was conducted that included 18 single-case experimental research studies with 45 participants identified in the quality review. Data were aggregated across domains of relevant variables including dependent variables, participant characteristics (i.e., age categories, intellectual/adaptive functioning levels), and learning contexts (i.e., student/client-led versus instructor-led instructional sessions) to determine the areas in which these interventions have evidence. The manuscript type (i.e., peer-reviewed or dissertation) was tested as a moderator to indicate the potential presence of publication bias. Convergent validity of visual analysis ratings with a nonoverlap effect size metric was assessed through meta-analytic techniques. In study 2, research questions included:

1. What are the overall effects of embedding interests on outcomes for individuals with ASD?
2. What are the effects for each included dependent variable?
3. What is the correlation between primary outcomes and self-stimulatory or ritualistic behaviors?
4. What are the effects of potential moderators including (a) dependent variables, (b) participant characteristics, (c) learning contexts, (d) publication types, and (e) visual

analysis of evidence categories for cases according to the WWC Standards (Kratochwill et al., 2010/2014, 2013)?

Study 3

Third, a single-case research study was conducted to address a gap noted in the literature on embedding interests. Specifically, the purpose of this study was to determine the effects of embedding interests as receptive identification targets on receptive identification acquisition, stimulus generalization, and generalization to tacts (i.e., labels). A secondary purpose was to appraise the use of added intervention components as necessary for timely learning to occur. Ancillary variables were evaluated to isolate if embedding interests acted as an EO to promote task-engagement. In study 3, research questions included:

1. Will preference for targets result in differential effects on receptive identification acquisition for children with ASD who lack or have minimal receptive identification skills?
2. Will participants: (a) attend to referent stimuli differentially, (b) make response attempts differentially, and (c) exhibit challenging behavior differentially across HP versus LP conditions?
3. What are the effects of HP versus LP conditions on participants' abilities to generalize to other exemplars of receptive identification targets?
4. What are the effects of HP versus LP conditions on participants' abilities to tact receptive identification targets?
5. What are the effects of added intervention components on receptive identification acquisition?

CHAPTER II

A QUALITY REVIEW OF THE RESEARCH ON EMBEDDING INTERESTS OF INDIVIDUALS WITH AUTISM SPECTRUM DISORDER

A core diagnostic criterion of autism spectrum disorders (ASD) is the demonstration of restricted and repetitive behavioral patterns, that can present as unusual or intense perseveration on objects or activities of interest (American Psychiatric Association, 2013). Restricted interests, also known as perseverative or circumscribed interests, are typically idiosyncratic. While the content of restricted interests is unique to the individual, the focus may consist of inanimate matters such as machinery and electronics, transportation and vehicles, mathematics, history, videos, pictures, maps, road signs, and household appliances (Attwood, 2003; Kanner, 1943; Mercier, Mottron, & Belleville, 2000; South, Ozonoff, & McMahon, 2005; Sasson, Elison, Turner-Brown, Dichter, & Bodfish, 2011). Restricted interests may also take form as specific parts or attributes of stimuli (Attwood, 2003; e.g., wheel of a toy car, the color blue). Although some forms of restricted interests of individuals with ASD can be considered developmentally appropriate, the intensity of them typically compete with alternative sources for stimulation due to a reluctance to attend to stimuli associated with the outside environment (Bruckner & Yoder, 2007).

Restricted interests can lead to a number of negative outcomes. Kanner (1943) originally noted that characteristically rigid behaviors appeared to be in stark contrast with social awareness and relationships seen with family members and peers of individuals with ASD. Intense interest in familiar objects and low interest in people among young children with ASD is associated with low rates of joint engagement during play with care-givers, a

pivotal skill for social and language development (Adamson, Deckner, & Bakeman, 2010). In addition, the developmental trajectories of motor engagement and intentional communicative acts are inversely related to restricted object use (Bruckner & Yoder, 2007). Restricted interests often interfere with and complicate instructional interventions, as the removal of them can evoke challenging behavior (Kanner, 1943). The presence of restricted interests can lead to social stigmatization for individuals with ASD and marginalization among their typically developing peers (Charlop, Kurtz, & Casey, 1990; Schroeder, Cappadocia, Bebko, Pepler, & Weiss, 2014). Social-communication and functional skill repertoires of individuals with ASD can be seriously limited as a result of these barriers associated with restricted interests (Cascio et al., 2014).

Attempting to reduce restricted interests through intervention may pose problems associated with motivation. Restricted interests, despite their negative impacts, are often considered to be a source of pleasure for individuals with ASD (Mercier et al., 2000). A qualitative study found that high-functioning individuals with ASD may have the ability to adapt or modify their interests due to sensitivity under social pressures, but such adaptation of restricted interests would require social awareness and motivation (Mercier et al., 2000). It appears that few quantitative studies have specifically targeted the reduction or modification of restricted interests (Patterson, Smith, & Jelen, 2010). Challenging behavior related to restricted interests may effectively be reduced with intervention while restricted interest levels remain stable (Boyd, Woodard, & Bodfish, 2011). While a reduction of challenging behavior and adaptability of interests is positive, these changes in behavior might occur as a result of punishing contingencies and learned helplessness, under which motivation to engage in targeted activities could remain an issue (Koegel & Mentis, 1985).

Producing desirable changes in behavior relies on the reinforcing effectiveness of procedures and is accomplished through contriving or capturing establishing operations (EOs; Michael, 1982; Sundberg, 1993).

Because successful instruction requires a sufficient level of engagement on behalf of the learner, research has begun to explore the use of restricted interests, and interests or hobbies in general, to facilitate positive outcomes for individuals with ASD. The research in this area can be broadly categorized into consequent-based and antecedent-based interventions (Boyd et al., 2007). Consequent-based interventions have evaluated how preferred reinforcement contingencies increase occurrences of appropriate behavior, finding generally positive outcomes (Baker & Milner, 1985; Charlop-Christy & Haymes, 1996, 1998; Charlop et al., 1990; Carnett et al., 2014). A number of antecedent-based interventions have made the target activity itself more reinforcing by embedding interests into the learning environment via modifying aspects of the original or neutral activity (e.g., Boyd, Alter, & Conroy, 2005; Boyd et al., 2007; Vismara & Lyons, 2007). These studies utilized individual interests by incorporating them into the environment, noncontingent on the occurrence of targeted behaviors.

The procedure of embedding interests can be conceptualized similarly to noncontingent reinforcement, but it differs as noncontingent reinforcement typically targets challenging behavior reduction as a primary measure by providing access to a reinforcing stimulus in conjunction with an existing activity. Embedded interest interventions are designed to increase attention to an existing activity in order to affect both compliance and active participation (Koegel et al., 2012b). Boyd et al. (2005, 2007), for example, compared less preferred tangible stimuli with restricted interests embedded within dyadic play

situations to examine their relative effects on the social peer interactions and initiations of children with ASD. Targeted stimuli (high-preferred [HP] versus low-preferred [LP]) were "embedded" into the context of dyadic play by equipping the participant and their peer with identical target items with which to base their interactions around.

Evaluating the Quality of Evidence

Three previous reviews found mostly positive outcomes among studies incorporating interests of children with ASD (Dunst, Trivette, & Hamby, 2012a, 2012b; Raab & Dunst, 2007). However, these reviews focused on incorporating interests, which was broadly defined and inclusive of various strategies. Dunst et al. (2012a, 2012b) included studies incorporating choices as an independent variable. Incorporating choice versus interests or preferences alone can result in different patterns of effects and should be considered as different independent variables (Morgan, 2006). While some studies included in these reviews investigated embedded interest strategies, others investigated the incorporation of situational interests, for which targeted outcomes varied.

Situational interests, defined as inviting sights and sounds, could be determined a priori—they are not necessarily individualized. This is often referred to as environmental enrichment in the behavioral literature, wherein stimuli are used to evoke engaged behavior and thereby reduce incompatible challenging behavior (Horner, 1980; Rapp, 2004). The literature on incorporating situational interests or environmental enrichment differs from embedding interests primarily because of differing outcomes. With environmental enrichment, the outcome is interaction or engagement with an item that is added to the environment to compete with alternative sources of stimulation. With embedding interests, "embedding" implies that preferences are paired with neutral or LP stimuli to improve

responding that is not otherwise probable. Embedding interests should theoretically work to draw more attention to alternative stimulation sources, rather than compete with alternative sources of stimulation.

Stimuli can invite attention without representing an individual's personal interests. The dimensions of reinforcement—quality, quantity, immediacy, response effort (Mace & Roberts, 1993)—may vary considerably across the interventions included in the previous reviews. There are no previous reviews of original studies specifically focused on embedding the unique interests of individuals with ASD into the aspects of the environment; although Raab and Dunst (2007) did evaluate this as a variable, finding greater effects for five studies that embedded interests to increase engagement in alternative activities as opposed to the studies that incorporated interests to increase engagement with the item of interest alone. Furthermore, each review found stronger effects for studies incorporating individual interests, although both individual interests and situational interests resulted in positive effects. These findings, however, may be confounded by differences in methodological applications between groups of studies.

In addition, the previous reviews in this area did not control for experimental rigor or quality. It is important to determine the status of the support in this area according to structured criteria to make inferences about evidence. The literature appears to suggest that embedded interest strategies may be effective to improve skills (e.g., social skills) for individuals with ASD, although studies vary in quality. Embedding interests of children with ASD may be common in practice as it has been promoted and described within a number of descriptive and case study reports (Lanou, Hough, & Powell, 2012; Mancil & Pearl, 2008; Porter, 2012; Vacca, 2007). While embedding interests may be considered value-added for

the recipient of behavior change, the literature-base must be inspected over standards of study quality to determine the empirical evidence of potential effects on learning outcomes.

Purpose

The purposes of conducting this review were to determine the quality of the research on embedding interests into treatment to improve outcomes for individuals with ASD and to determine the variables wherein the evidence lies. Intervention studies were aggregated that involved utilizing interests of individuals with ASD to improve on an area of demonstrated need (e.g., engagement, acquisition). Then, studies were analyzed for quality indicators using the Council for Exceptional Children (CEC) Standards for Evidence-Based Practice in Special Education (Cook et al., 2015) and the What Works Clearinghouse (WWC) Standards for Single-Case Design and Evidence (Kratochwill et al., 2010/2014, 2013). The following specific research questions were posed:

Research Questions

1. What is the quality of the evidence base for embedding interests for individuals with ASD according to the CEC Standards (Cook et al., 2015) for single-case and group-based research?
2. What is the quality of the evidence base for embedding interests for individuals with ASD according to the WWC Standards (Kratochwill et al., 2010/2014, 2013) for single-case research?
3. What dependent variables (e.g., social/communication skills) are targeted and how many studies, cases, and research groups make up the support?

Method

Studies were aggregated to evaluate the quality of the literature-base on embedding interests of people with ASD. Search procedures are displayed in Figure 2.

Search Procedures

Three databases including Education Resource Information Center (ERIC), PsycINFO, and ProQuest Dissertations and Theses Full Text were systematically searched to retrieve articles and dissertations in the fall of 2014. All possible pairs of terms were searched from the following two sets of terms: (a) *autis**, *Asperger**, or "*pervasive developmental*", and (b) *prefer**, *interest**, *reinforc**, *perseverat**, *ritual**, *obsessi**, *circumscribed*, and *restrict**. Terms from the latter set of words were restricted within the database search functions to be included in the title of the retrieved work. Additionally, terms from the first set were paired with the terms "*traditional materials*" or "*preferred materials*," with no restrictions to search functions. Searches were not restricted to peer-reviewed articles. There were 1,077 references found with duplicates removed, not including duplicates of publications based from dissertations.

Title and abstract screening. Inclusion and exclusion criteria were applied to categorize studies upon reading the title and abstract of each. References were excluded that were (a) not in English, (b) a synthesis of previous research, (c) descriptive (e.g., chapters, book reviews), or (d) absent of educational/environmental intervention conditions with student/client outcomes (e.g., studies training behavior-change agents, behavioral presentation and correlation studies, survey- or assessment-based studies, medication trials, animal models). Studies included within this initial gate were required to evaluate an

educational intervention, defined as manipulating the environment to change or teach behaviors (e.g., reinforcement, prompting, shaping).

Full-text screening. Qualifying studies (n = 446) were evaluated in full to determine if they evaluated effects of interests embedded within the learning environment for individuals with ASD. Embedding interests was defined as an antecedent intervention in which an individual's interest(s) is fixed into aspects of the curriculum; or an activity is modified to incorporate the interest(s). Qualifying experiments attempted to isolate this variable by comparing neutral, standard, or LP conditions to HP conditions. Condition had to be appropriately introduced to participants in order to compare them. If an embedded interest condition was only compared to a different intervention, such as differential reinforcement, it was excluded (e.g., Keen & Pennell, 2015). Studies had variability in terms of methods of assessment applied in determining interests or restricted interests. Therefore, this review is inclusive of studies embedding any reported object or activity interest of an individual with ASD, regardless of details characterizing the interest as "restricted" or otherwise. Studies were required to include some form of observation or a stakeholder report to ensure identified interests were individualized. If a formal stimulus preference assessment was conducted, it had to be informed by observations or reports. Thus, studies were excluded that used a priori determined stimuli to assess preferences (e.g., Lee & Sturmey, 2006). Twelve studies were included through this phase.

Ancestral search. An iterative ancestral search was conducted in the summer of 2015 that included (a) a database search determining studies that cited the included articles via Google Scholar and (b) a review of the reference lists of included articles. Titles were screened and in instances of potentially identifying a new study, the full article was screened.

The database search resulted in identifying an additional seven studies and the review of reference lists resulted in identifying an additional one study for inclusion, amounting to a total of 20 included studies.

Interrater reliability (IRR) on screening. A second rater used the same criteria to evaluate a random selection of 443 references from the original total of 1,077 (41%) for the title and abstract screening and a random selection of 163 references of 446 (37%) for the full-text screening. IRR was always evaluated by dividing the agreements by agreements and disagreements and obtaining a percentage by multiplying that figure by 100. Across categories for exclusion and inclusion, there was 90% agreement between raters for the title and abstract screening and 97% agreement for the full-text screening. The raters discussed disagreements if necessary to come to agreement.

CEC Standards

Studies were evaluated using the CEC Standards for Evidence-Based Practice in Special Education (Cook et al., 2015). This protocol allows for aggregate quality analysis of both group-based research and single-case research studies. Appendix C displays a researcher-developed summary of the rubric for the CEC criteria. Each dependent variable within a study was scored according to quality indicators with either a '+' denoting sufficiency in meeting an indicator or a '-' denoting insufficiency in meeting that indicator. Dependent variables from studies were denoted with 'M' in instances where support was mixed across cases. This was included in the coding scheme for added precision. The following standards and indicators were evaluated among the studies.

CEC context and participant descriptions. Standards 1.0 through 4.0 evaluate contextually relevant information of the study under examination. Standard 1.0 (indicator

1.1) appraises the context and setting of a study, for which studies must describe the features critically relevant to the review (e.g., type of school). Standard 2.0 appraises participant information described within the study and includes indicators on relevant demographics of participants (2.1) and participant disability or risk status with the method of determination reported (2.2). In this review, participant demographics of primary consideration were disability status and age. Standard 3.0 appraises the details the study provided regarding the intervention agent/facilitator, including indicators on the interventionist's role (3.1) and the interventionist's qualifications or training required for implementation (3.2). Standard 4.0 appraises the description of the practice in a study and includes indicators on intervention procedures (4.1) and materials (4.2).

CEC implementation fidelity and internal validity. Standards 5.0 through 6.0 evaluate the critical features for methodological considerations. Standard 5.0 appraises implementation fidelity with indicators regarding treatment adherence using reliable measures (5.1), direct and reliable measures to reveal dosage (5.2), and regularity of fidelity assessment (5.3). Standard 6.0 evaluates critical elements of internal validity including systematic manipulation of the relevant independent variable (6.1), condition descriptions (6.2), and limited or no access to treatment in baseline (6.3). Two studies were classified with 'M' on indicator 6.1 as only some participants appeared to maintain their interests throughout the study. Therefore, the independent variable (i.e., embedding interests) was not systematically evaluated. Specifically, Adams (1999) reported that two of five participants did not maintain their interests. Additionally, Agarwal (2012) reported two of three participants to have highly inconsistent findings between caregiver reports and stimulus preference assessment results. Indicator 6.2 was not met if studies may have included

additional procedural components with the embedded interest intervention (e.g., added reinforcement; Talebi, 2007; Koegel, Kim, Koegel, & Schwartzman, 2013). Individual designs from single-case studies must also include three replications to allow demonstrations of experimental effect (6.5), have a minimum of three data points per phase (with undesirable patterns of behavior in baseline data) or four data points per phase for alternating treatments designs (6.6), and use a properly executed experimental design (6.7). Indicators were classified with 'M' when some, but not all, designs met the criteria for a single-case research study. Group studies must additionally include an adequate description of assignment to groups using one of four specified methods (6.4), have low overall attrition (6.8), and have low differential attrition (6.9).

CEC outcomes and data analysis. Standards 7.0 and 8.0 evaluate the targeted outcomes and how they were reported within each study. Standard 7.0 evaluates the dependent variables of the targeted study in terms of the social importance (7.1), detail provided (7.2), reports or graphic display of all effects (7.3), frequency of measures (7.4), and interobserver reliability (IOA; 7.5). Single-case studies including designs with both minimum and below minimum numbers of data points were classified with 'M' for indicator 7.4. Standard 8.0 appraises the appropriateness of data analysis. Single-case studies must include clear visual representations of data to permit visual analysis (8.2). Group studies must include adequate evidence of internal or social validity (7.6), appropriate procedures for data-analysis (8.1), and appropriate effect sizes (8.3).

CEC recommendations for combining. According to recommendations by the CEC, study effects relevant to the review are coded as *Positive*, *Mixed or Neutral*, or *Negative*. Criteria for these effect codes in group-based studies are recommended to be

determined a priori, tailored to the clinical significance of effects and benchmarks for effect size interpretation. Criteria to code effects are provided for single-case research, in which study designs must demonstrate functional relations through at least three replicated effects (Kratochwill et al., 2013). *Positive* effects for single-case studies are defined as at least three out of four cases with a clinically significant therapeutic change in dependent variables, with no nontherapeutic effects (i.e., going in the opposite direction of intended change). Three of four cases must show nontherapeutic effects to be classified as *Negative*. To be classified as having *Positive* or *Negative* effects, a dependent variable within a study must include at least three cases (i.e., participants or participant groups such as a classroom). Furthermore, the minimum of three cases has to specifically include the population of interest (here, individuals with ASD). When these criteria are not met, studies are classified as *Mixed or Neutral*. For example, studies are *Mixed or Neutral* if half of the participants in a study using A-B-A-B designs showed functional relations, while the other half did not. Studies are synthesized to evaluate evidence when categories of dependent variables include at least three cases per study and they are deemed methodologically sound per meeting all of the relevant indicators. Finally, evidence is synthesized to determine the practice as *Evidence-Based Practice*, *Potentially Evidence-Based Practice*, *Mixed Evidence*, *Insufficient Evidence*, or *Negative Effects* based on support from qualifying single-case and group-based studies. A variety of combinations can make up the support for each one of these categories as described by Cook et al. (2015).

WWC Standards

WWC design evaluation. Appendix D displays a researcher-developed summary of the rubric for the WWC criteria. Dependent variables in cases of studies are analyzed

according to five Design Standards in the WWC Standards (Kratochwill et al., 2010/2014, 2013). These standards include (1) a systematically manipulated independent variable, (2) IOA collected for at least 20% of sessions (preferably, 20% *within* phases/conditions), (3) minimum thresholds of 80% IOA or .60 Kappa, (4) a minimum of three replications of effect attempted through the design, and (5) a minimum number of data points collected per phase of the design. It should be noted that Baker (2000) and Baker, Koegel, and Koegel (1998) incorporated some sessions with teacher prompting at approximately midway through the baseline phases. All intervention conditions initially included teacher prompting in these studies. This review considered baseline to begin at the sessions in which teacher prompting took place in order to best isolate the effects of embedding interests alone. Multiple-baseline and reversal/withdrawal designs require at least five points per phase to meet Standard 5, three points per phase to meet Standard 5 with reservation, and two or fewer points per phase to not meet Standard 5. Alternating treatments designs must have five points per condition to meet Standard 5, at least four to meet Standard 5 with reservation, and three or fewer to not meet Standard 5. Studies meeting each of these standards are classified as *Meets Design Standards*. Studies that meet the first four standards and meet the fifth standard with reservations are classified as *Meets Design Standards with Reservations*. Studies that do not meet one or more of these standards are classified as *Does Not Meet Design Standards* and are excluded from further review. When studies reported to collect IOA for at least 20% of data *within* phases, it was recorded for informational purposes in this review, but this did not affect overall scores.

WWC evidence evaluation. Cases classified as *Meets Design Standards* or *Meets Design Standards with Reservations* are evaluated using visual analysis of data patterns

within and between design phases. Visual analysis consists of evaluating data according to characteristics of level, variability, trend, immediacy of effects from one phase to another, overlap in data between different phases, and consistency of effects across the same phases of a design (Parsonson & Baer, 1978). Considering these characteristics, the presence of basic effects between neighboring phases can be determined as a whole per case in a single design. Functional relations for whole designs are determined by considering the number of replicated effects or the consistency of effects. Three replications of an effect are necessary to support a functional relation. Studies are then categorized as having *Strong Evidence*, *Moderate Evidence*, or *No Evidence*. *Strong Evidence* is classified when designs have at least three effect replications and there are no non-effects. *Moderate Evidence* is classified when designs include a ratio of at least three effects for every non-effect. *No Evidence* is classified when there are fewer than three effects for every non-effect in a design.

WWC recommendations for combining. Studies are combined for summarization that meet minimum standards of design or meet them with reservations. A minimum of five studies on an intervention, from at least three differing teams of investigators (i.e., different institutions without overlap in authorship), and with at least 20 cases (i.e., participants or aggregated sets of participants) can indicate strong support for a practice (Kratochwill et al., 2010/2014, 2013).

Variable Coding

Study variable codes under analysis in this review included dependent measures. Studies were descriptively summarized in terms of dependent measures, after which appropriate coding constructs were adopted. Dependent variable categories included (a) social/communication skills (SOCCOM), (b) task-engagement/accuracy/productivity

(TEAP), (c) affect (AFFECT), (d) self-stimulatory or ritualistic behaviors (SSRB), and (e) disruptive or off-task behavior (DOT). Some of these categories were broadly encompassing of a variety of behaviors; for instance, SOCCOM included dependent variables such as joint attention, social initiations, and social play. TEAP included measures related to academic or work skills. SOCCOM and TEAP were considered primary dependent variables, whereas the others were considered ancillary or side-effect measures. No additional targeted side-effect measures (e.g., peer proximity; Talebi, 2007) were included in the review because they were infrequently targeted overall.

IRR on Quality Indicator and Variable Coding

The quality indicator coding was completed by an independent second rater, and their codes were compared to the first rater's codes to determine agreements and disagreements. All disagreements were resolved through discussion until the raters agreed. Of 20 studies, 7 (35%) were randomly selected for IRR on CEC codes that included 15 dependent variables (33% of 45). Raters agreed for 96% (range, 80%-100% within quality indicator categories) of 330 opportunities for the CEC Standards. Of 18 single-case studies, 11 (61%) were randomly selected for IRR on WWC Design Standards codes that included 61 (55% of 110) dependent variables within cases by design. Raters agreed for 94% (range, 80%-100% within Design Standards) of 366 opportunities for the WWC Design Standards. For the WWC Evidence Standards, raters practiced with one study and the second rater then independently analyzed seven of 16 (44%) studies with 39 of 71 (55%) dependent variables within cases that qualified through the analysis of Design Standards. Raters agreed for 97% of opportunities in analyzing basic effects of dependent variables within cases and 92% of opportunities to classify overall evidence of functional relations. The dependent variables targeted were

checked for accuracy by a second evaluator for six (30% of 20) randomly selected articles. Within these articles, there were 35 dependent variables within cases by design out of a total of 96 (36%) and the second rater agreed for 100% of opportunities.

Results

Eighteen single-case and two group-based research studies were included in this review. There was a total of 45 participants with ASD from single-case studies and 34 participants with ASD from group-based studies. Single-case studies included 38 dependent variables and group-based studies included five dependent variables.

CEC Standards

Table 1 displays dependent variables from single-case research studies and Table 2 displays dependent variables from group-based research studies coded according to the CEC Standards. Regarding contextual and participant characteristics out of 43 dependent variables, 39 (91%) included adequate context/setting descriptions (1.1), 42 (98%) included relevant participant demographics (2.1), 38 (88%) included reports of how participant disability or risk status was determined (2.2), 40 (93%) included descriptions of the interventionist role (3.1), 16 (37%) included descriptions of the interventionist qualifications/training (3.2), 36 (84%) included adequate descriptions of interventionist procedures (4.1), and 42 (98%) included adequate descriptions of materials (4.2).

Regarding implementation fidelity, nine (21%) dependent variables included reliable measures of treatment adherence (5.1), 40 (93%) revealed dosage (5.2), and six (14%) regularly assessed fidelity (5.3). Regarding internal validity, 43 (100%) dependent variables included systematic manipulations of the independent variable (mixed support included; 6.1), 38 (88%) included adequate condition descriptions (6.2), and 43 (100%) did not include

access to treatment in baseline (6.3). Specific to internal validity of single-case studies, 38 (100%) dependent variables included at least three replication attempts for at least one participant (6.5), 33 (87%) included at least three data points per phase with a predictable pattern of undesired performance for at least one graph (6.6), and 36 (95%) used experimental designs and controlled internal validity threats for at least one graph (6.7). Specific to internal validity of group-based research, all five (100%) dependent variables included adequate descriptions of group assignments (6.4), low overall attrition (6.8), and low overall differential attrition (6.9).

Regarding outcomes and data analysis, all 43 (100%) dependent variables were considered socially important (7.1) and adequately described (7.2), 40 (93%) reported all of the effects from all measures (7.3), 40 (93%) included appropriate frequency of measures (mixed support included; 7.4), and 40 (93%) met adequate minimums of IOA (7.5). Specific to outcomes and data analysis of single-case studies, 35 (92%) dependent variables included clear visual representations of data (8.2). Specific to outcomes and data analysis of group-based studies, no (0%) dependent variables included evidence of internal or social validity (7.6), whereas all (100%) dependent variables included appropriate data-analysis techniques (8.1) and effect size reports (8.3).

WWC Standards

Figure 3 depicts the Evidence-Based Classification process outlined by the CEC Standards for both single-case and group-based research in which evidence is specifically analyzed within dependent variable categories. No group-based research studies qualified to be analyzed for evidence. One single-case study met all standards and included at least three participants (Boyd et al., 2007), allowing an analysis of evidence. This study targeted a

SOCCOM skill and the evidence was classified as *Positive* (all three participants showed improvement in the embedding interest intervention condition). This was determined as *Insufficient Evidence* overall per the classification categories described by Cook et al. (2015).

Table 3 displays the WWC Design Standards applied to 18 single-case research studies. There were 110 dependent variables within cases at the level of the design analyzed. Out of these effects, 98 (89%) met Design Standard 1 (i.e., isolation of independent variable). There were 101 (92%) effects that met Design Standard 2A (i.e., included sufficient measures of IOA), 39 (39%) of which clearly collected minimum percentages of IOA within phases or conditions. There were 100 (91%) effects that met Design Standard 2B (i.e., adequately high levels of IOA), 106 (96%) effects that met Design Standard 3 (i.e., included three attempts to replicate effects), and 95 (86%) effects that met Design Standard 4 or met it with reservation (i.e., included a sufficient number of data points).

Figure 4 depicts an overview of WWC Design and Evidence Standards applied to cases within categories of dependent variables and by design. Of 110 effects, 44 (40%) were classified as *Meets Design Standards*, 27 (25%) were classified as *Meets Design Standards with Reservations*, and 39 (35%) were classified as *Does Not Meet Design Standards*. Sixteen studies advanced to Evidence Evaluation in which 55 (77%) effects were found to have *Strong Evidence* and 16 (23%) effects were found to have *No Evidence*. No effects were identified to demonstrate *Moderate Evidence*.

Next, those effects demonstrating *Strong Evidence* were evaluated to determine evidence overall and within specified dependent variable categories based on WWC recommendations. Overall, 29 participants from 13 studies conducted by six different research teams met criteria to be classified as having *Strong Evidence*, supporting the use of

embedding interests for individuals with ASD. When applied to the SOCCOM dependent variables alone, 24 participants from nine studies and two teams were classified with *Strong Evidence*. Therefore, there were not enough research teams (i.e., a minimum of three) at this time in order to confidently support the practice of embedding interests specifically for improving SOCCOM outcomes. *Strong Evidence* outcomes on TEAP were supported with five participants, four studies, and four teams. *Strong Evidence* outcomes on AFFECT were supported with four participants, two studies, and one team. *Strong Evidence* outcomes on decreasing SSRB were supported with three participants from one study and team. Finally, *Strong Evidence* outcomes on decreasing DOT behaviors were supported with three participants, two studies, and two teams. Therefore, these remaining variables were not supported by enough participants (i.e., 20), among other reasons, to support the practice of embedding interests for individuals with ASD.

Rubric Comparison

Table 4 shows both the CEC and WWC classifications according to evidence for single-case research to supplement a comparison of the outcomes across rubrics. Outcomes varied considerably between the rubrics. Overall, four participants met all criteria for the CEC Standards and three of those participants could be evaluated for evidence, compared to the WWC Standards where 34 participants could be evaluated for evidence. Outcomes were consistent and positive for the three participants evaluated for evidence according to both rubrics.

Discussion

This quality indicator review evaluates the evidence across dependent variables in support of embedding interests for individuals with ASD. Both the CEC Standards for

Evidence-Based Practice in Special Education (Cook et al., 2015) and the WWC Standards for Single-Case Design and Evidence (Kratochwill et al., 2010/2014, 2013) were applied. The CEC protocol for Evidence-Based Classification resulted in findings of *Insufficient Evidence* for embedding interests of individuals with ASD. The WWC protocol for Evidence Evaluation resulted in the findings of 55 effects with *Strong Evidence* and 16 effects with *No Evidence*. Embedding interests for individuals with ASD has sufficient support as an empirically-validated practice according to the WWC Standards overall. However, there was not enough support for any one dependent variable alone when the effects were assessed by categories of dependent variables using the WWC recommendations for combing effects. Social/communication skills usually had positive effects and there was nearly sufficient support. New research teams are needed to validate the effects of embedding interests on social/communication outcomes. More research in general is also needed that targets task-engagement/accuracy/productivity outcomes. Research targeting both of these primary outcome areas show promise, although effects vary considerably.

This study allows for an analysis of convergent validity between the CEC and WWC Standards. There was very low agreement between the protocols because the CEC Standards are more conservative than the WWC Standards. While this can be considered a strength of the CEC protocol, it does place limits on large literature-bases that existed prior to the rise of rigorous conventions for educational research manuscripts. Specific CEC indicators that were infrequently met included those on adequate descriptions of interventionist's qualifications or training (3.2), inclusion of measures on treatment adherence (5.1), regularity of fidelity assessment (5.3), and adequate evidence of internal or social validity among group-based studies (7.6). While the WWC Standards do not require information to be reported on

contextual factors (e.g., intervention agent details) and treatment adherence, the protocol does encourage reviewers to consider these indicators of study quality as appropriate (Kratochwill et al., 2010/2014). This flexibility allows for a more conservative analysis. Another strength of the CEC protocol is that it is applicable to single-case and group-based research. The WWC protocol is only applicable to single-case research. There is currently not a WWC protocol for analyzing evidence by aggregating both single-case and group-based research. Given the strengths and limitations of these protocols, they appear to complement one another well to produce a clear picture of a given body of literature.

Limitations

There are limitations to consider for this review. First, it is important to note that only certified reviewers are qualified to apply the WWC Standards to make conclusions about evidence-based practices in education. Therefore, the evidence suggested here does not have the same level of defensibility. Second, outcomes were not analyzed by variables related to participant characteristics or intervention types. It is possible that these variables could moderate the effects. For instance, some participants appeared to display more stereotypical behaviors in the embedded interest conditions (Adams, 1999; Morrison & Rosales-Ruiz, 1997) whereas others displayed less stereotypical behavior in the embedded interest conditions (Baker, 2000). This in turn, among other factors, could differentially affect levels of engagement and positive outcomes that occur as a result of embedding interests. Also, interventions included differing instructional formats (e.g., student-led versus instructor-led) that may influence outcomes. Meta-analytic or correlational methodologies would be useful in exploring these possibilities. Potential moderators contributing to varied effects may be

best evaluated without restrictions on study quality in order to be more inclusive of the limited literature-base.

Implications for Practice

Embedding the interests of individuals with ASD into the learning environment is an intervention with a bourgeoning evidence base. Outcomes are generally positive, but have at times shown to be neutral and even negative. Therefore, practitioners should take caution when embedding student interests by monitoring data and comparing typical conditions to HP conditions. Practitioners should also consider collecting data not only on behaviors intended for increase (e.g., engagement, joint attention), but also on behaviors that may interfere with learning (e.g., challenging behavior, stereotypical behavior). The added effects of embedding interests on behavior should be monitored in consideration to the cost or resource effectiveness of the intervention. With appropriate monitoring, embedding interests of students with ASD has the potential to improve a variety of skills, particularly social or communication skills.

CHAPTER III

A META-ANALYSIS OF SINGLE-CASE RESEARCH ON EMBEDDING INTERESTS OF INDIVIDUALS WITH AUTISM SPECTRUM DISORDER

Defining characteristics of autism spectrum disorder (ASD) are deficits in social-communication skills and repetitive or restricted behaviors and interests (RRBIs; American Psychiatric Association, 2013). RRBIs are displayed in several ways, including stereotypic motor movements or speech, insistence on sameness, sensory hypo- or hyperactivity, and restricted interests (also described as circumscribed or perseverative interests). The interests of individuals with ASD tend to be more intense and differ in content relative to typically-developing individuals (Anthony et al., 2013). Restricted interests are often expressed by individuals with ASD through restricted or repetitive object use, preoccupations with certain attributes of stimuli, or fascinations for certain topics or activities (Bishop, Richler, & Lord, 2006; Bishop et al., 2013; Bruckner & Yoder, 2007). Restricted interest can become more apparent with age, and perhaps more interfering or resistant to change (South et al., 2005).

Restricted object interest or use can interfere with important sources of alternative stimulation and be at odds with the development of pivotal skills (Bruckner & Yoder, 2007). Studies that target the reduction of restricted interests may successfully reduce related problem behavior, but may not readily treat the intensity of restricted interests (Boyd et al., 2011). Koegel and Mentis (1985) and Carr (2007) provide compelling rationales for an interest-based approach to intervention strategies for individuals with ASD. Many studies demonstrate that restricted interests can be harnessed to act as powerful tangible reinforcement for pro-social behavior and performance (Baker & Milner, 1985; Charlop-

Christy & Haymes, 1996, 1998; Charlop et al., 1990; Carnett et al., 2014). Another growing area of literature shows that restricted interests or general preferences can be embedded into aspects of the environment to promote participation in less-preferred or low-probability activities.

A disproportionate record of publications across dependent variables appears to exist in the literature of embedding interests for persons with ASD at large. Specifically, many studies evaluated embedding interests on social/communication outcomes (e.g., Boyd et al., 2005; Boyd et al., 2007; Baker, 2000; Baker et al., 1998) whereas fewer evaluated academic or pre-academic outcomes (e.g., Adams, 1999). This may speak to the dependent variables for which this intervention is relatively effective or feasible. Alternatively, results may be under control of the context within which they are taught, such as during repetitive practice or under naturalistically situated contingencies that promote shared control to increase motivation (Koegel & Mentis, 1985).

Previous Reviews

Three reviews have been conducted in the area of embedding interests into learning environments for individuals with ASD (Dunst et al., 2012a, 2012b; Raab & Dunst, 2007). Dunst et al. (2012a) conducted a meta-analysis of 14 single-case research studies with young children with ASD using the intra-individual point-biserial correlation coefficient. Dunst et al. (2012b) meta-analyzed 24 group-based and single-case research studies with young children with ASD using the Cohen's *d* effect size (ES). Raab and Dunst (2007) aggregated 25 group-based and single-case research studies with young children both with and without disabilities using the Cohen's *d* ES.

All reviews included studies with children that were 6 years of age or younger, and two evaluated age as a moderator showing some evidence that effects tended to have larger improvements with age (Dunst et al., 2012a, 2012b). Severity of ASD diagnosis and intervention setting were among other moderators analyzed by Dunst et al. (2012a, 2012b). Both reviews found that cases including children with milder symptoms of ASD produced slightly larger effects relative to children with moderate or severe symptoms, as did home settings relative to clinic or school settings; but interpretations are limited by considerable overlap in confidence interval ranges. Raab and Dunst (2007) evaluated mostly group-based research and identified three different ways that included studies were based upon child interests. Specifically, studies were categorized by those that evaluated (a) child engagement with items of interest, (b) embedded interests to evoke engagement with alternative activities, and (c) task performance in relation to demonstrated interest in the task or learning domain. While studies that embedded interests produced the largest effects, this may be due to considerable differences in study methods and constructs.

There are a number of limitations in the three previous reviews to consider. Included studies were not appraised for quality and outcomes were aggregated across studies that had substantial differences in methods. There appears to be issues with the inclusivity of various operational definitions used to characterize studies that incorporate interests. Studies incorporating situational interests were included in all three reviews. Situational interests were defined as the characteristics of the social or nonsocial environment (e.g., sights and sounds) that invite attention or engagement with material or people. Examples of specific situational interests included social stories (e.g., Lorimer, Simpson, Myles, & Ganz, 2002), the use of music (e.g., Kern, Wolery, & Aldridge, 2007), and animal-assisted therapy (Martin

& Farnum, 2002). Situational interests, as opposed to individual interests, were not necessitated to have any form of individualized determination of interests.

Behavior analytic literature tends to label interventions that incorporate situational interests as "environmental enrichment" (Horner, 1980; Rapp, 2004). Such treatments may be controlled by different mechanisms than embedding interests or preferences, and the studies within each of these areas clearly target different outcomes. Embedded interest studies are specifically concerned with increasing interaction with alternative stimuli, whereas environmental enrichment strategies are generally aimed to reduce challenging behavior and increase appropriate behavior. Each of the previous reviews found that situational interests versus individual interests moderated effects, favoring individual interests (Dunst et al., 2012a, 2012b; Raab & Dunst, 2007); although the independent and dependent variables likely varied between the groups too.

Also, studies incorporating choice-making opportunities (e.g., Moes, 1998) were included in two reviews (Dunst et al., 2012a, 2012b). Including choice-making opportunities as opposed to embedding interests alone can have differences in effects as well and thus likely differences in acting mechanisms (Morgan, 2006; Romaniuk & Miltenberger, 2001). The influences of reinforcement—the amount, immediacy, quality, and response effort requirements (Mace & Roberts, 1993)—may differ considerably within and between studies incorporating choices and preferences (Morgan, 2006). This is why it is critical to accurately distinguish preference or infer interest as a variable in research studies (Morgan, 2006). Given these assumptions and concerns, a more conservative definition of incorporating interests must be adopted.

"Preference" implies that specific procedures (e.g., indirect and/or direct assessment) were carried out to determine someone's choice between items or activities. The term is relative and does not imply "interest." "Interest," here, is defined as a stimulus that an individual tends to interact with at their leisure. Direct stimulus preference assessment methods include observing interactions with single items (Pace, Ivancic, Edwards, Iwata, & Page, 1985), providing choices between items (DeLeon & Iwata 1996; Fisher et al., 1992), and assessing how long and appropriately an individual engages with items (e.g., DeLeon, Iwata, Conners, & Wallace, 1999). Indirect preference assessment methods include reports from individuals (e.g., parent). To assess embedded interests, an experiment can be arranged to compare between high-preferred (HP) and low-preferred (LP) or neutral conditions. In order to adequately isolate the variable of embedded interests, LP versus HP conditions should be the only variable manipulated in a study. In this way, potential moderators and underlying theoretical mechanisms (i.e., how and why) in support of embedding interests alone as a treatment can be explored.

Single-Case Research Meta-Analysis

Meta-analysis is a means of interpreting the generality of the literature overall and within areas through aggregation of study effects (Glass, 1976; Lipsey & Wilson, 2001). There is cause to conduct a meta-analysis to determine the characteristics of studies under which magnitudes of effect tend to vary or show consistency in the literature of embedding interests of people with ASD. The majority of the literature in this area appears to be single-case research. Conducting a meta-analysis of single-case research can raise a variety of threats to internal validity if not foreseen or controlled. To improve the validity of single-case meta-analysis, it can be useful to control for confounds of poorly defined constructs (Burns,

2012). In this way, potential moderators including participant characteristics, treatment components, and dependent variables may be best gleaned.

It is also important for meta-analyses of single-case research to address statistical validity of ESs used (Burns, 2012). ES metrics available for nonparametric research methods are limited in that no one statistical method available comprises all considerations of visual analysis and experimental design analysis (Carter, 2013). Visual analysis is nuanced, considerate to all possible pattern of single-case data, and it is used to detect experimental control and functional relations (Franklin, Gorman, Beasley & Allison, 1996; Gast, 2010; Kennedy, 2005; Parsonson & Baer, 1992). Visual analysis, however, does not produce a standardized metric to interpret the generality of effects in terms of their magnitude. A number of studies demonstrate or make suggestions as to how we can preserve the integrity of experimental control in single-case meta-analysis and data aggregation (Burns, 2012; Carter, 2013; Horner & Kratochwill, 2012; Kratochwill & Levin, 2014; Manolov, Sierra, Solanas, & Botella, 2014; Ninci et al., 2015; Parker & Vannest, 2012). One such method is to require minimum quality indicators of internal validity as criteria for including studies. Several quality appraisal rubrics for single-case research are available that categorize studies or cases based on characteristics of design and evidence (Maggin, Briesch, Chafouleas, Ferguson, & Clark, 2014; Wendt & Miller, 2012). The credibility of inferences from statistics can also be validated by comparing ES outcomes to visual analyzed ratings of evidence (Ninci et al., 2015). Ninci et al. (2015) found that the Tau nonoverlap ES showed consistency with visual analysis indicators of overlap, basic effects between phases, and to a lesser degree of certainty, the overall presence of experimental control. These results were produced via moderator analyses with categories based on the What Works Clearinghouse

(WWC) Standards for Single-Case Design and Evidence (Kratochwill et al., 2010/2014, 2013).

The Tau nonoverlap ES is a robust measure of nonoverlap of all pairs of data points between two conditions, ranging from values of -1 to 1 (Parker, Vannest, Davis, & Sauber, 2011b). A number of recent meta-analyses have used the nonparametric statistics of Tau or Tau-*U* (which controls for baseline trend) and nonoverlap of all pairs (NAP; which differs in scale) to measure effects (e.g., Bowman-Perrott et al., 2013; Heath, Ganz, Parker, Burke, & Ninci, 2015; Ninci et al., 2015; Roth, Gillis, & DiGennaro Reed, 2014; Whalon, Conroy, Martinez, & Werch, 2015). These ES methods fit the assumptions of single-case design and consider all of the relevant data within phases (Parker et al., 2011a, 2011b).

Purpose

The purpose of this review is to extend the previous reviews by (a) refining the construct of embedding interests, (b) evaluating same, similar, and new potential moderators, (c) evaluating publication bias, and (d) evaluating studies based on quality.

Research Questions

1. What are the overall effects of embedding interests on outcomes for individuals with ASD?
2. What are the effects for each included dependent variable?
3. What is the correlation between primary outcomes and self-stimulatory or ritualistic behaviors?
4. What are the effects of potential moderators including (a) dependent variables, (b) participant characteristics, (c) learning contexts, (d) publication types, and (e) visual

analysis of evidence categories for cases according to the WWC Standards (Kratochwill et al., 2010/2014, 2013)?

Method

Outcomes from the search and gating procedures of the quality review described in Chapter 2 were applied for this meta-analytic review, with final inclusion of only single-case research studies. Studies were gathered to evaluate embedding interests of individuals with ASD. Search procedures are presented in Figure 2.

Search Procedures

Three databases were systematically searched including Education Resource Information Center (ERIC), PsycINFO, and ProQuest Dissertations and Theses Full Text in the fall of 2014. Publications and dissertations were included. All pairs of terms from two sets of words were searched: (a) *autis**, "*pervasive developmental*", or *Asperger**, and (b) *prefer**, *reinforc**, *interest**, *perseverat**, *circumscribed*, *ritual**, *obsessi**, and *restrict**. The latter set of terms were restricted in the database search to be included within the title of retrieved studies. Terms from the first word set were also paired with the terms "*preferred materials*" or "*traditional materials*," with no restrictions to the search functions. Through these procedures, 1,077 references with duplicates removed were identified (duplicates of publications from dissertations were included).

Title and abstract screening. Inclusion and exclusion criteria for studies were applied based on reviewing the title and abstract of each article. Articles were excluded if they (a) were not in English, (b) were a literature review, (c) were descriptive (e.g., book reviews, chapters), or (d) did not include an educational/environmental intervention with measures of student/client behaviors (e.g., assessment or survey studies, behavioral

presentation and correlation studies, medication trials, animal studies). At this point, 446 studies advanced for further review that evaluated an educational/environmental intervention (e.g., reinforcement).

Full-text screening. Studies were evaluated in full to identify if (a) the purpose was to isolated embedded interests and (b) the study included an individual with ASD. Embedded preference interventions fix or pair preferred stimuli into a curriculum or activity. Included studies attempted to isolate this independent variable by comparing standard, neutral, or LP arrangements to HP arrangements. If a study evaluated embedded interests in comparison to a different intervention (e.g., differential reinforcement), it was not included (Keen & Pennell, 2015). The intensity of participant interests could not be categorized with confidence given the detail of some studies, but all studies had to include some type of observational or descriptive report (e.g., interview with stakeholders) of each participant's individualized interests. This was often times followed up with a formal stimulus preference assessment and a narrowed range of stimuli. If studies included only a stimulus preference assessment with stimuli determined a priori, it was not included (e.g., Lee & Sturmey, 2006). There were 12 single-case studies identified through this phase. Although group-based studies were included through this phase, none were identified. Ancestral searches were applied in the summer of 2015. These iterative searches included a Google Scholar database search of references citing the included articles and a reference list review for each included article. The article titles were screened and if there was possibility of another qualifying study, the article was screened in full. The database ancestral search resulted in identifying an additional five studies and the reference list ancestral search resulted in an additional one study, resulting in a total of 18 included single-case research studies. Two group-based

studies were identified through the ancestral search, but were excluded from further inclusion at this point.

Interrater reliability (IRR) on screening. Another rater used the criteria to evaluate 443 randomly selected references from the original 1,077 (41%) for the title and abstract screening and 163 randomly selected references from 446 (37%) for the full-text screening. For all parts of the study, IRR was computed as a percentage by dividing the rater agreements by the agreements plus disagreements and obtaining a percentage through multiplying by 100. There was 90% agreement between the raters across inclusion and exclusion categories of the title and abstract screening and 97% agreement for screening the full-text. Disagreements were discussed by raters to come to agreement.

WWC Quality Standards

An overview of the WWC Standards is presented in Appendix D. Cases from studies were included that systematically manipulated the independent variable of embedding interests with individuals with ASD. According to WWC Standards (Kratochwill et al., 2010/2014, 2013), this is the first Design Standard for inclusion. Specific participants were eliminated here if their interests were reported to deteriorate through the study (two participants from Adams, 1999) or interests were not informed by original descriptive or observational reports (two participants from Agarwal, 2012). A number of other Design Standards were applied to then determine if studies should be further analyzed for Evidence Standards (which includes visual analysis between and within phases). However, these additional Design Standards (related to interobserver agreement (IOA) minimums, replication attempts, and the number of data points per phase) were not considered in advancing to visual analysis for this meta-analysis as to be more inclusive. For instance,

studies must attempt three replications of effect to meet WWC Design Standards and proceed with visual analysis, but cases with as little as two replication attempts were evaluated using visual analysis in this meta-analysis. The visual analysis criteria by WWC was used as a stand-alone tool to reliably code all of the included cases from studies and determine basic effects.

To determine the statistical validity of the results, visual analysis codes on basic effects (BASIC: YES or BASIC: NO) per WWC Standards were evaluated as a moderator to determine the congruence of ESs with ratings based upon visual analysis. The presence of basic effects was determined between two phases or conditions in a single case (i.e., participant). It does not necessarily indicate experimental control, depending on the design; but it does represent indicators that are integral to the visual analysis process. A final conclusion on the presence of basic effects was determined per case by traditional visual analysis methods, with consideration to level, variability, trend, immediacy of effects, consistency of effects across same phases, and overlap of data between phases (Parsonson & Baer, 1978). Studies that met WWC Design Standards were also evaluated on their overall evidence. These studies met Design Standards by not just manipulating the independent variable, but also including minimum criteria for (a) IOA, (b) attempts to replicate effects, and (c) numbers of data points per condition or phase. Overall evidence codes represent both the design rigor and experimental control (defined as three total replications of effect with at least three effects to each non-effect) for whole designs. Studies with *Strong Evidence* and *Moderate Evidence* were aggregated and coded with EVID: STR/MOD, studies with No Evidence were coded with EVID: NO, and studies not meeting minimum quality Design Standards were coded with NO DS.

IRR on WWC design and evidence standards. A random selection of 11 (61% of 18) single-case studies were evaluated for IRR on WWC Design Standards codes. These studies included 61 (55% of 110) dependent variables within cases and by design. The two raters agreed for an average of 94% (range, 80%-100% within Design Standards) of 366 agreement opportunities. Regarding WWC Evidence Standards, the two raters practiced together with one study and the second rater then independently evaluated seven (39% of 18) studies with 39 (40% of 98) dependent variables within the cases by design that were determined to have systematically manipulated the independent variable. Raters agreed for 97% of opportunities on the presence of basic effects through visually analyzing data. Raters agreed for 92% of opportunities in classifying the overall evidence in support of experimental control.

Variable Coding

Studies were coded descriptively and then evaluated to determine potential moderator categories. Dependent variables categories included social/communication behaviors (SOCCOM), task-engagement/accuracy/productivity (TEAP), positive affect (AFFECT), disruptive or off-task behavior (DOT), and self-stimulatory or ritualistic behavior (SSRB). SOCCOM variables included a variety of behaviors such as social play, social interactions, joint attention, and scripted conversation. TEAP variables included academic (e.g., social studies, reading comprehension), pre-academic (e.g., matching), and task-analyzed skills. Teaff (2001) included data on both disruptive and desirable behavior with work assignments, but as these were the inverse of one another, only desirable behavior was included. AFFECT, DOT behavior, and SSRB were evaluated among several studies to supplement primary measures; thus, these were included as dependent variable categories to assess alongside

primary outcomes in this meta-analysis. However, the variables of looking at targets (Naoi, Tsuchiya, Yamamoto, & Nakamura, 2008) and proximity (Talebi, 2007) were each measured once and not included considering these behaviors do not represent active engagement with alternative stimulation sources.

Participant characteristics were coded with variables including age and intellectual or adaptive skill functioning level. Age categories included 2 to 5 years or preschool-aged (PRESCH), 5 to 10 years or elementary-aged (ELEM), and 11 to 21 years or secondary/adolescent-aged (SEC/ADO). One study did not provide enough detail on age and thus was excluded from this analysis (Koegel, Dyer, & Bell, 1987). For functioning level categories, severe autism (SAU) was assigned for participants described as having ASD and (a) severe language delays, (b) either mental retardation or intellectual disability, (c) a reported IQ below 70, or (d) a delay of approximately two or more years as determined by adaptive behavior scores or age-equivalent scores. AU was assigned for participants described as having ASD or autism, without meeting criteria for the other functioning level categories. HFAAS was assigned for participants described as having relatively high-functioning autism and for participants described as having Asperger syndrome. HFAAS was also assigned when participants were said to be fully on their grade level or have an average to high IQ.

Learning context was evaluated, including a client/student-led category (STU) versus an instructor-led category (INS). Involvement in target behaviors or participation was voluntary for the student-led category. If only encouragement or initial prompting in a session with fading were used, the variable was classified as student-led. When there were

any specific demands, prompts, or expectations held for participants throughout the intervention, the variable was categorized as instructor-led.

Lastly, studies were coded as either peer-reviewed (PR) or dissertation (DISS) to determine publication bias through a moderator analysis. If dissertations produced a lower ES with statistical significance in comparison to peer-reviewed publications, an indicator of publication bias could potentially be demonstrated.

IRR on variable coding. A second evaluator determined the accuracy of ratings made by a primary evaluator to obtain IRR for six (33% of 18) randomly selected studies. The second evaluator determined whether there was an agreement or disagreement with each code by referencing the original article under review. There were 35 of 96 (36%) dependent variables within cases analyzed across five moderator categories (i.e., age, functioning level, learning context, dependent variable, publication type) totaling to 175 opportunities for agreement. The second rater agreed with the primary rater for 100% of opportunities.

Data Extraction and Analysis of Effects

Data extraction was completed by hand to estimate values on the y-axis in correspondence with values in each phase or condition of the x-axis. Studies included in this review used alternating treatments, reversal, and multiple-baseline across participant design variations to compare between LP and HP conditions. The LP conditions were considered as baseline and the HP conditions were considered as intervention. Phases evaluating generalization and maintenance were excluded to be analyzed independently. There were 2,507 data points extracted for analyses.

A number of studies had unique conditions for which analyses were adapted. Baker (2000) and Baker et al. (1998) included a variety of different baseline conditions, some of

which included prompting. As the intervention conditions in these studies initially included teacher prompting, the baselines were considered to commence when teacher prompting sessions took place in order to properly isolate the independent variable. Additionally, Koegel et al. (1987) used a B-A-B-A-B design with one participant. The last phase was not included as it had no condition for comparison. Also, this study measured social avoidance, the inverse of which could be considered social engagement. Therefore, the inverse of the ES was used for this measure. Lastly, the third participant in Koegel et al. (2012a) began taking medication midway through intervention and these sessions were not included in the analyses.

ESs were computed by comparing baseline to intervention phases or alternating treatment phases using the Tau/Tau-*U* nonoverlap statistic (Parker et al., 2011b). ES computations were made using online calculators available at www.singlecaseresearch.org (Vannest, Parker, & Gonen, 2010). The Tau-*U* nonoverlap metric was applied under instances in which baseline trend was present as determined through visual analysis. Specifically, Tau-*U* trend control was applied for 10 phase contrasts. Trend control through Tau-*U* was not applied for alternating treatments design phase contrasts, as trend in the control condition could likely occur as a result of interaction effects.

The Tau/Tau-*U* nonoverlap statistic is interpreted as a percentage of data showing improvement or nonoverlap under intervention conditions, with the option to control for confounding trend in the baseline phase (Parker et al., 2011b). The Tau nonoverlap calculation includes all pairwise comparisons between the data points of two phases, represented by the following equation:

$$\frac{S}{\#\ of\ pairs}$$

where *S* = (number of positive or improved values – number of negative values) and is calculated from a difference matrix of all pairwise comparisons in a time-forward progression (Parker et al., 2011b). The Tau-*U* ES is designed to control for undesirable trend in the baseline phase by subtracting it from the *S* in the original formula, represented by the following equation:

$$\frac{(S\ nonoverlap\ -\ S\ trend)}{\#\ of\ pairs}$$

where *S* trend is calculated within the baseline phase.

ESs for dependent variables within studies were evaluated with confidence interval ranges set at 95%. Statistics for overall effects were computed using WINPEPI software (Abramson, 2011). Specifically, heterogeneity of the results were measured with the *H* and I^2 statistics described by Higgins and Thompson (2002). Effects were aggregated in two groups to test heterogeneity, with those intended for increasing and those intended for decreasing. The *H* index explains the proportion of total variation in effect estimates that is a result of heterogeneity (Higgins & Thompson, 2002). An *H* above 1.5 is generally representative of high heterogeneity. The I^2 is the percentage value of the variance in effect estimates that is a result of between-study variation (Higgins & Thompson, 2002). Higgins, Thompson, Deeks, and Altman (2003) describe benchmarks of interpretation with an I^2 of 25% representing low, 50% representing moderate, and 75% representing high heterogeneity. Moderator analysis results were interpreted in terms of ES magnitudes with nonoverlap in confidence intervals ranges. Confidence interval ranges were set at 83.4% upper and lower limits to interpret nonoverlap in forest plots. At these limits, nonoverlap in confidence interval ranges between variables is approximately representative of $p < .05$ (Payton, Greenstone, & Schenker, 2003).

Effects intended for increasing (i.e., SOCCOM, TEAP, AFFECT) were analyzed separately from effects intended for decreasing (i.e., DOT, SSRB). Furthermore, primary outcomes (i.e., SOCCOM and TEAP) were the only variables analyzed for the moderator analyses of age, functioning level, and learning context. On the other hand, all effects intended for increasing, including AFFECT, were included for the moderator analyses of publication type, basic effects, and overall evidence. Effects intended for decreasing were not meta-analyzed outside of a dependent variable moderator analysis, but an analysis of the Pearson correlation coefficient between SSRB and primary outcomes (i.e., SOCCOM or TEAP) was included.

IRR on data extraction. Data extraction was analyzed for accuracy by a second independent rater for nine (50%) studies with 22 (49%) cases and 1,040 (41% of 2,507) data points. The codes for each data point were compared to graphs by the second rater to obtain a percentage of agreements out of the total number of agreement possibilities. There were two disagreements resulting in a mean of 100% (range, 99.5%-100%) agreement. Discrepancies were reanalyzed until the raters reached consensus.

Results

Table 5 presents moderator codes for each dependent variable within cases. Table 6 presents the Tau/Tau-*U* nonoverlap ESs for dependent variables within studies with confidence interval ranges set at 95%. Table 7 presents the overall descriptive results with corresponding effect sizes, standard errors, confidence intervals (95%), and heterogeneity tests. Of 135 total unique effects or contrasts, 106 were intended for increasing (including AFFECT), with 90 for primary variables (i.e., SOCCOM and TEAP). There were 29 total unique contrasts intended for decreasing (i.e., SSRB and DOT). Effects were analyzed at the

level of the dependent variable within studies to test the heterogeneity of overall effects. There were 32 dependent variables intended for increasing and 6 intended for decreasing overall. Although the Tau-*U* nonoverlap ES has no standard benchmarks of interpretation, results here were interpreted as neutral for ESs and confidence intervals within the +/- 0.00 to 0.25 range, low within the +/- 0.26 to 0.50 range, moderate within the +/- 0.51 to 0.75 range, and high within the +/- 0.76 and above range. Effects intended for increasing resulted in a low/moderate ES of 0.55 (CI_{95} = 0.49 < > 0.61) and very high heterogeneity (H = 3.3; I^2 = 90.8%). Effects intended for decreasing resulted in a neutral ES of -0.03 (CI_{95} = -0.12 < > 0.07) and very high heterogeneity (H = 4.7; I^2 = 95.5%).

Analyses of Dependent Variables

Figure 5 presents the moderator analysis for dependent variables intended for increasing. Of 106 total contrasts intended for increasing, 68 (64%) were SOCCOM, 22 (21%) were TEAP, and 16 (51%) were AFFECT. According to nonoverlap in confidence interval ranges, there was a statistically significant difference between the primary outcome categories of SOCCOM with moderate to high effects (ES = 0.79; $CI_{83.4}$ = 0.73 < > 0.84) and TEAP with neutral effects (ES = 0.03; $CI_{83.4}$ = -0.04 < > 0.11). Side-effects of AFFECT behaviors were also moderate to high (ES = 0.73; $CI_{83.4}$ = 0.60 < > 0.85).

Figure 6 presents the moderator analysis for dependent variables intended for decreasing. Of 29 total contrasts intended for decreasing, 14 (48%) were SSRB and 15 (52%) were DOT. The SSRB variable resulted in neutral effects (ES = 0.14; $CI_{83.4}$ = 0.06 < > 0.23) and the DOT variable resulted in neutral to low effects (ES = -.30; $CI_{83.4}$ = -0.40 < > -0.19), demonstrating a statistically significant difference. The fact that SSRB is in the neutral ES range indicates a potential unintended side-effect of embedding interests.

Figure 7 presents a correlation analysis between SSRB and primary outcomes (i.e., SOCCOM and TEAP). Three single-case studies with seven participants and 14 effects measured SSRB in addition to primary outcomes. The analysis produced a moderate negative Pearson correlation coefficient (r = -.60). In other words, reductions in SSRB were associated with increases in primary outcomes and increases in SSRB were associated with decreases in primary outcomes.

Analyses of Participant Characteristics

Moderator analyses of participant characteristics included age categories and functioning levels. Figure 8 presents the moderator analysis for age categories (i.e., preschool, elementary, or secondary/adolescent aged). Ages ranged from 2 to 18 years and there were 45 participants total. Across categories, eight (18%) participants were classified as PRESCH, 18 (40%) as ELEM, 16 (36%) as SEC/ADO, while ages of three (7%) participants were unclear. Of the 90 contrasts for primary dependent variables, there were 16 (18%) for the PRESCH variable, 31 (34%) for the ELEM variable, 37 (41%) for the SEC/ADO variable, and 6 (7%) contrasts were unclear. Effects by age categories ranged from neutral to moderate and showed increases with each age category. The PRESCH age range resulted in neutral to low effects (ES = 0.22; $CI_{83.4}$ = 0.12 < > 0.33) with statistical significance in comparison to both ELEM with low to moderate effects (ES = 0.48; $CI_{83.4}$ = 0.41 < > 0.55) and SEC/ADO with moderate effects (ES = 0.68; $CI_{83.4}$ = 0.61 < > 0.74). There was also statistical significance between ELEM and SEC/ADO.

Figure 9 presents the moderator analysis for the functioning level variable (i.e., severe autism, autism, or high-functioning autism/Asperger syndrome). Across categories, 13 (29%) participants were classified with SAU, 17 (38%) were classified with AU, and 15 (33%) were

classified with HFAAS. Of 90 contrasts for primary dependent variables, there were 28 (31%) for the SAU variable, 34 (38%) for the AU variable, and 28 (31%) for the HFAAS variable. In the moderator analysis of functioning levels, effects ranged from neutral to high with statistically significant increases from SAU to AU and from AU to HFAAS. The SAU functioning level resulted in neutral effects (ES = 0.15; $CI_{83.4}$ = 0.07 < > 0.22). The AU functioning level resulted in moderate effects (ES = 0.63; $CI_{83.4}$ = 0.56 < > 0.70). The HFAAS functioning level resulted in high effects (ES = 0.93; $CI_{83.4}$ = 0.84 < > 1.00).

Analysis of Learning Context

Figure 10 presents the moderator analysis for learning context (i.e., student versus instructor-led). Of 96 dependent variables targeted within participants, the STU variable included 69 (72%) effects and the INS variable included 27 (28%) effects. Of 90 contrasts for primary dependent variables, there were 58 (64%) for the STU variable and 32 (36%) for the INS variable. In the moderator analysis of learning context, the STU variable resulted in high effects (ES = 0.92; $CI_{83.4}$ = 0.86 < > 0.98) with statistical significance in comparison to the INS variable, with neutral effects (ES = 0.10; $CI_{83.4}$ = 0.04 < > 0.16).

Analysis of Publication Type

Publication types (i.e., peer-reviewed versus dissertation) were evaluated as a moderator to test for publication bias. Figure 11 presents the moderator analysis for publication type. Of 96 dependent variables targeted within participants, the PR variable included 74 (77%) effects and the DISS variable included 22 (23%) effects. Of 106 unique total contrasts for effects intended for increasing, there were 83 (78%) for the PR variable and 23 (22%) for the DISS variable. There were only four dissertations compared to 14 peer-reviewed articles. In the moderator analysis of publication type, the PR variable resulted in

moderate effects (ES = 0.69; $CI_{83.4}$ = 0.64 < > 0.74) with statistical significance in comparison to the DISS variable, with neutral to low effects (ES = 0.25; $CI_{83.4}$ = 0.17 < > 0.32). There was a difference of 0.44 in the Tau/Tau-*U* nonoverlap ESs between categories. This suggests a publication bias within the literature-base.

Analyses of WWC Quality Standards

Two WWC Quality Standards (i.e., basic effects, overall evidence) were evaluated to test the validity of the outcomes. Figure 12 presents the moderator analysis for the presence of basic effects according to WWC Standards. Of 96 dependent variables targeted within participants, the presence of basic effects (BASIC: YES) variable included 79 (82%) effects and the absence of basic effects (BASIC: NO) variable included 17 (18%) effects. Of 106 unique total contrasts for effects intended for increasing, there were 88 (83%) for the BASIC: YES variable and 18 (17%) for the BASIC: NO variable. In the moderator analysis of basic effects, the BASIC: YES variable resulted in high effects (ES = 0.89; $CI_{83.4}$ = 0.84 < > 0.94) with statistical significance in comparison to the BASIC: NO variable, with neutral to low negative effects (ES = -0.19; $CI_{83.4}$ = -0.26 < > -0.12). It appears that visual analysis on a dichotomous scale had general congruence with the Tau/Tau-*U* nonoverlap ES.

Figure 13 presents the moderator analysis for the presence of overall evidence according to WWC Standards. Of 96 dependent variables targeted within participants, the presence of strong or moderate evidence (EVID: STR/MOD) variable included 57 (59%) effects and the absence of evidence (EVID: NO) variable included 14 (15%) effects. There were 25 (26%) effects that did not meet Design Standards (NO DS) to be evaluated for evidence. Of 106 unique total contrasts for effects intended for increasing, there were 61 (58%) for the EVID: STR/MOD variable, 9 (8%) for the EVID: NO variable, and 36 (34%)

for the NO DS variable. In the moderator analysis of overall evidence, the EVID: STR/MOD variable resulted in high effects (ES = 0.91; $CI_{83.4}$ = 0.85 < > 0.97) with statistical significance in comparison to the EVID: NO variable, with neutral effects (ES = -0.14; $CI_{83.4}$ = -0.23 < > -0.05). The NO DS variable resulted in low effects (ES = 0.36; $CI_{83.4}$ = 0.29 < > 0.44) that fell between the other variables with complete nonoverlap in confidence intervals. This moderator shows that the effect size generally had congruence with ratings on the presence versus absence of experimental control and a functional relation in whole designs. However, 34% of the effects did not include sufficient indicators of internal validity to determine evidence; and as these effects did contribute to the analyses, all moderator results should be interpreted with caution.

Discussion

The purpose of this meta-analysis was to determine the overall effects and moderators of embedding interests for individuals with ASD. Moderators of primary interest included dependent variables, participant characteristics, and learning contexts. Primary outcomes included SOCCOM and TEAP. SOCCOM resulted in moderate to high effects while TEAP resulted in low effects. Side-effect variables evaluated included AFFECT, SSRB, and DOT behavior. AFFECT resulted in moderate to high effects showing that individuals with ASD generally tended to have more positive affect behavior in the HP conditions. SSRB resulted in neutral effects while DOT behaviors resulted in neutral to low effects. A correlation included in this review shows SSRBs to be negatively correlated with primary outcomes. The literature shows that embedding interests can either evoke or abate engagement with alternative stimulation sources. It could be that when restricted interests of individuals with ASD are embedded into the learning environment, there is an increased likelihood that the

stimuli could be distracting. This is supported by demonstrations of increased stereotypical behaviors in correspondence to negative primary outcomes (Adams, 1999; Morrison & Rosales-Ruiz, 1997) and decreased stereotypical behaviors in correspondence to positive primary outcomes (Baker, 2000). Nadig, Lee, Singh, Bosshart, and Ozonoff (2010), a group-based study, also found negative effects of embedding interests when restricted and repetitive interest severity was high. Perhaps individuals with more stereotypical behavior have more difficulty with devoting attention to alternative stimuli during embedded interest interventions. RRBIs such as stereotypic or repetitive motor movements, vocal responses, and self-injurious behavior are often self-stimulatory or self-serving responses that are reinforced automatically (Ringdahl, Wacker, Berg, & Harding, 2001). Children with ASD who have few socially-mediated reinforcers and more automatically reinforcing behaviors tend to make less gain through early intervention (Klintwall & Eikeseth, 2012). This is likely because socially-mediated reinforcement can be easily used to evoke desirable behaviors (e.g., communication, engagement, skill acquisition) and reduce maladaptive behaviors, whereas automatically reinforced behaviors may compete with other sources of stimulation (Klintwall & Eikeseth, 2012).

Although the dependent and independent variables in previous reviews were more broad and inclusive than the current review, outcomes among commonly analyzed moderators tended to concur. Similar to previous quantitative syntheses in this area of the literature, effects tended to have more improvement with age (Dunst et al., 2012a, 2012b). In addition, the current review produced similar findings to these previous reviews in that participants with milder symptoms of ASD tended to make more treatment gains than participants with moderate to severe symptoms. While restricted interests may be present

more commonly among individuals on the spectrum that have higher nonverbal IQs, repetitive use of objects is more common in individuals with lower nonverbal IQs (Bishop et al., 2006). Stereotypic behaviors often include repetitive motor movements with specific or preferred stimuli, and these behaviors are generally associated with less treatment gains (Klintwall & Eikeseth, 2012). Therefore, this meta-analysis is consistent with previous research that might lead to a hypothesis that embedded interest interventions can cause increased stereotypical behaviors in individuals with moderate to severe ASD.

Another moderator analyzed in this review was the learning context (i.e., STU versus INS). Given the widely varied results for this moderator, it appears that the methods or nature of the task may influence embedded interest outcomes. Embedded interest interventions with instructor demands in place resulted in neutral overall effects. Embedded interest interventions that took place in a free operant context with no consistent instructor demands in place resulted in high overall effects. Challenging behaviors can sometimes occur when ritualistic activities with interests are interrupted (e.g., Rispoli, Camargo, Machalicek, Lang, & Sigafoos, 2014); this could possibly influence behavioral patterns during embedded interest interventions that are led by the instructor. While naturalistic activities that are led by participants can promote some indicators of engagement, those outcomes may not necessarily equate to prosocial or appropriate behavior. For instance, one group-based study found that embedding restricted interests resulted in increased eye gaze to a conversation partner, but also increased maladaptive behavior including atypical utterances during conversation and decreased conversation reciprocity (Nadig et al., 2010).

Publication type was evaluated as a moderator to test publication bias. This analysis compared PR to DISS studies. The results demonstrate a record of publication bias in the

literature-base by showing positive effects to have a higher likelihood of publication in a PR journal. The overall Tau/Tau-*U* nonoverlap ES among PR published studies is 0.44 higher than the overall ES for the DISS studies. Publication bias is a common issue across fields of study in general. The behavior analytic single-case research literature appears to demonstrate the issue here as well as in previous research (Sham & Smith, 2014).

Two of the WWC Standards were tested as moderators to assess the internal validity of the outcomes. First, the WWC Evidence Standards (Kratochwill et al., 2010/2014, 2013) were applied to categorize cases based on their presence of basic effects between phases or conditions. The presence of basic effects was analyzed as a moderator to determine correspondence of ESs with ratings that encompass the visual analysis process. Second, the overall evidence of each design was determined according to the WWC Design and Evidence Standards (Kratochwill et al., 2010/2014, 2013). The presence of overall evidence was analyzed as a moderator to determine the correspondence of ESs with overall determinations of experimental control and internal validity within designs. Methods and findings are similar to a previous meta-analysis using the Tau nonoverlap ES (Ninci et al., 2015). Specifically, the Tau nonoverlap ES showed consistency with dichotomous ratings on basic effects between phases or conditions and overall evidence on whole designs for studies that met Design Standards. Studies that did not meet all of the Design Standards (NO DS) were included in this meta-analysis and while these effects were uncommon and low, they do generally present as a threat to the internal validity of the findings.

Limitations

There are limitations present in this meta-analysis. Although age and symptom severity had clear trends with statistical significance between categories, outcomes are

skewed with older participants having a tendency to be categorized with HFAAS. The outcomes also appear to be skewed in that activities led by students versus instructors were more common among studies with SEC/ADO participants categorized with HFAAS. While SOCCOM resulted in the strongest effect as a primary dependent variable category, it was also more commonly targeted among this subpopulation of individuals associated with high effects. Therefore, it is generally difficult to attribute moderating effects to any one of these variables analyzed. In addition to this, there was high heterogeneity in the overall effects intended for both increasing and decreasing. Perhaps removing outliers or looking within specific dependent variable categories to test moderators would result in different findings given the characteristics of these data. Finally, as studies were included in this review that did not meet the WWC Design Standards and there was some evidence of publication bias within the literature-base, results should be interpreted accordingly.

Future Research

Future single-case research should be conducted to evaluate some of the hypotheses presented in this meta-analysis with precision. The literature on embedding interests for individuals with ASD is diverse. It is unclear if results vary due to the primary dependent variables, participant characteristics, and/or learning contexts. There is considerable support for studies targeting SOCCOM. Only seven studies in this area have addressed TEAP and this support is even further limited due variations in study quality. Therefore, future research should continue to evaluate TEAP as a primary dependent variable alongside side-effect measures.

A number of studies in this meta-analysis show support for primary outcomes to generalize to the original LP activity (e.g., Baker, 2000; Baker et al., 1998; Naoi et al., 2008;

Vismara & Lyons, 2012). For instance, exhibiting joint attention in conditions that are HP to the individual with ASD could generalize to LP conditions that did not originally evoke joint attention behaviors (Vismara & Lyons, 2012). Future studies should review the outcomes on generalization within the literature-base of embedded interests. Original studies could also isolate generalization experimentally. It is possible that embedding interests could act to pair original, neutrally-preferred activities to become conditioned reinforcers. Assessing generalization to original activities is a relevant concern in this body of literature. If embedded interest interventions can assist to not only expand skills but also interests or preferences, individuals with ASD will access new communities of reinforcement that can work to expand skills even further.

CHAPTER IV

USE OF PREFERRED STIMULI AS RECEPTIVE IDENTIFICATION TARGETS FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

Receptive language is demonstrated by the nonverbal behavior of a listener in response to the spoken language of another person (Grow & LeBlanc, 2013; Skinner, 1989). Receptive identification, a form of receptive language, involves discrimination between visual stimuli in one's environment in correspondence with a delivered instruction (Grow & LeBlanc, 2013). It is pivotal to develop receptive language skills during the early years of childhood as they are predictive of gains in various advanced skill domains (Ben Itzchak & Zachor, 2009; Marion et al., 2003; Wetherby, Watt, Morgan, & Shumway, 2007; Yoder, Watson, & Lambert, 2015). While typically developing children rapidly acquire receptive language through interactions that occur naturally throughout activities of daily living, individuals with autism spectrum disorder (ASD) often require intensive programmed instruction to develop this pivotal skill (Lovaas, 1977).

Early intensive behavioral intervention for receptive language is shown to be highly effective for many young children with ASD (Ben Itzchak & Zachor, 2007; Dawson et al., 2010; Fava et al., 2011). Use of differential reinforcement, error correction, and prompting systems are common components of generally effective receptive language programs (Goldstein & Wetherby, 1984; Green, 2001; Grow & LeBlanc, 2013). Acquisition of auditory-visual stimulus relations can be bolstered through use of stimulus control transfer procedures in which targeted stimuli are taught in the contexts of various functional responses (Carp, Peterson, Arkel, Petursdottir, & Ingvarsson, 2012; Fisher, Kodak, & Moore,

2007; Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005). Linguistic mapping can enhance symbolic associations of objects to corresponding pictures. In linguistic mapping, labels are paired with referent pictures and/or objects through modeling (Iacono, 1999). It is not uncommon to find differential rates of progress among children with ASD in response to normative skill building approaches (Ben Itzchak & Zachor, 2007). As the population of individuals with ASD is considerably heterogeneous, it is important to identify individual idiosyncrasies in responses to interventions that target receptive language (Pelios & Lund, 2001). Studies on receptive identification acquisition that are designed to evaluate skill-development based on the characteristics of targets are particularly warranted.

By determining the characteristics of targets that young children tend to acquire early in receptive language development, early intervention programs may be able to expedite acquisition. Typically developing children tend to acquire nominal words (i.e., words referring to things such as people, animals, toys, and food) and words that occasion actions (e.g., no, dance, kiss) first in terms of their receptive language development (Benedict, 1979). Studies evaluating the composition of receptive language repertoires of children with ASD found some consistency with that of typically developing children (Bruckner, Yoder, Stone, & Saylor, 2007; Charman, Drew, Baird, & Baird, 2003; Schafer, Williams, & Smith, 2013); but studies used predetermined word samples making it difficult to capture idiosyncrasies for each child. It is possible that the restricted and idiosyncratic preoccupations of children with ASD could influence receptive language development (Bruckner et al., 2007).

In addition to marked deficits in social-communicative functioning, individuals with ASD commonly demonstrate interest in a restricted range of objects, activities, or topics (American Psychiatric Association, 2013). These restricted interests can negatively affect

one's attendance to outside events, which is predictive of skill deficits in critical areas of development (Adamson et al., 2010; Bruckner & Yoder, 2007). Sustained attention to referent stimuli during child-directed speech is predictive of concurrent receptive language ability in children with ASD (Paul, Chawarska, Fowler, Cicchetti, & Volkmar, 2007; Watson, Baranek, Roberts, David, & Perryman, 2010). Restricted and repetitive behaviors are negatively correlated with development of both expressive and receptive language abilities (Ray-Subramanian & Weismer, 2012). The level of interest in common toys, social routines, and activities exhibited by children with ASD strongly predicts their rates of both verbal and nonverbal skill acquisition in response to intervention (Klintwall, Macari, Eikeseth, & Chawarska, 2015).

Single-case research methodology lends well to determine how treatment effects vary based on individualized variables such as stimulus preference. A body of single-case research demonstrates that interventions designed to embed interests of children with ASD can promote attendance, active participation, and response accuracy (e.g., Boyd et al., 2007; El Zein, Solis, Lang, & Kim, 2014; Vismara & Lyons, 2007). Programming to teach expressive communication to individuals with language delays often begins with a preference assessment to determine what objects will motivate the learner and evoke engaged or interactive behavior. Preferred stimuli are thereby used as targets to efficiently teach mands and tacts (i.e., requests and labels; Davis, Kahng, & Coryat, 2012; Gilliam, Weil, & Miltenberger, 2013; Sundberg & Michael, 2001; Wallace, Iwata, & Hanley, 2006). While there is much research in this area, the unique effects of preferences as targets for early receptive identification programs has yet to be isolated.

Early in receptive identification programming, it is common to target functional items in order to promote independence with every-day functional living skills. Such targets may be frequently encountered in daily living activities resulting in more instructional opportunities to promote language acquisition (Goldstein & Wetherby, 1984). However, functional items may not offer reinforcing quality through which to promote engagement and evoke receptive language. As many children with ASD devote attention toward a restricted range of stimuli, it is possible that utilizing preferences as receptive identification targets may draw differential amounts of attention to referent stimuli, making target behaviors more amenable to change. The child may be more engaged when asked to receptively identify preferred stimuli, as demonstrated by their directed eye gaze. The child may be more motivated when asked to receptively identify preferred stimuli, as demonstrated by response attempts or challenging behaviors. It is possible that once some receptive identification targets are initially acquired, the skill will expand more rapidly. Acquired receptive targets may more readily generalize to other exemplars if they are highly preferred. Preferred targets may also more readily generalize to other language operants, such as tacts.

Purpose

If HP targets are initially acquired first, practitioners may have cause to begin receptive language programming with such targets. If there are no clinically significant differences between the procedures or LP targets are acquired first, practitioners can justify the use of targets that might assist in the development of functional living skills regardless of student preferences. The current study is designed to evaluate the relative effects of high-preferred (HP) stimuli as targets versus functional yet neutral or low-preferred (LP) stimuli as targets on the acquisition and generalization of receptive identification in children with

ASD. Targets in HP and LP conditions were exposed to the same type and amount of teaching procedures in order to isolate the additive effects of preferences as targets alone. Potential mechanisms of effects were evaluated by measuring ancillary variables representing child engagement. Intervention components were systematically added and evaluated depending on acquisition trends per phase.

Research Questions

1. Will preference for targets result in differential effects on receptive identification acquisition for children with ASD who lack or have minimal receptive identification skills?
2. Will participants: (a) attend to referent stimuli differentially, (b) make response attempts differentially, and (c) exhibit challenging behavior differentially across HP versus LP conditions?
3. What are the effects of HP versus LP conditions on participants' abilities to generalize to other exemplars of receptive identification targets?
4. What are the effects of HP versus LP conditions on participants' abilities to tact receptive identification targets?
5. What are the effects of added intervention components on receptive identification acquisition?

Method

Participant Characteristics

Three participants were recruited for this study through a university-supported autism clinic, based on staff recommendation. Participants were required to have a clinical diagnosis or educational disability categorization of ASD. Children presenting with significant levels of

ASD behaviors, as determined by the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2012) or the Autism Spectrum Rating Scales (ASRS; Goldstein & Naglieri, 2009), were also qualified for inclusion. Assessments or diagnoses had to be carried out by an appropriately-credentialed health or mental health professional. Diagnostic, disability categorization, and assessment information were parent-reported or obtained via client records made available at the clinic. Participants were required to be between 3 to 8 years of age and demonstrate minimal receptive identification skills. Participants had to demonstrate a prerequisite ability to match-to-sample. Performance on the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008) was used to determine if participants met these skill-based criteria. Mastered and current instructional program goals were also referenced. According to VB-MAPP scores, all participants functioned in the 18 to 30-month-old age range for Visual Perceptual Skills and Matching-to-Sample and in the 0 to 18-month-old range for Listener Responding. Appendix E includes a pre-screening form that guided interviews with parents and primary clinic therapists of potential participants to determine (a) what skills were in the child's repertoire, (b) their interests or preferred objects, and (c) objects that they encounter during activities of daily living.

Three boys with clinical diagnoses and educational disability categorizations of ASD participated. Participant information is presented in Table 8, including age, intervention length, ethnicity or race, communication mode, challenging behavior, and stereotypical behavior. Challenging behaviors and stereotypical behaviors were determined for all participants by informal interviews with parents and primary therapists as well as observations. Parent rating outcomes from selected scores of the ASRS (Goldstein & Naglieri, 2009) are in Table 9. Selected milestones and barrier scores from the VB-MAPP

(Sundberg, 2008), including scores from the Early Echoic Skills Assessment (EESA) Subtest (Esch, 2008), are in Table 10. Scores from the Receptive One-Word Picture Vocabulary Test (ROW-PVT – 4th ed.; Martin & Brownell, 2011) are in Table 11.

David was 7 years and 4 months old. He was Caucasian. According to his ASRS (Goldstein & Naglieri, 2009), he had a *very elevated* Total T-score of 77, a *very elevated* Social/Communication Scale T-score of 75, a *very elevated* DSM-5 Scale T-score of 75, a *very elevated* Stereotypy Scale T-score of 78, and a *very elevated* Attention Scale T-score of 71. He attended public school within a self-contained special education class for children with characteristics of ASD. He attended the autism clinic for summer applied behavior analysis (ABA) services five days a week for approximately one month at the start of the intervention. He subsequently attended the autism clinic for two days a week. He also attended weekly speech and occupational therapies outside of public school. David expressively communicated using Phase 5 of the Picture Exchange Communication System (PECS; Bondy & Frost, 1994) and some vocal approximations with independence or a model to make requests (e.g., "ah", "bah", "peh"). He independently used descriptors with PECS occasionally (e.g., "I want white putty."). According to selected scores from his VB-MAPP Milestones Assessment (Sundberg, 2008), David's Listener Responding skills included receptively identifying approximately five reinforcing stimuli. His Motor Imitation skills were in the 18 to 30-month-old range and his Echoic skills were in the 0 to 18-month-old range. According to selected scores from his VB-MAPP Barriers Assessment, *severe* barriers for David included Self-Simulation and *persistent* barriers included Negative Behavior, Listener Repertoires, Prompt Dependent, Impaired Scanning, Failure to Make Conditional Discriminations, Weak or Atypical motivating operations (MOs), and Hyperactive Behavior.

Response Requirement Weakens the MO and Reinforcement Dependent were identified to be *moderate* barriers for David. According to his ROW-PVT (Martin & Brownell, 2011), he received a receptive vocabulary age-equivalent placement of 1 year and 3 months. David's challenging behaviors included eloping (defined as 1 foot or more away from the instructional area), closing or covering his eyes for 2 or more seconds, putting his head down for 2 or more seconds, stomping, screaming, crying, and physical aggression (e.g., hitting). His stereotypical behaviors included repetitive hand movements, tensing his body up, and bouncing.

Eli was 4 years and 1 month old. He was Hispanic. According to his ASRS (Goldstein & Naglieri, 2009), he had a *very elevated* Total T-score of 78, a *very elevated* Social/Communication Scale T-score of 80, a *very elevated* DSM-5 Scale T-score of 81, a *very elevated* Stereotypy Scale T-score of 75, and a *very elevated* Attention/Self-Regulation Scale T-score of 81. He attended public school within a self-contained special education class for children with characteristics of ASD. He attended the autism clinic for summer ABA services three days a week for approximately one month at the start of the intervention. He subsequently attended the autism clinic for two days a week. He also attended weekly speech and occupational therapies outside of public school. Eli expressively communicated using PECS (Phase 4; Bondy & Frost, 1994) and several vocal approximations with independence or a model. According to selected scores from his VB-MAPP Milestones Assessment (Sundberg, 2008), Eli's Listener Responding skills included receptively identifying approximately five reinforcing stimuli. His Motor Imitation skills were in the 18 to 30-month-old range and his Echoic skills were in the 0 to 18-month-old range. According to selected scores from his VB-MAPP Barriers Assessment, *persistent* barriers for Eli included

Listener Repertoires, Impaired Scanning, and Failure to Make Conditional Discriminations. His *moderate* barriers included Negative Behaviors, Prompt Dependent, Weak or Atypical MOs, Response Requirement Weakens the MO, and Reinforcement Dependent. Self-Stimulation and Hyperactive Behavior were identified to be *occasional* barriers for Eli. According to his ROW-PVT (Martin & Brownell, 2011), he received a receptive vocabulary age-equivalent placement of less than 1 year. Eli's challenging behaviors included eloping, screaming, crying, and pushing task materials away. His stereotypical behaviors included repetitive hand movements, rocking, and bouncing.

Mikey was 5 years and 6 months old. He was Caucasian. According to his ASRS (Goldstein & Naglieri, 2009), he had an *elevated* Total T-score of 69, a *very elevated* Social/Communication Scale T-score of 71, a *very elevated* DSM-5 Scale T-score of 72, a *very elevated* Stereotypy Scale T-score of 71, and an *elevated* Attention/Self-Regulation Scale T-score of 66. He attended public school within a self-contained special education class for children with characteristics of ASD. He attended the autism clinic for summer ABA services two days a week for approximately one month at the start of the intervention. He subsequently attended the autism clinic for approximately one day a week. He did not receive additional therapies outside of public school. Mikey expressively communicated using PECS (Phase 3b; Bondy & Frost, 1994) and several vocal approximations with independence or a model. According to selected scores from his VB-MAPP Milestones Assessment (Sundberg, 2008), Mikey's Listener Responding skills included receptively identifying approximately two reinforcing stimuli. His Motor Imitation skills were in the 18 to 30-month-old range and his Echoic skills were in the 0 to 18-month-old range. According to selected scores from his VB-MAPP Barriers Assessment, *severe* barriers for Mikey included Listener Repertoires,

Failure to Make Conditional Discriminations, Weak or Atypical MOs, Self-Stimulation, and Hyperactive Behavior. His *persistent* barriers included Negative Behavior, Prompt Dependence, Impaired Scanning, Response Requirement Weakens the MO, and Reinforcement Dependent. According to his ROW-PVT (Martin & Brownell, 2011), he received a receptive vocabulary age-equivalent placement of less than 1 year. Mikey's challenging behaviors included eloping, screaming, crying, and physical aggression (e.g., hitting). His stereotypical behaviors included repetitive hand movements, looking to the side, and covering his ears.

Setting, Materials, and Implementer

Instructional sessions were set in a 3 x 4 m room in a university-supported autism clinic equipped with a child-sized table with chairs. The participant and an instructor were present in the room. A video recording device was situated in front of the table and across from the participant and instructor. All sessions were video recorded for later coding. Other materials in the room were limited to those necessary within each phase of the study (i.e., instructional materials, reinforcers). The study took place during participants' regularly scheduled clinic sessions, approximately one to five days a week. Study conditions took place approximately 30 minutes per day with one to two receptive identification sessions a day. The intervention duration (including absences and holiday breaks) lasted four months for David, four months for Eli, and five months for Mikey. The implementer was the principle investigator, a former employee of the clinic and a Board Certified Behavior Analyst (BCBA) with experience implementing educational interventions for young learners with ASD. The experimenter practiced adherence to the procedural steps in role plays with

another adult for each phase of the study until 100% implementation fidelity was reached at least once.

Experimental Design

This study used an adapted alternating treatments single-case research design to compare HP to LP conditions on acquisition and performance measures (Sindelar, Rosenberg, & Wilson, 1985). In addition, an analyses of added intervention components took place through an A-B-A-C design with A being least-to-most prompting and differential reinforcement, B being most-to-least prompting and differential reinforcement, and C being least-to-most prompting, differential reinforcement, and linguistic mapping. A preference assessment first determined potential HP and LP targets to be evaluated in baseline. These targets were then counterbalanced between experimental conditions according to sameness of receptive identification baseline outcomes and target characteristics (i.e., number of syllables) to create equivalent stimulus pools for comparison.

Response Definitions and Data Collection

The primary measure of this study was receptive identification. Receptive identification was defined as independently selecting a picture from an array that corresponds to the spoken word delivered by the instructor within 7 seconds after the delivery of a discriminative stimulus (Give me [item].”). Receptive identification was measured as a percentage of four opportunities per session in which individual targets were correctly identified and a percentage of eight opportunities per condition (HP and LP) in which two targets were correctly identified. Target mastery criteria was defined as 15 out of 16 consecutive trials correct (or a minimum of 94% correct for four sessions). This determined when to incorporate new targets and assess mastered targets for generalization. Receptive

identification generalization to multiple exemplars of targets was defined the same as receptive identification and measured as a percentage of four opportunities per session (pre- and post-intervention) in which individual targets were correctly identified.

Tact was defined as an intraverbal label of a target stimulus within 7 seconds of a given verbal discriminative stimulus ("These are/This is a…") as the instructor holds up a referent picture in the participant's line of sight. Target tact responses were individually identified at the start of the study based on responses to echoic probes to determine vocal abilities of each participant (Carp et al., 2012). Echoic probes occurred for up to ten times per target or until an approximation of a word occurred, which was followed by reinforcement (i.e., praise and a token) in the context of working with a token economy. Participants were required to produce at least one corresponding phoneme as a vocal approximation for every potential target in the echoic probes to be evaluated for generalization to tacts. David was unable to produce a phoneme for every target and thus was not evaluated on tact generalization. Tacts were measured as a percentage of three opportunities per target with correct responses pre- and post-intervention.

Various ancillary measures were included to assess potential mechanisms of differential outcomes between conditions. Participants' attending, demonstrated by eye gaze to referent stimuli, was collected during receptive identification trials. Eye gaze was defined to be in the direction of referent stimuli after a discriminative stimulus was delivered. Eye gaze to referent stimuli was measured both as the average duration (i.e., percentage of seconds) per condition and the percentage of trials in which any eye gaze occurred at all in a trial (i.e., dichotomous or yes/no). For the percentage of seconds with eye gaze, the total recording time window began at the second immediately following a demand (antecedent)

and ended 7 seconds after the discriminative stimulus or when a response attempt was completed (whichever occurred first). For each trial, the duration of eye gaze in seconds was divided by the total number of seconds in the time window to yield a percentage. The percentage of seconds was averaged across trials within conditions each session. A response attempt was defined as selecting any one picture from an array and placing it in the instructor's hand. Challenging behavior was defined individually for each participant (see Table 8). Engagement was defined to encompass eye gaze to referent stimuli, a response attempt, and no instances of challenging behavior. Data were measured as a percentage of trials for eye gaze to referent stimuli, response attempts, challenging behavior, and demonstrated engagement within a 7 seconds period after a discriminative stimulus was delivered or when a response attempt was completed (whichever occurred first).

Interobserver agreement (IOA) and implementation fidelity. Measures of IOA, implementation fidelity, and IOA of implementation fidelity were collected by two independent observers for a minimum of 20% of randomly selected sessions for each participant in each phase within conditions of the study. For receptive identification, generalization measures, looking at or scanning the stimulus array, response attempts, challenging behavior, and the aggregate measure of engagement, agreement was scored when each observer documented a non-occurrence or occurrence of the defined target behavior. Percentages of IOA were computed by dividing the number of agreements by the number of agreements and disagreements within a session and multiplying by 100. For duration of eye gaze to referent stimuli, agreement was scored when both the numerator (number of seconds looking) and denominator (total number of seconds to respond) of each rater were within 1 second of the other rater's numerator and denominator. Mean duration-per-occurrence IOA

was calculated for duration of eye gaze (Cooper, Heron, & Heward, 2007). Specifically, the shorter recorded duration of eye gaze was divided by the longer recorded duration of eye gaze per trial. These figures were summed from a given session per condition, divided by the total number of figures, and multiplied by 100 to attain a percentage. Data on implementation fidelity was collected using task analyses (with approximately six to ten tasks per phase) developed by the investigator. Implementation fidelity was calculated by dividing the number of steps with adherence by the number of total steps and multiplying by 100. IOA on implementation fidelity data was collected through two independent observers as a percentage of steps agreed upon (number of agreements/number of opportunities for agreement x 100). Means and ranges of IOA, fidelity, and IOA on fidelity per participant, dependent variable, and study phase are presented in Tables 13 to 21.

Data Analysis

Line graph displays of data were analyzed primarily through visual analytic methods (e.g., analysis of level, variability, trend, immediacy). Means and ranges per phase and participant were collected to summarize level and variability changes over time for correct receptive identification. Bar graphs were used to provide data for individual targets on measures of receptive identification and tacts. Tau nonoverlap metrics with confidence interval ranges at the 95% upper and lower limits were calculated for all ancillary measures (e.g., engagement). The Tau nonoverlap calculations were made by using an online calculator available at www.singlecaseresearch.org (Vannest et al., 2010). The Tau nonoverlap metric is considered robust as each data point in a condition is tested by its relative rank to each data point in another condition (Parker et al., 2011b). Corrections that allow controlling for baseline trend (i.e., Tau-*U*) were not used here. Tau ranges from -1 to 1 and figures in the

negative range specify either deleterious effects or effects for behaviors intended for reduction (e.g., stereotypy). This metric was used to compute nonoverlap of all the pairs of data points between two series (LP versus HP) per participant and across their aggregated intervention phases. This produced a single percentage of estimated improvement per dependent variable and participant.

Procedures

The individualized treatment programs of each participant were evaluated prior to the study to determine if receptive identification was a goal, and if so, what procedures were used. Any mastered targets and current targets were determined. To determine potential HP and LP targets for this study, participants' parents and clinic therapists were facilitated to identify five to 10 potentially reinforcing stimuli for their child/client and an additional five to 10 frequently encountered stimuli in routines of daily living for their child/client. Novel exemplars of these potential targets were used to ensure equal amounts of exposure and instruction. No potential targets were represented within the participants' PECS books. Preferences for these potential targets were tested using a multiple stimulus without replacement (MSWO) preference assessment (DeLeon & Iwata, 1996) in order to obtain a rank order. Laminated photographs (3.5 x 3.5 in) were created of approximately five HP and five LP stimuli identified from the preference assessment. Two photographs were created of each potential target to permit use of a picture prompt. An additional novel exemplar of each target was created for the purpose of evaluating generalization. Appendix F includes pictures used with Eli as an example.

Several constant conditions were in place for all receptive identification sessions throughout the study. HP and LP sessions took place in a discrete-trial teaching instructional

arrangement with a token economy and 10 tokens each. All participants had prior experience working with a token economy. Participants selected a terminal reinforcing stimulus (options were unrelated to study targets) from a choice board at the start of each session. Participants were instructed to receptively identify each stimulus from an array of four. The instructor secured instructional control prior to presenting demands by ensuring the participant was seated and facing forward with their hands placed near the edge of the table and not engaging in challenging behavior. High-probability instructions were presented intermittently as not to extinguish response attempts, similar to Carp et al. (2012) and Greer et al. (2005). High-probability instructions were not related to study targets and reinforcement (i.e., praise and/or a token) was provided for correct and prompted responses. For receptive identification trials, the discriminative stimulus presented by the instructor consisted of saying "Give me (item)." while holding her palm up beside the participant. For the receptive identification arrays, HP stimuli were presented only among other HP stimuli and LP stimuli were presented only among other LP stimuli. An exception to this was made in the last phase for David in which the two LP distractor items were used instead of the HP distractors in the HP array as to redirect his attention away from the distractors and promote progress with acquisition. Each potential target was presented in every possible placement (to control for position biases) in the array of four, in a quasi-random order, to obtain four opportunities or trials per target within a session. The instructor rotated or counterbalanced the presentation of the two targets within each condition. HP and LP conditions were counterbalanced as to which came first each day and a 2-minute break with reinforcement occurred both before and after each condition. The study was programmed to stop once two targets were mastered per participant. Appendix G includes implementation fidelity data sheets.

Baseline. Receptive identification baseline trials with pictures of HP and LP objects occurred with the instructor allowing 7 seconds for a response attempt. No error correction took place. All correct and incorrect responses for receptive identification probes were met with no programmed consequence by the instructor; they only proceeded to the next trial. Four potential targets at a time were tested for baseline levels, but a terminal reinforcement period took place after every eight demands to replicate the number of trials that would take place in a single HP or LP intervention session. Receptive identification targets were counterbalanced across conditions according to baseline averages, extreme preference ranks (i.e., highest and lowest preferences), and word similarity (i.e., number of syllables).

Intervention. Identical procedures were used across conditions to determine the additive effects of preferences as targets. Within each HP and LP condition, there were two targets for receptive identification (or four targets total at any given time). Targets were replaced with new ones after they were mastered. Procedures took place similar to the identity matching and differential reinforcement (DR) conditions evaluated by Carp et al. (2012) and Fisher et al. (2007) in the interest of using well-validated intervention components. These study conditions embedded picture prompts in addition to using DR for independent correct responses. The picture prompt is hypothesized to cue a differential observing response toward distinguishing stimuli (Fisher et al., 2007).

Least-to-most prompting. The first intervention phase consisted of least-to-most (L-M) prompting with a hierarchy replicating procedures described by Carp et al. (2012) and Fisher et al. (2007). The instructor presented receptive identification demands allowing 7 seconds for a response attempt. Independent correct responses were reinforced with a token and praise. In instances of incorrect responses, the instructor held a picture identical to the

target picture above the match in the array and pointed to it saying, “These are/This is a (item).”, prior to pointing to the target picture while presenting the discriminative stimulus again. If the participant responded correctly to the prompt, they were provided with praise. If the participant responded incorrectly, they were provided with a physical prompt, followed by no programmed consequence and advancement to the next trial.

Most-to-least prompting. Trend was evaluated at and after the first five L-M prompting sessions and if there was no trend, the case advanced to the most-to-least (M-L) prompting phase. The implementer provided a prompt at the target level immediately before each receptive identification instruction. The first prompt level consisted of the instructor holding a picture identical to the target picture above and in proximity to the match in the array and pointing to it saying, “These are/This is a (item).”, prior to a pointing/gesture prompt to the target picture while presenting the discriminative stimulus. The second prompt level was a picture with a label and proximity to the match only. The third prompt level was a picture with a label prompt only in which the there was a delay of 1 second between labeling the identical picture and presenting the stimulus array with the receptive identification demand. Each prompt level was faded once a participant reached at least 80% correct at that level across a pair of HP and LP conditions. Correct responses at the target prompt level were reinforced with a token and praise. More intrusive prompts were followed by praise only and full-physical prompts were followed by no programmed consequence. After nine sessions, a return to L-M prompting occurred for one to three sessions in order to allow participants to independently respond and demonstrate improvements.

Linguistic mapping. Cases advanced to the added linguistic mapping component if no clear level change or trend change was demonstrated in either condition within three

sessions of the return to the L-M prompting phase. This phase consisted of the same procedures as the L-M prompting phase with an added mapping component that occurred immediately prior to receptive identification session. During mapping, the implementer ensured participant engagement (i.e., eye gaze in direction of picture) and named the target picture just prior to handing the participant the corresponding object. Specifically, the instructor held up the picture and presented the discriminative stimulus for tacts followed by an immediate answer (e.g., "This is a—Plate."). This occurred five times per target, rotating between the two targets within a condition. The implementer allowed the participant to interact with the object for up to approximately 15 seconds per mapping trial. If the object was rejected (i.e., pushed away) or 3 seconds passed without the participant contacting the object, the implementer removed the item and proceeded to the next trial.

Multiple exemplar and tact generalization. Generalization of mastered targets to multiple exemplars were probed once in the baseline phase and assessed after targets were either mastered or the intervention ceased. Four multiple exemplar probes occurred per target pre- and post-intervention. Procedures were similar to baseline including a 7-second response time with no error correction, but differential reinforcement was applied to avoid potential effects of extinction. Specifically, correct receptive identification responses were met with generalized reinforcement (i.e., token and praise) and reinforcement was withheld for incorrect responses. Multiple exemplar pictures were presented within arrays of other multiple exemplar pictures (either HP or LP, depending on the condition) that were used as distractors. Although David ended intervention with LP distractors in the HP array, the post-intervention multiple exemplar generalization session used the same original HP distractors

as the pre-intervention session. Once an intervention target was mastered, a generalization session occurred on the following scheduled day prior to other sessions.

Intraverbal tacts were probed three times per target, once in the baseline phase and once after targets were either mastered or the intervention ceased. Similar to receptive identification sessions, the implementer ensured instructional control prior to presenting each discriminative stimulus to tact and intermittently presented high-probability instructions in the context of working with a token economy. The implementer held a single targeted picture up in front of the participant and said, "These are/This is a…" to present the discriminative stimulus. The implementer waited 7 seconds for a response and did not correct errors. Correct tact responses were met with generalized reinforcement (i.e., token and praise) and reinforcement was withheld for incorrect responses.

Results

Table 12 displays the research questions with reference to associated dependent variables and figures. Figure 14 displays line graphs on correct receptive identification for HP and LP conditions through each phase of the intervention. Figure 15 displays bar graphs comparing relative preferences of targets (percentage of opportunities selected during MSWO) to their percentages of opportunities with correct responses in baseline (three sessions) and the final phase of the intervention (linguistic mapping).

David's original HP stimuli were Balloon and Koosh and his LP stimuli were Plate and Socks. It was suspected that David no longer preferred Koosh as he rarely played with it for a full 15 seconds during the mapping phase. This was confirmed when his preferences were reassessed after Balloon was mastered. Koosh was then replaced with a new target in addition to replacing Balloon, as Balloon was mastered. The second set of HP targets

included Marblerun and Track. There were no suspected changes in preferences during the mapping phase for the new two HP stimuli as David typically played for the full 15 seconds with each. To balance the design after Koosh was removed, the LP target of Socks was also removed and replaced with Underwear. In this way, an equal number of trials were experienced by David in each condition. In three baseline sessions, David correctly identified Balloon for 17% (range, 0%-25%) of trials, Koosh for 17% (range, 0%-25%) of trials, Marblerun for 17% (range, 0%-50%) of trials, Track for 8% (range, 0%-25%) of trials, Plate for 17% (range, 0%-50%) of trials, Socks for 17% (range, 0%-25%) trials, and Underwear for 25% (range, 0%-50%) of trials. David did not make progress in the L-M+DR phase of the intervention, so he moved to the M-L+DR phase in which prompts were faded to the second level. Upon returning to the L-M+DR phase, he still made no gains beyond the chance range in one session. Aggregated across the first and second L-M+DR phases, David correctly identified Balloon for 5% (range, 0%-25%) of trials, Koosh for 5% (range, 0%-25%) of trials, Plate for 27% (range, 0%-50%) of trials, and Socks for 14% (range, 0%-50%) of trials. When he advanced to the mapping phase, David receptively identified Balloon for 63% (range, 0%-100%) of trials, Koosh for 6% (range, 0%-25%) of trials, Marblerun for 70% (0%-100%) of trials, Track for 29% (0%-75%) of trials, Plate for 69% (0%-100%) of trials, Socks for 3% (0%-25%) of trials, and Underwear for 13% (0%-50%) of trials. Both HP and LP conditions in David's mapping phase increased steadily in trend. David made more gains in his correct receptive identification of HP targets when the HP array was modified to include LP distractor stimuli. David mastered two HP targets, Balloon and Marblerun, in 112 and 84 instructional trials and one LP target, Plate, in 196 instructional trials across phases.

Eli's original HP stimuli were Slinky and Blocks. Once Slinky was mastered in the mapping phase, it was replaced with Putty. Eli's two LP stimuli were Plate and Shorts. In three baseline sessions, Eli correctly identified Slinky for 33% (range, 0%-50%) of trials, Blocks for 42% (range, 0%-75%) of trials, Putty for 33% (range, 0%-75%) of trials, Plate for 50% (range, 25%-75%) of trials, and Shorts for 17% (range, 0%-25%) of trials. Eli did not make progress in the L-M+DR phase of the intervention, so he moved to the M-L+DR phase in which prompts were faded to the third level. Upon returning to the L-M+DR phase, he still made no gains beyond the chance range in three sessions. Aggregated across the first and second L-M+DR phases, Eli correctly identified Slinky for 6% (range, 0%-25%) of trials, Blocks for 25% (range, 0%-75%) of trials, Plate for 22% (range, 0%-50%) of trials, and Shorts for 11% (range, 0%-25%) of trials. When he advanced to the mapping phase, Eli receptively identified Slinky for 60% (range, 25%-100%) of trials, Blocks for 79% (range, 50%-100%) of trials, Putty for 88% (range, 75%-100%) of trials, Plate for 25% (range, 0%-75%) of trials, and Shorts for 18% (range, 0%-75%) of trials. In the mapping phase, Eli's HP condition had an immediate effect and clear upward trend whereas the LP condition had an increasing trend but no intercept gap. Eli mastered two HP targets, Slinky and Blocks, in 112 and 128 instructional trials across phases. He was near mastery of the HP target of Putty within only 16 instructional trials, at which point the intervention was terminated as he mastered two targets.

Mikey's original HP stimuli were Slinky and Track and his LP stimuli were Socks and Towel. In three baseline sessions, Mikey correctly identified Slinky for 25% (range, 0%-50%) of trials, Track for 25% (no range) of trials, Socks for 25% (no range) of trials, and for Towel 17% (range, 0%-25%) of trials. Mikey did not make progress in the L-M+DR phase of

the intervention, so he moved to the M-L+DR phase in which prompts were faded to the third level. Upon returning to the L-M+DR phase, he made only a slight increase in gains beyond the chance range in three sessions. Aggregated across the first and second L-M+DR phases, Mikey correctly identified Slinky for 31% (range, 0%-50%) of trials, Track for 34% (range, 0%-75%) of trials, Socks for 28% (range, 25%-50%) of trials, and Towel for 28% (range, 0%-50%) of trials. When he advanced to the mapping phase, Mikey receptively identified Slinky for 25% (range, 0%-50%) of trials, Track for 40% (range, 25%-75%) of trials, Socks for 35% (range, 0%-75%) of trials, and Towel for 20% (range, 0%-25%) of trials. There was no improvement in either condition in Mikey's mapping phase and after five sessions the study was terminated due to repeated absences and scheduling conflicts.

Figure 16 displays line graphs of the average duration of attending to referent stimuli in HP and LP intervention conditions. David directed his eye gaze at the HP stimulus arrays for a mean duration of 56% (range, 27%-90%) of the time and directed his eye gaze at LP arrays for a mean duration of 36% (range, 12%-74%) of the time across phases. There was a decrease in David's eye gaze duration when the HP array was modified to include LP distractors. Eli directed his eye gaze at the HP stimulus arrays for a mean duration of 53% (range, 16%-85%) of the time and directed his eye gaze at LP arrays for a mean duration of 38% (range, 0%-83%) of the time across phases. Eli's duration eye gaze steadily increased in trend in both conditions during the mapping phase with more immediate effects occurring in the HP condition. Mikey directed his eye gaze at the HP stimulus arrays for a mean duration of 65% (range, 31%-98%) of the time and directed his eye gaze at LP arrays for a mean duration of 47% (range, 13%-75%) of the time across phases. Mikey's data patterns remained relatively stable through all intervention phases. Tau nonoverlap effect sizes

between LP and HP conditions for duration of eye gaze are 0.63 (CI95% = 0.40 < > 0.86) for David, 0.37 (CI95% = 0.09 < > 0.66) for Eli, and 0.59 (CI95% = 0.24 < > 0.95) for Mikey.

Figure 17 displays line graphs of the percentage of trials with eye gaze to referent stimuli in HP and LP intervention conditions. David directed his eye gaze at the HP stimulus arrays for a mean of 88% (range, 63%-100%) of trials and directed his eye gaze at LP arrays for a mean of 67% (range, 38%-100%) of trials across phases. David's data patterns remained stable through all intervention phases. Eli directed his eye gaze at the HP stimulus arrays for a mean of 85% (range, 50%-100%) of trials and directed his eye gaze at LP arrays for a mean of 67% (range, 0%-100%) of trials across phases. Eli's percentages of trials with eye gaze steadily increased in trend in both conditions during the mapping phase with more immediate effects occurring in the HP condition. Mikey directed his eye gaze at the HP stimulus arrays for a mean of 87% (range, 38%-100%) of trials and directed his eye gaze at LP arrays for a mean of 67% (range, 25%-100%) of trials across phases. Mikey's data patterns remained stable through all intervention phases. Tau nonoverlap effect sizes between LP and HP conditions for percentage of trials with eye gaze are 0.67 (CI95% = 0.44 < > 0.90) for David, 0.43 (CI95% = 0.15 < > 0.72) for Eli, and 0.52 (CI95% = 0.17 < > 0.88) for Mikey.

Figure 18 displays line graphs of the percentage of trials with response attempts in HP and LP intervention conditions. David attempted to respond with the HP stimulus arrays for a mean of 71% (range, 13%-100%) of trials and attempted to respond with the LP arrays for a mean of 71% (range, 25%-100%) of trials across phases. David's response attempt data patterns were similar across conditions with an increasing trend in the mapping phase. Eli attempted to respond with the HP stimulus arrays for a mean of 60% (range, 0%-100%) of

trials and attempted to respond with the LP arrays for a mean of 45% (range, 0%-100%) of trials across phases. Eli's percentage of trials with response attempts steadily increased in trend in both conditions during the mapping phase with more immediate effects occurring in the HP condition. Mikey attempted to respond with the HP stimulus arrays for a mean of 94% (range, 75%-100%) of trials and attempted to respond with the LP arrays for a mean of 97% (range, 88%-100%) of trials across phases. Mikey's response attempt patterns were consistent across intervention conditions and phases. Tau nonoverlap effect sizes between LP and HP conditions for response attempts are 0.03 (CI95% = -0.20 < > 0.26) for David, 0.30 (CI95% = 0.01 < > 0.58) for Eli, and -0.13 (CI95% = -0.48 < > 0.22) for Mikey.

Figure 19 displays line graphs of the percentage of trials with challenging behavior exhibited in HP versus LP intervention conditions. David displayed challenging behavior with the HP stimulus arrays for a mean of 4% (range, 0%-25%) of trials and displayed challenging behavior with the LP arrays for a mean of 10% (range, 0%-50%) of trials across phases. Eli displayed challenging behavior with the HP stimulus arrays for a mean of 2% (range, 0%-25%) of trials and displayed challenging behavior with the LP arrays for a mean of 6% (range, 0%-50%) of trials across phases. Mikey displayed challenging behavior with the HP stimulus arrays for a mean of 0.6% (range, 0%-13%) of trials and displayed challenging behavior with the LP arrays for a mean of 3% (range, 0%-50%) of trials across phases. Challenging behavior remained low across phases for all participants. Tau nonoverlap effect sizes between LP and HP conditions for challenging behavior are -0.31 (CI95% = -0.54 < > -0.08) for David, -0.19 (CI95% = -0.48 < > 0.09) for Eli, and -0.05 (CI95% = -0.40 < > 0.30) for Mikey.

Figure 20 displays the aggregate measure of "engagement" exhibited in HP versus LP intervention conditions, defined as the percentage of trials with eye gaze, a response attempt, and no challenging behavior. David displayed engagement with the HP stimulus arrays for a mean of 65% (range, 13%-100%) of trials and displayed engagement with the LP arrays for a mean of 52% (range, 13%-88%) of trials across phases. David's engagement data patterns were somewhat similar across conditions until the mapping phase, under which a clear difference in level emerged favoring the HP condition. Eli displayed engagement with the HP stimulus arrays for a mean of 57% (range, 0%-100%) of trials and displayed engagement with the LP arrays for a mean of 37% (range, 0%-75%) of trials across phases. Eli's engagement patterns were also somewhat similar across conditions until mapping took place, under which a clear difference in immediacy of effect emerged. Both of Eli's conditions included data with an increase in trend through the mapping phase. Mikey displayed engagement with the HP stimulus arrays for a mean of 84% (range, 38%-100%) of trials and displayed engagement with the LP arrays for a mean of 65% (range, 25%-88%) of trials across phases. Mikey's engagement patterns were similar across intervention phases. Tau nonoverlap effect sizes between LP and HP conditions for engagement are 0.36 (CI95% = 0.13 < > 0.59) for David, 0.41 (CI95% = 0.13 < > 0.70) for Eli, and 0.56 (CI95% = 0.20 < > 0.91) for Mikey.

Figure 21 displays generalization to multiple exemplars by HP and LP targets for David and Eli, who acquired targets. As Mikey did not acquire targets in either condition, he was not assessed for generalization post-intervention. David correctly receptively identified multiple exemplars of Balloon for 0% of trials at pre-intervention and 100% of trials at post-intervention, Marblerun for 0% of trials at both pre- and post-intervention, Track for 25% of

trials at both pre- and post-intervention, Plate for 25% of trials at pre-intervention and 0% of trials at post intervention, and Underwear for 0% of trials at both pre- and post-intervention. Eli correctly receptively identified multiple exemplars of Slinky for 0% of trials at pre-intervention and 50% of trials at post-intervention, Blocks for 0% of trials at pre-intervention and 75% of trials at post-intervention, Putty for 25% of trials at pre-intervention and 75% of trials at post-intervention, Plate for 0% of trials at pre-intervention and 25% of trials at post-intervention, and Shorts for 0% of trials at both pre- and post-intervention.

Figure 22 displays generalization to tact responses by HP and LP targets and for Eli only. Eli made no correct tact responses for any targets during three pre-intervention probes. After the last receptive identification session per target, Eli correctly emitted tacts of Slinky for 100% of trials, Blocks for 67% of trials, Putty for 100% of trials, Plate for 0% of trials, and Shorts for 0% of trials.

Discussion

The primary purpose of this study was to evaluate the use of highly preferred versus neutrally-preferred or LP stimuli on receptive identification acquisition of children with ASD and severe language delays. Results for two participants show promise in using HP targets early in receptive identification programming, although the magnitude of effects varied across participants and a third participant made no improvements across conditions and phases. Instructional methods were replicated from previous studies in this area with similar participant populations (Carp et al., 2012; Fisher et al., 2007). Intervention components were added and modified until increases in acquisition were made. David did not show improvement until the linguistic mapping component was added to DR and L-M prompting, and he made relatively more gains in the HP condition. While David eventually mastered one

LP target, it took considerably more trials relative to HP targets. Furthermore, David rarely appeared to make conditional discriminations in the LP condition, indicated by the fact that he almost always selected one of the two targets in the array regardless of the audio stimulus. While this often appeared to be true within the HP condition as well, it occurred less frequently as indicated by his data reaching above 50% within a session on multiple occasions. Eli made rapid gains in the HP condition under the linguistic mapping intervention component that was added. Mikey, unlike David and Eli, did not demonstrate an immediate increase in levels of acquisition in response to the linguistic mapping component.

The linguistic mapping component of the intervention, that paired pictures of objects with identical objects and a corresponding audio stimulus, appeared to facilitate symbolic associations of objects to referent pictures for participants. This pattern of development is also common for typically developing children (Ganea, Pickard, & DeLoache, 2008). Naturalistic, play-based interventions such as linguistic mapping can be useful in recruiting attention and active participation in learners with severe language deficits (Iacono, 1999). Both didactic and naturalistic teaching strategies have considerable support for early language development in children with ASD (Paul, 2008). This study provides support for the use of naturalistic teaching strategies in addition to didactic strategies for two participants, although effects were not replicated to attempt experimental control.

Potential mechanisms of increases in acquisition across conditions were evaluated through a number of ancillary variables. The duration of eye gaze to referent stimuli as well as a dichotomous measure of eye gaze per trial (i.e., yes or no) indicated that all participants tended to gaze for longer durations and more often at the HP stimulus arrays. Although these measures do not show that participants gazed more at the specific targets within trials, they

do indicate that participants attended more in the HP condition and this may have enabled more opportunities for auditory-visual discriminations. Although David showed reductions in his eye gaze durations once the HP stimulus array was modified to include LP distractors, his acquisition did improve indicating that the HP distractor items may have diverted his attention away from the HP targets. Additional ancillary measures included response attempts and challenging behaviors. Only Eli showed improvement with making response attempts in the HP condition relative to the LP condition, whereas there were no clear differences in response attempts between conditions for David or Mikey. Challenging behavior remained low for all participants throughout the study, but there was slightly more challenging behavior in the LP condition for David. The dichotomous variables of eye gaze, response attempts, and the absence of challenging behavior were also aggregated to measure the construct of engagement. Engagement was higher in the HP condition for all participants. This is helpful in understanding how various indicators of motivation could influence outcomes on acquisition. It is interesting that Eli made increases throughout the LP condition for eye gaze measures, response attempts, and acquisition in correspondence with gains made in the HP condition. It is possible that the early acquisition gains made in the HP condition facilitated improvements in his LP condition, but this is not supported by experimental control.

It is important to note that there is an alternative procedure to improve observing responses to referent stimuli. That is, audio or visual stimuli could be conditioned as reinforcers to promote observing responses, which can be a useful method to promote language development in children with ASD (Longano & Greer, 2015). This procedure can consist of a considerably high number of learning trials for students. It may be most efficient

for early learners with ASD to develop language targets that are naturally preferred first as their observing responses to targets may be more likely to occur during instruction without specific programming as shown here for all participants. As suspected with Eli's outcomes, it is possible that observing responses to HP stimuli could eventually generalize to LP stimuli in similar learning contexts.

Another purpose of the study was to evaluate generalization to multiple exemplars of targets and to tacts without the use of specific programming. David only generalized one HP target to another exemplar. It cannot be inferred that David was making conditional discriminations (as opposed to simple discriminations) during multiple exemplar generalization sessions, similar to many of his intervention sessions in both conditions. Eli made gains for all of his HP targets on generalizations to multiple exemplars. Mikey was not tested for multiple exemplar generalization post-intervention as he did not acquire targets. Generalization to tacts was assessed for participants meeting minimum echoic abilities, although Mikey did not participate as he did not acquire targets. Eli generalized HP receptive identification targets to untaught intraverbals tacts. It is likely that the instructors modeled use of tacts through the picture prompt and linguistic mapping procedures facilitated Eli's transfer of stimulus control to tacts (Nottingham, Vladescu, & Kodak, 2015). In the mapping phase of the study, auditory stimuli were paired with the delivery of referent objects and this may have influenced the auditory stimuli to become conditioned reinforcers for Eli's HP targets. This appeared to be possible for Eli as he frequently engaged in echoic behavior during mapping sessions with HP stimuli, although these responses were not required to obtain the object.

Limitations

This study has notable limitations. First, generalization to multiple exemplars was assessed after the intervention but not programmed. The usefulness of the intervention was considerably limited for David as he did not generalize to multiple exemplars. Concurrently teaching multiple exemplars can produce greater acquisition and generalization outcomes than serially teaching multiple exemplars of targets to vocal children with developmental delays (Wunderlich, Vollmer, Donaldson, & Phillips, 2014) and minimally vocal children with ASD (Allen, Hartley, & Cain, 2015). Ideally, this study would have replicated a best practice such as this for teaching receptive identification in order to determine the added value of incorporating interests as targets to a comprehensive variety of well-validated intervention components.

Additionally, this study differed in some ways from the previous literature in support of L-M prompting with a simultaneous picture and gesture prompt in addition to DR (Carp et al., 2012; Fisher et al., 2007). Specifically, the current study differed in the use of reinforcement techniques. The current study included a token economy on a fixed-ratio of 1 (FR1) schedule with 10 tokens to work toward a backup reinforcer. Both of the previous studies used a FR1 schedule with edible reinforcement for independent correct responses. It is possible that including more immediate reinforcement in this study would have affected acquisition and engagement positively. Also, Fisher et al. did not include praise for any form of prompted responses. Carp et al., as here, did provide praise only for responses requiring a picture prompt and no reinforcement for responses requiring a physical prompt. Furthermore, participants were older (ages 10 and 12 years) in the Fisher et al. study, although they were reported to have made little to no progress with conditional discriminations in previous

interventions. Carp et al. included similar-aged participants as here, and two of four participants appeared to cognitively function near the levels of participants in this study. The outcomes of those two participants show similar patterns to that of participants in the current study; that is, it took several sessions to show slight progress and mastery levels were not reached with the L-M prompting procedure involving a picture prompt. One of the similar participants was able to reach mastery levels through doubling the dosage of trials per session. The dosage (i.e., number of trials per session and number of sessions per week) for David and Eli in the current study was similar to the dosage for participants in Carp et al. (i.e., one to two sessions per day, two to three days a week). Mikey, had fewer opportunities for sessions each week in this study and multiple absences. This is suspected to be why Mikey did not make adequate progress in any condition.

Preferences for leisure items can change over time for individuals with developmental disabilities (Zhou, Iwata, Goff, & Shore, 2001), making them somewhat difficult to isolate. David's interest in one particular target reduced midway through the study and the preference assessment had to be conducted a second time to validate this, after which that target was replaced with a truly HP target. This was evident in the linguistic mapping phase in which he consistently began to reject that object instead of taking the opportunity to play with it for a period of time. Therefore, there is a period in which David's HP condition includes a target that no longer maintained his interest, and the commencement of that period is unknown. Fortunately, the linguistic mapping component acted as a single-stimulus preference assessment to assess the daily maintenance of participant interests. All other HP stimuli were noted to maintain as HP for participants given their behaviors observed in the linguistic mapping component.

Future Research

One area for future research is to determine if initial acquisition of HP receptive targets could facilitate acquisition of LP targets for children with ASD. This could be best answered through a group-based research design in which matched participants learn either both HP and LP targets in the intervention condition or only LP targets in the control condition. This is important to determine because LP stimuli can often be the more imperative to learn in order to influence other important skills, such as daily living skills. A parent, for instance, could likely be more concerned with teaching their child to respond to "Go get your shoes." as opposed to "Go get your slinky.", assuming 'slinky' is highly preferred. However, if receptively learning 'slinky' positively influenced receptively learning 'shoes,' beginning with the HP target would be the justified choice.

A similar area for continued research would be to conduct a correlational study determining how preference for stimuli in a given environment (e.g., the home) influences known receptive vocabulary of children with ASD. It is important to note that preference is clearly not mutually exclusive from items of daily living. Some items of daily living can be highly preferred. For instance, Eli was reported to highly prefer his cup. It was not included as a potential target for the sake of consistency in including toys as HP targets and items of daily living as LP targets. However, a study that analyzes correlations of relative preferences in an entire environment to known receptive vocabulary could be telling of the correspondence of preferences to receptive language development.

Implications for Practitioners

Practitioners should consider beginning receptive identification acquisition programming with preferred stimuli as targets for children with ASD and severe language

delays. Increased levels of instructional engagement can occur through embedding interests as receptive identification targets and this may in turn lead to faster receptive identification acquisition. Eye gaze may particularly increase under HP conditions as an indicator of engagement. Practitioners should consider teaching receptive identification by using a variety of empirically-based methods. While an analysis of added intervention components can be beneficial to determining the efficiency and necessity of certain methods, there is a considerable literature-base to suggest that children with severe ASD warrant intensive interventions and supports to develop early receptive identification. Two cases from the current study suggest that teaching receptive identification across instructional environments, including both naturalistic and instructor-led learning opportunities, was important for HP target acquisition and generalization.

CHAPTER V

SUMMARY AND CONCLUSIONS

Embedding interests is an intervention than entails fixing aspects of one's interest into their learning environment to improve their compliance, active participation, and related skills (Koegel et al., 2012b). This intervention has often been applied in working with individuals with autism spectrum disorder (ASD) in treatment or educational environments. Individuals with ASD, in addition to core deficits in social-communication, have a tendency to devote attention to a restricted range of environmental events (American Psychiatric Association, 2013). ASD is considered a pervasive developmental disability because it affects multiple areas of development and life (e.g., academics, independence). Embedded interest interventions are intended to remediate core and related deficits in individuals with ASD through increasing one's motivation to participate.

Summary

The overarching purpose of this three-part study was to determine areas in which embedding interests for individuals with ASD has support. No previous reviews exist in this specific area. First, a quality review of the embedded interest literature with individuals with ASD was conducted. Both group-based and single-case research was included. Second, a meta-analysis of single-case research studies on embedding interests for individuals with ASD was carried out to compliment the quality review. Third, an original single-case research study was conducted to determine the effects of using interests as receptive identification targets for three children with ASD and severe language delays. All studies compared high-preferred (HP) to low-preferred (LP) or neutrally preferred stimulus

conditions. Effects were found to be primarily positive in favor of embedding interests for individuals with ASD across the three studies.

Quality Review

The quality review applied sets of standards available from both the What Works Clearinghouse (WWC; Kratochwill et al., 2010/2014, 2013) and the Council for Exceptional Children (CEC; Cook et al., 2015). The CEC Standards were conservative relative to the WWC Standards. Embedding interests for individuals with ASD has *Insufficient Evidence* according to the CEC Standards. The intervention has strong support according to the WWC Standards, but only when applied to the literature base as a whole versus individual dependent variable categories. Primary dependent variable categories included social/communication (SOCCOM) and task-engagement/accuracy/productivity (TEAP). There was nearly sufficient support for SOCCOM outcomes while TEAP included few effects and resulted in mixed support. Original research is needed to replicate and extend the literature on embedding interests in order to make conclusions about specific outcomes.

Meta-Analysis

The meta-analysis evaluated overall effects and effects within studies on embedding interests for individuals with ASD. Moderators on dependent variables, participant characteristics, and learning contexts were of primary interest. Publication bias and indicators of internal validity were also tested via moderator analyses. Effects were sometimes found to be neutral for a variety of moderator variables analyzed. There were even deleterious effects within some studies. Characteristics of self-stimulatory or ritualistic behavior (SSRB) that can occur in the presence of restricted object or activity interests was suspected as a reason why embedding interests produced negative effects. Three studies in the meta-analysis

measured SSRB as an ancillary variable to primary outcomes (i.e., SOCCOM and TEAP) and a correlation analysis resulted in an inverse relation. That is, single-case studies measuring and noting increases in repetitive behaviors when interests were embedded were associated with no effects or worsened outcomes on primary measures (Adams, 1999; Morrison & Rosales-Ruiz, 1997). On the contrary, Baker (2000) found SSRB to decrease and primary outcomes to increase across participants. These findings appear to be a primary source of outlying effects. In addition, SOCCOM outcomes produced relatively stronger effects than TEAP. Results were also considerably stronger for older participants that were considered to be relatively high-functioning. The learning context may also play a role in varied outcomes as student-led (STU) activities produced stronger outcomes than instructor-led (INS) activities. Evidence of a potential publication bias was demonstrated. Results showed general consistency of the Tau/Tau-*U* nonoverlap effect sizes (ESs) with visual analysis ratings on a dichotomous scale according to WWC Evidence Standards. However, results were included in this meta-analysis that did not meet all WWC Design Standards. Results must be interpreted with caution.

Single-case Research Evaluation

The single-case research study compared HP targets to LP targets on receptive identification acquisition in three children with ASD. Two children acquired more HP targets in fewer trials overall. A third participant had inconclusive results for acquisition. A number of ancillary variables were evaluated to examine acting theoretical mechanisms of embedding interests as receptive identification targets. Specifically, eye gaze behaviors, response attempts, and challenging behaviors were evaluated. All participants demonstrated increased eye gaze to referent stimuli in the HP condition relative to the LP condition.

Findings for challenging behavior and response attempts were mixed. Practitioners may consider beginning with HP targets in receptive identification programs for children with ASD, but side-effects including SSRB should be monitored in tandem with acquisition outcomes.

Conclusions

There are a number of considerations regarding the potential mechanism of action for embedding interests of individuals with ASD. As demonstrated in the current reviews and single-case study, embedding interests can act as an establishing operation (EO) to evoke attention or engagement and thereby increase opportunities to interact with alternative sources for stimulation. However, interests can clearly also act as an abolishing operation (AO) to abate attention, depending on the case. It is not entirely clear what influences embedding interests to act as an EO versus an AO for an individual, but the current meta-analysis suggests a number of moderators to be explored further through original research studies. In particular, individuals with ASD that exhibit high levels of SSRBs with objects or activities of interest may not be ideal candidates for embedded interest interventions. However, continued research is needed to determine this with confidence.

It appears to be possible that embedding interests could act to condition LP stimuli as reinforcers. This is apparent for some participants in several studies that assessed generalization to LP conditions or stimuli (e.g., Baker, 2000; Baker et al., 1998; Naoi et al., 2008; Vismara & Lyons, 2012). This is promising as the restricted interests of individuals with ASD can be socially stigmatizing and take a central focus that deters one from alternative activities. By pairing highly preferred objects or activities with an alternative

activity, the alternative activity may become a source of reinforcement in the absence of the HP stimuli. Distal effects of incorporating interests such as this should be explored.

In sum, there is a dynamic literature-base of interventions that embed interests into the learning environment by comparing HP to LP conditions for individuals with ASD. Given the variability in outcomes, the preliminary evidence suggests that practitioners should implement this intervention with caution and procedural modifications as necessary. When this intervention is applied alongside evidence-based practices, additive effects can occur. Engaging students with ASD is a challenging but necessary aspect of treatment. Embedding interests can be considered as a strength or interest-based approach to treatment. By incorporating what is important to individuals with ASD into their learning environments, they may become more inclined or motivated to engage in activities that are important to members of their community. As a result, individuals with ASD may experience more success with their social integration and learning outcomes.

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APPENDIX A

TABLES

Table 1

Council for Exceptional Children Standards for Evidence-Based Practices in Special Education: Single-Case Research

	1.1	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	5.3	6.1	6.2	6.3	6.5	6.6	6.7	7.1	7.2	7.3	7.4	7.5	8.2
Adams (1999), *Task Score*	+	+	+	+	-	-	+	-	-	-	M	+	+	+	M	M	+	+	+	+	-	+
Adams (1999), *Off-Task*	+	+	+	+	-	-	+	-	-	-	M	+	+	+	M	M	+	+	+	+	+	+
Adams (1999), *Self-Stimulatory Behavior*	+	+	+	+	-	-	+	-	-	-	M	+	+	+	-	-	+	+	+	+	+	+
Agarwal (2012), *Scripted Conversation*	+	+	+	+	-	+	+	+	+	+	M	+	+	+	+	+	+	+	+	+	+	-
Agarwal (2012), *Unscripted Conversation*	+	+	+	+	-	+	+	+	+	+	M	+	+	+	+	+	+	+	+	+	+	-
Agarwal (2012), *Script Acquisition*	+	+	+	+	-	+	+	+	+	+	M	+	+	+	+	+	+	+	+	+	+	-

	1.1	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	5.3	6.1	6.2	6.3	6.5	6.6	6.7	7.1	7.2	7.3	7.4	7.5	8.2
Baker (2000), *Social Play*																						
	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Baker (2000), *Joint Attention*																						
	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Baker (2000), *Affect*																						
	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Baker (2000), *Ritualistic Behaviors*																						
	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Baker, Koegel, & Koegel (1998), *Social Play*																						
	+	+	+	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Baker, Koegel, & Koegel (1998), *Affect*																						
	+	+	+	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	-	+	-	+
Boyd, Alter, & Conroy (2005), *Social Initiations*																						
	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Boyd, Conroy, Mancil, Nakao, & Alter (2007), *Social Interactions*																						
	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Clarke et al. (1995), *Disruptive Behavior*																						
	+	+	+	-	-	-	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+

	1.1	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	5.3	6.1	6.2	6.3	6.5	6.6	6.7	7.1	7.2	7.3	7.4	7.5	8.2
Clarke et al. (1995), *Desirable Behavior*	+	+	+	-	-	-	+	-	+	-	+	+	+	+	-	-	+	+	+	+	+	+
Clarke et al. (1995), *Productivity*	+	+	+	-	-	-	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
El Zein, Solis, Lang, & Kim (2014), *Reading Comprehension*	+	+	-	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
El Zein, Solis, Lang, & Kim (2014), *Retell*	+	+	-	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	-	+
Koegel, Dyer, & Bell (1987), Study 2, *Social Avoidance*	+	-	+	+	-	+	+	-	+	-	+	+	+	+	-	+	+	+	+	-	+	+
Koegel, Fredeen et al. (2012), *Engaged with Peers*	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	-	+	+	+
Koegel, Fredeen et al. (2012), *Initiations with Peers*	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	-	+	+	+
Koegel, Kim, Koegel, & Schwartzman (2013), *Engaged with Peers*	+	+	+	+	+	+	+	-	+	-	+	-	+	+	M	+	+	+	+	M	+	+
Koegel, Kim, Koegel, & Schwartzman (2013), *Initiations with Peers*	+	+	+	+	+	+	+	-	+	-	+	-	+	+	M	+	+	+	+	M	+	+

	1.1	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	5.3	6.1	6.2	6.3	6.5	6.6	6.7	7.1	7.2	7.3	7.4	7.5	8.2
Koegel, Vernon, Koegel, Koegel, & Paullin (2012), *Engaged with Peers*	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Koegel, Vernon, Koegel, Koegel, & Paullin (2012), *Social Initiations*	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Morrison & Rosales-Ruiz (1997), *Stereotypic Behavior*	+	+	+	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Morrison & Rosales-Ruiz (1997), *Correct Responses*	+	+	+	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Naoi, Tsuchiya, Yamamoto, & Nakamura (2008), *Initiating Joint Attention*	+	+	+	+	-	+	+	-	+	-	+	+	+	+	-	+	+	+	+	-	+	+
Naoi, Tsuchiya, Yamamoto, & Nakamura (2008), *Affect*	+	+	+	+	-	+	+	-	+	-	+	+	+	+	-	+	+	+	+	-	+	+
Neely, Rispoli, Camargo, Davis, & Boles (2013), *Challenging Behavior*	+	+	-	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Neely, Rispoli, Camargo, Davis, & Boles (2013), *Academic Engagement*	+	+	-	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Talebi (2007), *Social Engagement*	+	+	+	+	-	+	+	-	+	-	+	-	+	+	+	+	+	+	+	+	+	+

	1.1	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	5.3	6.1	6.2	6.3	6.5	6.6	6.7	7.1	7.2	7.3	7.4	7.5	8.2
Talebi (2007), Social Initiations																						
	+	+	+	+	-	+	+	-	+	-	+	-	+	+	+	+	+	+	+	+	+	+
Talebi (2007), Affect																						
	+	+	+	+	-	+	+	-	+	-	+	-	+	+	+	+	+	+	+	+	+	+
Teaff (2001), Desirable Behavior																						
	+	+	-	+	-	-	-	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Vismara & Lyons (2007), Joint Attention Initiations																						
	+	+	+	+	+	+	+	+	+	+	+	+	+	M	+	+	+	+	+	+	+	+
Vismara & Lyons (2007), Affect																						
	+	+	+	+	+	+	+	+	+	+	+	+	+	M	+	+	+	+	+	+	+	+

Note. + = met indicator; - = did not meet indicator; M = mixed.

Table 2

Council for Exceptional Children Standards for Evidence-Based Practices in Special Education: Group-Based Research

	1.1	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	5.3	6.1	6.2	6.3	6.4	6.8	6.9	7.1	7.2	7.3	7.4	7.5	7.6	8.1	8.3
Donaldson & Olswang (2007), *Requests for Information*	+	+	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+
Nadig, Lee, Singh, Bosshart, & Ozonoff (2010), *Topic Maintenance*	-	+	+	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+
Nadig, Lee, Singh, Bosshart, & Ozonoff (2010), *Level of Information*	-	+	+	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+
Nadig, Lee, Singh, Bosshart, & Ozonoff (2010), *Atypical Utterances*	-	+	+	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+
Nadig, Lee, Singh, Bosshart, & Ozonoff (2010), *Eye Gaze*	-	+	+	+	-	+	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+*	-	+	+

Note. + = met indicator; - = did not meet indicator; * = software precluded need for reliability measure.

Table 3

What Works Clearinghouse Standards for Single-Case Design

Study/ID	Design	Graph/Participant ID	Overall	DS#1	DS#2A	DS#2A within	DS#2B	DS#3	DS#4
Adams (1999)									
1	MBL x Tasks	*Jerry Task Score*	0	N	N	N/A	N	Y	Y
2	MBL x Tasks	*Grace Task Score*	0	Y	N	N/A	N	Y	Y
3	MBL x Tasks	*Tom Task Score*	0	N	N	N/A	N	Y	Y
4	MBL x Tasks	*Eddie Task Score*	0	Y	N	N/A	N	Y	Y
5	MBL x Tasks	*Ray Task Score*	0	Y	N	N/A	N	Y	Y
6	MBL x Tasks	*Jerry Off-Task*	0	N	Y	N	Y	Y	Y
7	MBL x Tasks	*Grace Off-Task*	2	Y	Y	N	Y	Y	Y
8	MBL x Tasks	*Tom Off-Task*	0	N	Y	N	Y	Y	Y
9	MBL x Tasks	*Eddie Off-Task*	2	Y	Y	N	Y	Y	Y
10	MBL x Tasks	*Ray Off-Task*	2	Y	Y	N	Y	Y	Y
11	MBL x Tasks	*Jerry Self-Stimulatory Behavior*	0	N	Y	N	Y	Y	Y
12	MBL x Tasks	*Grace Self-Stimulatory Behavior*	2	Y	Y	N	Y	Y	Y
13	MBL x Tasks	*Tom Self-Stimulatory Behavior*	0	N	Y	N	Y	Y	Y
14	MBL x Tasks	*Eddie Self-Stimulatory Behavior*	2	Y	Y	N	Y	Y	Y
15	MBL x Tasks	*Ray Self-Stimulatory Behavior*	2	Y	Y	N	Y	Y	Y
Agarwal (2012)									
16	ATD	*Andrew Scripted Conversation*	0	N	Y	Y	Y	Y	Y
17	ATD	*Richard Scripted Conversation*	0	N	Y	Y	Y	Y	Y
18	ATD	*Jennifer Scripted Conversation*	2	Y	Y	Y	Y	Y	Y
19	ATD	*Andrew Unscripted Conversation*	0	N	Y	Y	Y	Y	Y
20	ATD	*Richard Unscripted Conversation*	0	N	Y	Y	Y	Y	Y

Study/ID	Design	Graph/Participant ID	Overall	DS#1	DS#2A	DS#2A within	DS#2B	DS#3	DS#4
21	ATD	*Jennifer Unscripted Conversation*	2	Y	Y	Y	Y	Y	Y
22	ATD	*Andrew Card Reader Acquisition*	0	N	N	N/A	N	Y	Y
23	ATD	*Richard Card Reader Acquisition*	0	N	N	N/A	N	Y	Y
24	ATD	*Jennifer Card Reader Acquisition*	0	Y	N	N/A	N	Y	Y
Baker (2000)									
25	MBL x P	*Ken Social Play*	2	Y	Y	Y	Y	Y	Y
26		*Wayne Social Play*	2	Y	Y	Y	Y	Y	Y
27		*Annie Social Play*	2	Y	Y	Y	Y	Y	Y
28	MBL x P	*Ken Joint Attention*	2	Y	Y	Y	Y	Y	Y
29		*Wayne Joint Attention*	2	Y	Y	Y	Y	Y	Y
30		*Annie Joint Attention*	2	Y	Y	Y	Y	Y	Y
31	MBL x P	*Ken Affect*	2	Y	Y	Y	Y	Y	Y
32		*Wayne Affect*	2	Y	Y	Y	Y	Y	Y
33		*Annie Affect*	2	Y	Y	Y	Y	Y	Y
34	MBL x P	*Ken Ritualistic Behavior*	2	Y	Y	Y	Y	Y	Y
35		*Wayne Ritualistic Behavior*	2	Y	Y	Y	Y	Y	Y
36		*Annie Ritualistic Behavior*	2	Y	Y	Y	Y	Y	Y
Baker et al. (1998)									
37	MBL x P	*Don Social Play*	1	Y	Y	Y	Y	Y	R
38		*Amy Social Play*	1	Y	Y	Y	Y	Y	R
39		*Jenny Social Play*	1	Y	Y	Y	Y	Y	R
40	MBL x P	*Don Affect*	0	Y	Y	N	Y	Y	R
41		*Amy Affect*	0	Y	Y	N	Y	Y	R
42		*Jenny Affect*	0	Y	Y	N	N	Y	R

Study/ID	Design	Graph/Participant ID	Overall	DS#1	DS#2A	DS#2A within	DS#2B	DS#3	DS#4
Boyd et al. (2005)									
43	ATD	*Greg Social Initiations*	1	Y	Y	N	Y	Y	R
Boyd et al. (2007)									
44	ATD	*Jason Social Interactions*	2	Y	Y	Y	Y	Y	Y
45	ATD	*Allen Social Interactions*	2	Y	Y	Y	Y	Y	Y
46	ATD	*Jin Social Interactions*	2	Y	Y	Y	Y	Y	Y
Clarke et al. (1995)									
47	ABAB	*Arnold Disruptive Behavior*	2	Y	Y	N	Y	Y	Y
48	ABAB	*Arnold Desirable Behavior*	2	Y	Y	N	Y	Y	Y
49	ABAB	*Arnold Productivity*	2	Y	Y	N	Y	Y	Y
El Zein et al. (2014)									
50	ATD	*Jim Reading Comprehension*	2	Y	Y	Y	Y	Y	Y
51	ATD	*Jim Retell*	0	Y	N	N/A	N	Y	Y
Koegel et al. (1987)									
52	ABAB	*Participant 11 Social Avoidance*	0	Y	Y	N	Y	Y	N
53	BABAB	*Participant 1 Social Avoidance*	0	Y	Y	N	Y	Y	N
54	ABAB	*Participant 2 Social Avoidance*	0	Y	Y	N	Y	Y	N
Koegel et al. (2012a)									
55	MBL x P with ABABAB for P 1	*Participant 1 Engaged with Peers*	2	Y	Y	N	Y	Y	Y
56		*Participant 2 Engaged with Peers*	2	Y	Y	N	Y	Y	Y
57		*Participant 3 Engaged with Peers*	2	Y	Y	N	Y	Y	Y

Study/ID	Design	Graph/Participant ID	Overall	DS#1	DS#2A	DS#2A within	DS#2B	DS#3	DS#4
58	MBL x P with ABABAB for P 1	*Participant 1 Initiations with Peers*	2	Y	Y	N	Y	Y	Y
59		*Participant 2 Initiations with Peers*	2	Y	Y	N	Y	Y	Y
60		*Participant 3 Initiations with Peers*	2	Y	Y	N	Y	Y	Y
Koegel et al. (2013)									
61	MBL x P	*Participant 1 Engaged with Peers*	1	Y	Y	N	Y	Y	R
62		*Participant 2 Engaged with Peers*	1	Y	Y	N	Y	Y	R
63		*Participant 3 Engaged with Peers*	1	Y	Y	N	Y	Y	R
64		*Participant 4 Engaged with Peers*	1	Y	Y	N	Y	Y	R
65	MBL x P	*Participant 5 Engaged with Peers*	0	Y	Y	N	Y	Y	N
66		*Participant 6 Engaged with Peers*	0	Y	Y	N	Y	Y	N
67		*Participant 7 Engaged with Peers*	0	Y	Y	N	Y	Y	N
68	MBL x P	*Participant 1 Initiations with Peers*	1	Y	Y	N	Y	Y	R
69		*Participant 2 Initiations with Peers*	1	Y	Y	N	Y	Y	R
70		*Participant 3 Initiations with Peers*	1	Y	Y	N	Y	Y	R
71		*Participant 4 Initiations with Peers*	1	Y	Y	N	Y	Y	R
72	MBL x P	*Participant 5 Initiations with Peers*	0	Y	Y	N	Y	Y	N
73		*Participant 6 Initiations with Peers*	0	Y	Y	N	Y	Y	N
74		*Participant 7 Initiations with Peers*	0	Y	Y	N	Y	Y	N
Koegel et al. (2012b)									
75	MBL x P with ABAB for P 1	*Child 1 Engaged with Peers*	1	Y	Y	N	Y	Y	R
76		*Child 2 Engaged with Peers*	1	Y	Y	N	Y	Y	R
77		*Child 3 Engaged with Peers*	1	Y	Y	N	Y	Y	R

Study/ID	Design	Graph/Participant ID	Overall	DS#1	DS#2A	DS#2A within	DS#2B	DS#3	DS#4
78	MBL x P with ABAB for P 1	*Child 1 Social Initiations*	1	Y	Y	N	Y	Y	R
79		*Child 2 Social Initiations*	1	Y	Y	N	Y	Y	R
80		*Child 3 Social Initiations*	1	Y	Y	N	Y	Y	R
Morrison & Rosales-Ruiz (1997)									
81	Multielement	*Child Stereotypic Behavior Set A*	2	Y	Y	N	Y	Y	Y
82	Multielement	*Child Stereotypic Behavior Set B*	2	Y	Y	N	Y	Y	Y
83	Multielement	*Child Correct Responses Set A*	2	Y	Y	N	Y	Y	Y
84	Multielement	*Child Correct Responses Set B*	2	Y	Y	N	Y	Y	Y
Naoi et al. (2008)									
85	MBL x P	*Ken Joint Attention*	0	Y	Y	N	Y	Y	N
86		*Tsutomu Joint Attention*	0	Y	Y	N	Y	Y	N
87		*Kyoko Joint Attention*	0	Y	Y	N	Y	Y	N
88	MBL x P	*Ken Affect*	0	Y	Y	N	Y	Y	N
89		*Tsutomu Affect*	0	Y	Y	N	Y	Y	N
90		*Kyoko Affect*	0	Y	Y	N	Y	Y	N
Neely et al. (2013)									
91	ABAB	*Elton Challenging Behavior*	2	Y	Y	Y	Y	Y	Y
92	ABAB	*Elton Challenging Behavior*	2	Y	Y	Y	Y	Y	Y
93	ABAB	*Dan Academic Engagement*	2	Y	Y	Y	Y	Y	Y
94	ABAB	*Elton Academic Engagement*	2	Y	Y	Y	Y	Y	Y
Talebi (2007)									
95	MBL x P	*Jaya Social Engagement*	1	Y	Y	Y	Y	Y	R
96		*Patterson Social Engagement*	1	Y	Y	Y	Y	Y	R
97		*Oliver Social Engagement*	1	Y	Y	Y	Y	Y	R

Study/ID	Design	Graph/Participant ID	Overall	DS#1	DS#2A	DS#2A within	DS#2B	DS#3	DS#4
98	MBL x P	*Jaya Social Initiations*	1	Y	Y	Y	Y	Y	R
99		*Patterson Social Initiations*	1	Y	Y	Y	Y	Y	R
100		*Oliver Social Initiations*	1	Y	Y	Y	Y	Y	R
101	MBL x P	*Jaya Affect*	1	Y	Y	Y	Y	Y	R
102		*Patterson Affect*	1	Y	Y	Y	Y	Y	R
103		*Oliver Affect*	1	Y	Y	Y	Y	Y	R
Teaff (2001)									
104	ABAB	*Stan Desirable Behavior*	2	Y	Y	Y	Y	Y	Y
Vismara & Lyons (2007)									
105	BAB	*Child 1 Joint Attention*	0	Y	Y	N	Y	N	Y
106	BAB	*Child 1 Affect*	0	Y	Y	N	Y	N	Y
107	BAB	*Child 2 Joint Attention*	0	Y	Y	N	Y	N	Y
108	BAB	*Child 2 Affect*	0	Y	Y	N	Y	N	Y
109	ABAB	*Child 3 Joint Attention*	2	Y	Y	N	Y	Y	Y
110	ABAB	*Child 3 Affect*	2	Y	Y	N	Y	Y	Y

Note. ATD = alternating treatments design; MBL = multiple-baseline design; P = participant(s); Y = yes; N = no; N/A = not applicable; 2 = *Meets Design Standards*; 1 = *Meets Design Standards with Reservations*; 0 = *Does Not Meet Design Standards*.

Table 4

Council for Exceptional Children and What Works Clearinghouse Evidence Evaluation

Study/Dependent Variable	*n*	# CEC Meeting Standards	CEC Evidence	# WWC for Evidence Evaluation	WWC Evidence
Adams (1999)					
Task Score	5	0	N/A	0	N/A
Off-Task	5	0	N/A	3	No
Self-Stimulatory Behavior	5	0	N/A	3	No
Agarwal (2012)					
Scripted Conversation	3	0	N/A	1	No
Unscripted Conversation	3	0	N/A	1	No
Card Reader Acquisition	3	0	N/A	0	N/A
Baker (2000)					
Social Play	3	0	N/A	3	Strong
Joint Attention	3	0	N/A	3	Strong
Affect	3	0	N/A	3	Strong
Ritualistic Behavior	3	0	N/A	3	Strong
Baker et al. (1998)					
Social Play	3	0	N/A	3	Strong
Affect	3	0	N/A	0	N/A
Boyd et al. (2005)					
Social Initiations	1	0	N/A	1	Strong
Boyd et al. (2007)					
Social Interactions	3	3	Positive	3	Strong
Clarke et al. (1995)					
Disruptive Behavior	1	0	N/A	1	Strong
Desirable Behavior	1	0	N/A	1	No
Productivity	1	0	N/A	1	Strong
El Zein et al. (2014)					
Reading Comprehension	1	0	N/A	1	Strong
Retell	1	0	N/A	0	N/A
Koegel et al. (1987)					
Social Avoidance	3	0	N/A	0	N/A

Study/Dependent Variable	*n*	# CEC Meeting Standards	CEC Evidence	# WWC for Evidence Evaluation	WWC Evidence
Koegel et al. (2012a)					
Engaged with Peers	3	0	N/A	3	Strong
Initiations with Peers	3	0	N/A	3	Strong
Koegel et al. (2013)					
Engaged with Peers	7	0	N/A	4	Strong
Initiations with Peers	7	0	N/A	4	Strong
Koegel et al. (2012b)					
Engaged with Peers	3	0	N/A	3	Strong
Social Initiations	3	0	N/A	3	Strong
Morrison & Rosales-Ruiz (1997)					
Stereotypic Behavior	2	0	N/A	2	No
Correct Responses	2	0	N/A	2	No
Naoi et al. (2008)					
Joint Attention	3	0	N/A	0	N/A
Affect	3	0	N/A	0	N/A
Neely et al. (2013)					
Challenging Behavior	2	0	N/A	2	Strong
Academic Engagement	2	0	N/A	2	Strong
Talebi (2007)					
Social Engagement	3	0	N/A	3	Strong
Social Initiations	3	0	N/A	3	Strong
Affect	3	0	N/A	3	No
Teaff (2001)					
Desirable Behavior	1	0	N/A	1	Strong
Vismara & Lyons (2007)					
Joint Attention	3	1	N/A	1	Strong
Affect	3	1	N/A	1	Strong

Note. # = number of dependent variables within cases at the design level of studies; N/A = not applicable.

Table 5

Variables Analyzed as Moderators by Dependent Variables within Cases

Study/Case	Age	Level	Context	DV	Type	WWC Basic	WWC Evidence
Adams (1999)							
Grace	PRESCH	SAU	INS	TEAP	DISS	NO	NO DS
Grace	PRESCH	SAU	INS	DOT	DISS	NO	NO
Grace	PRESCH	SAU	INS	SSRB	DISS	NO	NO
Eddie	PRESCH	SAU	INS	TEAP	DISS	NO	NO DS
Eddie	PRESCH	SAU	INS	DOT	DISS	NO	NO
Eddie	PRESCH	SAU	INS	SSRB	DISS	NO	NO
Ray	PRESCH	SAU	INS	TEAP	DISS	NO	NO DS
Ray	PRESCH	SAU	INS	DOT	DISS	NO	NO
Ray	PRESCH	SAU	INS	SSRB	DISS	NO	NO
Agarwal (2012)							
Jennifer	SEC/ADO	AU	INS	SOCCOM	DISS	NO	NO
Jennifer	SEC/ADO	AU	INS	SOCCOM	DISS	NO	NO
Jennifer	SEC/ADO	AU	INS	TEAP	DISS	NO	NO DS
Baker (2000)							
Ken	ELEM	AU	STU	SOCCOM	PR	YES	STR/MOD
Ken	ELEM	AU	STU	SOCCOM	PR	YES	STR/MOD
Ken	ELEM	AU	STU	AFFECT	PR	YES	STR/MOD
Ken	ELEM	AU	STU	SSRB	PR	YES	STR/MOD
Wayne	ELEM	SAU	STU	SOCCOM	PR	YES	STR/MOD
Wayne	ELEM	SAU	STU	SOCCOM	PR	YES	STR/MOD
Wayne	ELEM	SAU	STU	AFFECT	PR	YES	STR/MOD
Wayne	ELEM	SAU	STU	SSRB	PR	YES	STR/MOD
Annie	ELEM	SAU	STU	SOCCOM	PR	YES	STR/MOD
Annie	ELEM	SAU	STU	SOCCOM	PR	YES	STR/MOD
Annie	ELEM	SAU	STU	AFFECT	PR	YES	STR/MOD
Annie	ELEM	SAU	STU	SSRB	PR	YES	STR/MOD
Baker et al. (1998)							
Don	ELEM	AU	STU	SOCCOM	PR	YES	STR/MOD
Don	ELEM	AU	STU	AFFECT	PR	YES	NO DS
Amy	ELEM	AU	STU	SOCCOM	PR	YES	STR/MOD
Amy	ELEM	AU	STU	AFFECT	PR	YES	NO DS
Jenny	ELEM	AU	STU	SOCCOM	PR	YES	STR/MOD

Study/Case	Age	Level	Context	DV	Type	WWC Basic	WWC Evidence
Jenny	ELEM	AU	STU	AFFECT	PR	YES	NO DS
Boyd et al. (2005)							
Greg	ELEM	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Boyd et al. (2007)							
Jason	ELEM	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Allen	ELEM	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Jin	ELEM	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Clarke et al. (1995)							
Arnold	ELEM	SAU	INS	DOT	PR	YES	STR/MOD
Arnold	ELEM	SAU	INS	SOCCOM	PR	NO	NO
Arnold	ELEM	SAU	INS	TEAP	PR	YES	STR/MOD
El Zein et al. (2014)							
Jim	ELEM	AU	INS	TEAP	PR	YES	STR/MOD
Jim	ELEM	AU	INS	TEAP	PR	YES	NO DS
Koegel et al. (1987)							
P 1	MIX	SAU	INS	SOCCOM	PR	YES	NO DS
P 2	MIX	SAU	INS	SOCCOM	PR	YES	NO DS
P 11	MIX	SAU	INS	SOCCOM	PR	YES	NO DS
Koegel et al. (2012a)							
P 1	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
P 1	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
P 2	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 2	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 3	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 3	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
Koegel et al. (2013)							
P 1	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
P 1	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
P 2	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 2	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 3	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 3	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 4	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 4	SEC/ADO	AU	STU	SOCCOM	PR	YES	STR/MOD
P 5	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	NO DS
P 5	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	NO DS
P 6	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	NO DS

Study/Case	Age	Level	Context	DV	Type	WWC Basic	WWC Evidence
P 6	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	NO DS
P 7	SEC/ADO	AU	STU	SOCCOM	PR	YES	NO DS
P 7	SEC/ADO	AU	STU	SOCCOM	PR	YES	NO DS
Koegel et al. (2012b)							
Child 1	ELEM	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Child 1	ELEM	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Child 2	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Child 2	SEC/ADO	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Child 3	ELEM	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Child 3	ELEM	HFAAS	STU	SOCCOM	PR	YES	STR/MOD
Morrison & Rosales-Ruiz (1997)							
P	ELEM	SAU	INS	SSRB	PR	NO	NO
P	ELEM	SAU	INS	TEAP	PR	NO	NO
Naoi et al. (2008)							
Ken	ELEM	SAU	STU	SOCCOM	PR	YES	NO DS
Ken	ELEM	SAU	STU	AFFECT	PR	NO	NO DS
Tsutomu	PRESCH	AU	STU	SOCCOM	PR	YES	NO DS
Tsutomu	PRESCH	AU	STU	AFFECT	PR	YES	NO DS
Kyoko	ELEM	SAU	STU	SOCCOM	PR	NO	NO DS
Kyoko	ELEM	SAU	STU	AFFECT	PR	YES	NO DS
Neely et al. (2013)							
Elton	ELEM	HFAAS	INS	DOT	PR	YES	STR/MOD
Elton	ELEM	HFAAS	INS	TEAP	PR	YES	STR/MOD
Dan	PRESCH	AU	INS	DOT	PR	YES	STR/MOD
Dan	PRESCH	AU	INS	TEAP	PR	YES	STR/MOD
Talebi (2007)							
Jaya	SEC/ADO	HFAAS	STU	SOCCOM	DISS	YES	STR/MOD
Jaya	SEC/ADO	HFAAS	STU	SOCCOM	DISS	YES	STR/MOD
Jaya	SEC/ADO	HFAAS	STU	AFFECT	DISS	NO	NO
Patterson	SEC/ADO	HFAAS	STU	SOCCOM	DISS	YES	STR/MOD
Patterson	SEC/ADO	HFAAS	STU	SOCCOM	DISS	YES	STR/MOD
Patterson	SEC/ADO	HFAAS	STU	AFFECT	DISS	YES	NO
Oliver	SEC/ADO	HFAAS	STU	SOCCOM	DISS	YES	STR/MOD
Oliver	SEC/ADO	HFAAS	STU	SOCCOM	DISS	YES	STR/MOD
Oliver	SEC/ADO	HFAAS	STU	AFFECT	DISS	YES	NO
Teaff (2001)							
Stan	SEC/ADO	AU	INS	TEAP	DISS	YES	STR/MOD

Study/Case	Age	Level	Context	DV	Type	WWC Basic	WWC Evidence
Vismara & Lyons (2007)							
Child 1	PRESCH	SAU	STU	SOCCOM	PR	YES	NO DS
Child 1	PRESCH	SAU	STU	AFFECT	PR	YES	NO DS
Child 2	PRESCH	AU	STU	SOCCOM	PR	YES	NO DS
Child 2	PRESCH	AU	STU	AFFECT	PR	YES	NO DS
Child 3	PRESCH	AU	STU	SOCCOM	PR	YES	STR/MOD
Child 3	PRESCH	AU	STU	AFFECT	PR	YES	STR/MOD

Note. DV = dependent variable; P = participant.

Table 6

Tau/Tau-U Effect Sizes and Confidence Interval Ranges for Dependent Variables within Studies

Article	*n*	Target behavior	# of Contrasts	Tau-*U*	CI95	
					LL	UL
Adams (1999)	3	*Task Score* (TEAP)	9	-0.03	-0.21	0.15
		Off-Task (DOT)	9	0.04	-0.15	0.22
		Self-Stimulatory Behavior (SSRB)	9	-0.01	-0.20	0.17
Agarwal (2012)	1	*Scripted Responses* (SOCCOM)	1	0.16	-0.13	0.45
		Unscripted Responses (SOCCOM)	1	0.21	-0.08	0.50
		Card Reader Acquisition (TEAP)	1	-0.13	-0.43	0.17
Baker (2000)	3	*Social Play* (SOCCOM)	3	0.99	0.71	1.00
		Joint Attention (SOCCOM)	3	0.97	0.69	1.00
		Affect (AFFECT)	3	0.81	0.52	1.00
		Ritualistic Behavior (SSRB)	3	-0.43	-0.71	-0.15
Baker et al. (1998)	3	*Social Play* (SOCCOM)	3	1.00	0.52	1.00
		Affect (AFFECT)	3	0.90	0.41	1.00
Boyd et al. (2005)	1	*Social Initiations* (SOCCOM)	1	1.00	0.15	1.00
Boyd et al. (2007)	3	*Social Interactions* (SOCCOM)	3	0.79	0.44	1.00
Clarke et al. (1995)	1	*Disruptive Behavior* (DOT)	2	-0.98	-1.00	-0.58
		Desirable Behavior (SOCCOM)	2	-0.07	-0.47	0.33
		Productivity (TEAP)	2	0.89	0.49	1.00
El Zein et al. (2014)	2	*Reading Comprehension* (TEAP)	1	0.64	0.15	1.00
		Retell (TEAP)	1	0.64	0.15	1.00
Koegel et al. (1987)	3	*Social Avoidance** (SOCCOM)	6	1.00	0.56	1.00
Koegel et al. (2012a)	3	*Engaged with Peers* (SOCCOM)	5	1.00	0.70	1.00
		Initiations with Peers (SOCCOM)	5	1.00	0.70	1.00
Koegel et al. (2013)	7	*Engaged with Peers* (SOCCOM)	7	0.91	0.66	1.00
		Initiations with Peers (SOCCOM)	7	0.88	0.63	1.00
Koegel et al. (2012b)	3	*Engaged with Peers* (SOCCOM)	4	0.96	0.65	1.00
		Social Initiations (SOCCOM)	4	0.96	0.65	1.00
Morrison & Rosales-Ruiz (1997)	1	*Stereotypic Behavior* (SSRB)	2	0.75	0.52	0.97
		Correct Responses (TEAP)	2	-0.82	-1.00	-0.60
Naoi (2008)	3	*Joint Attention* (SOCCOM)	3	0.52	0.06	0.98
		Affect (AFFECT)	3	0.53	0.06	0.99
Neely et al. (2013)	2	*Challenging Behavior* (DOT)	4	-1.00	-1.00	-0.65
		Academic Engagement (TEAP)	4	1.00	0.65	1.00
Talebi (2007)	3	*Social Engagement* (SOCCOM)	3	1.00	0.61	1.00
		Social Initiations (SOCCOM)	3	0.88	0.48	1.00
		Affect (AFFECT)	3	0.72	0.33	1.00
Teaff (2001)	1	*Desirable Behavior* (TEAP)	2	0.86	0.33	1.00
Vismara et al. (2012)	3	*Joint Attention* (SOCCOM)	4	0.77	0.37	1.00
		Affect (AFFECT)	4	0.61	0.22	1.00

Note. CI = confidence interval; * = effect size represents the inverse of measures.

Table 7

Overall Descriptive Results, Overall Effects, and Heterogeneity Test

Analysis	Studies	*n*	Contrasts	DVs	Tau-*U*	SE	CI95		*H*	I^2
							LL	UL		
Increasing	18	45	106	32	0.55	0.03	0.49	0.61	3.3	90.8%
Decreasing	5	10	29	6	-0.03	0.05	-0.12	0.07	4.7	95.5%

Note. CI = confidence interval; DVs = dependent variables; LL = lower limits; SE = standard error; UL = upper limits.

Table 8

Participant Information

Name	Age	Intervention Length	Ethnicity / Race	Communication Mode	Challenging Behavior	Stereotypical Behavior
David	7 y 4 mo	4 mo	Caucasian	PECS Phase 5, some vocal approximations	Elopement, eye closing or covering, head down, stomping, screaming, crying, physical aggression	Repetitive hand movements, tensing up body, bouncing
Eli	4 y 1 mo	4 mo	Hispanic	PECS Phase 4, some vocal approximations	Head down, screaming, crying, pushing materials away	Repetitive hand movements, rocking, bouncing
Mikey	5 y 6 mo	5 mo	Caucasian	PECS Phase 3b, some vocal approximations	Elopement, screaming, crying, physical aggression	Repetitive hand movements, looking to side, covering ears

Note. PECS = Picture Exchange Communication System.

Table 9

Autism Spectrum Rating Scales – Parent Ratings

Participant/Scale	T-score (90% CI)	Percentile	Classification
David (6-18 Years)			
Total Score	77 (74-79)	99	Very Elevated Score
ASRS Scales			
Social/Communication	75 (70-77)	99	Very Elevated Score
DSM-5 Scale	75 (70-76)	99	Very Elevated Score
Treatment Scales			
Stereotypy	78 (65-79)	99	Very Elevated Score
Attention	71 (64-74)	98	Very Elevated Score
Eli (2-5 Years)			
Total Score	78 (74-80)	99	Very Elevated Score
ASRS Scales			
Social/Communication	80 (76-82)	99	Very Elevated Score
DSM-5 Scale	81 (76-83)	99	Very Elevated Score
Treatment Scales			
Stereotypy	75 (64-77)	99	Very Elevated Score
Attention/Self-Regulation	81 (71-82)	99	Very Elevated Score
Myles (2-5 Years)			
Total Score	69 (66-71)	97	Elevated Score
ASRS Scales			
Social/Communication	71 (67-73)	98	Very Elevated Score
DSM-5 Scale	72 (67-75)	99	Very Elevated Score
Treatment Scales			
Stereotypy	71 (60-74)	98	Very Elevated Score
Attention/Self-Regulation	66 (58-70)	95	Elevated Score

Note. DSM = Diagnostic and Statistical Manual of Mental Disorders.

Table 10

Verbal Behavior Milestones Assessment and Placement Program

VB-MAPP Domains	David	Eli	Mikey
Selected Milestones			
Visual Perceptual Skills and MTS	18-30 months	18-30 months	18-30 months
Listener Responding	0-18 months	0-18 months	0-18 months
Motor Imitation	18-30 months	18-30 months	18-30 months
Echoic	0-18 months	0-18 months	0-18 months
Selected Barriers			
Negative Behavior	Persistent	Moderate	Persistent
Listener Repertoires	Persistent	Persistent	Severe
Prompt Dependent	Persistent	Moderate	Persistent
Impaired Scanning Skills	Persistent	Persistent	Persistent
Conditional Discriminations	Persistent	Persistent	Severe
Weak or Atypical MOs	Persistent	Moderate	Severe
Response Requirement Weakens MO	Moderate	Moderate	Persistent
Reinforcement Dependent	Moderate	Moderate	Persistent
Self-Stimulation	Severe	Occasional	Severe
Hyperactive Behavior	Persistent	Occasional	Severe

Note. MTS = match-to-sample; MO = motivating operation.

Table 11

Receptive One-Word Picture Vocabulary Test – 4th ed.

Name	Raw Score	Standard Score	Age Equivalent	Percentile Rank
David	12	< 55	1 yr 3 mo	< 1
Eli	1	< 55	< 1.0	< 1
Mikey	2	< 55	< 1.0	< 1

Table 12

Single-Case Research Study Questions with Associated Dependent Variables and Figures

Research Questions	Dependent Variables	Figures of Hypothetical Data
1. Will preference for targets result in differential effects on receptive identification acquisition for children with ASD who lack or have minimal receptive identification skills?	Receptive identification	Figure 14 Figure 15
2. Will participants: (a) attend to referent stimuli differentially, (b) make response attempts differentially, and (c) exhibit challenging behavior differentially across HP versus LP conditions?	Eye gaze (duration) Eye gaze (percentage of trials) Response attempt Challenging behavior Engagement (aggregate measure)	Figure 16 Figure 17 Figure 18 Figure 19 Figure 20 (aggregate measure)
3. What are the effects of HP versus LP conditions on participants' abilities to generalize to other exemplars of receptive identification targets?	Multiple exemplar generalization	Figure 21
4. What are the effects of HP versus LP conditions on participants' abilities to tact receptive identification targets?	Tact generalization	Figure 22
5. What are the effects of added intervention components on receptive identification acquisition?	Receptive identification	Figure 14

Table 13

Preference Assessment IOA, Fidelity, and IOA Fidelity

	David	Eli	Mikey
IOA	100%	100%	100%
Fidelity	97% (95%-100%)	100%	95%
IOA Fidelity	100%	100%	100%

Note. Data collected 40% of sessions for all. David had two preference assessments.

Table 14

IOA Means and Ranges on Correct Receptive Identification, Generalization to Multiple Exemplars, and Tacts for David, Eli, and Mikey in HP and LP Conditions and Phases

	David HP	David LP	Eli HP	Eli LP	Mikey HP	Mikey LP
BL	100%	100%	100%	100%	100%	100%
L-M+DR	100%	100%	100%	100%	100%	100%
M-L+DR	100%	100%	100%	100%	100%	88%
L-M+DR+ Mapping	100%	98% (88%-100%)	100%	100%	100%	100%
ME Gen (Pre/Post)	100%	100%	100%	100%	N/A	N/A
Tacts (Pre/Post)	N/A	N/A	100%	100%	N/A	N/A

Note. DR = differential reinforcement; Gen = generalization; HP = high-preferred; LP = low-preferred; L-M = least-to-most; ME = multiple exemplar; M-L = most-to-least.

Table 15

IOA Means and Ranges on Duration Eye Gaze for David, Eli, and Mikey in HP and LP Conditions and Phases

	David HP	David LP	Eli HP	Eli LP	Mikey HP	Mikey LP
L-M+DR	81% (75%-90%)	97% (90%-100%)	100%	94% (83%-100%)	90% (77%-100%)	87% (82%-90%)
M-L+DR	85% (69%-100%)	98% (96%-100%)	83% (78%-88%)	91% (86%-95%)	84% (67%-100%)	85% (74%-96%)
L-M+DR+ Mapping	93% (88%-100%)	90% (81%-100%)	90% (88%-94%)	84% (71%-99%)	92%	88% (75%-100%)

Note. DR = differential reinforcement; HP = high-preferred; LP = low-preferred; L-M = least-to-most; M-L = most-to-least.

Table 16

IOA Means and Ranges on Percentage of Trials with Eye Gaze for David, Eli, and Mikey in HP and LP Conditions and Phases

	David HP	David LP	Eli HP	Eli LP	Mikey HP	Mikey LP
L-M+DR	82% (75%-88%)	94% (88%-100%)	96% (88%-100%)	84% (75%-88%)	97% (88%-100%)	85% (75%-100%)
M-L+DR	88% (75%-100)	88%	100%	100%	100%	82% (75%-88%)
L-M+DR+ Mapping	94% (88%-100%)	80% (63%-88%)	88% (63%-100%)	96% (88%-100%)	100%	88% (75%-100%)

Note. DR = differential reinforcement; HP = high-preferred; LP = low-preferred; L-M = least-to-most; M-L = most-to-least.

Table 17

IOA Means and Ranges on Response Attempts for David, Eli, and Mikey in HP and LP Conditions and Phases

	David HP	David LP	Eli HP	Eli LP	Mikey HP	Mikey LP
L-M+DR	100%	94% (88%-100%)	100%	100%	94% (88%-100%)	100%
M-L+DR	100%	100%	94% (88%-100%)	88% (75%-100%)	94% (88%-100%)	100%
L-M+DR+ Mapping	100%	98% (88%-100%)	96% (88%-100%)	88%	94% (88%-100%)	94% (88%-100%)

Note. DR = differential reinforcement; HP = high-preferred; LP = low-preferred; L-M = least-to-most; M-L = most-to-least.

Table 18

IOA Means and Ranges on Challenging Behavior for David, Eli, and Mikey in HP and LP Conditions and Phases

	David HP	David LP	Eli HP	Eli LP	Mikey HP	Mikey LP
L-M+DR	97% (88%-100%)	97% (88%-100%)	96% (88%-100%)	96% (88%-100%)	100%	94% (75%-100%)
M-L+DR	94% (88%-100%)	100%	94% (88%-100%)	88% (75%-100%)	100%	100%
L-M+DR+ Mapping	100%	90% (63%-100%)	100%	100%	100%	100%

Note. DR = differential reinforcement; HP = high-preferred; LP = low-preferred; L-M = least-to-most; M-L = most-to-least.

Table 19

IOA Means and Ranges on Engagement for David, Eli, and Mikey in HP and LP Conditions and Phases

	David HP	David LP	Eli HP	Eli LP	Mikey HP	Mikey LP
L-M+DR	97% (88%-100%)	88% (75%-100%)	100%	96% (88%-100%)	94% (88%-100%)	82% (75%-88%)
M-L+DR	100%	88%	94% (88%-100%)	82% (75%-88%)	94% (88%-100%)	88%
L-M+DR+ Mapping	96% (88%-100%)	80% (63%-100%)	100%	88%	94% (88%-100%)	82% (75%-88%)

Note. DR = differential reinforcement; HP = high-preferred; LP = low-preferred; L-M = least-to-most; M-L = most-to-least.

Table 20

Fidelity Across Phases for David, Eli, and Mikey in HP and LP Conditions

	David HP	David LP	Eli HP	Eli LP	Mikey HP	Mikey LP
BL	100%	100%	100%	100%	100%	100%
L-M+DR	100%	97% (86%-100%)	96% (88%-100%)	96% (88%-100%)	100%	97% (88%-100%)
M-L+DR	100%	100%	100%	100%	100%	100%
L-M+DR+ Mapping	100%	98% (90%-100%)	100%	100%	100%	100%
ME Gen (Pre/Post)	100%	88%	88%	88%	N/A	N/A
Tacts (Pre/Post)	N/A	N/A	100%	100%	N/A	N/A

Note. DR = differential reinforcement; Gen = generalization; HP = high-preferred; LP = low-preferred; L-M = least-to-most; ME = multiple exemplar; M-L = most-to-least.

Table 21

IOA on Fidelity Across Phases for David, Eli, and Mikey in HP and LP Conditions

	David HP	David LP	Eli HP	Eli LP	Mikey HP	Mikey LP
BL	100%	100%	100%	100%	100%	100%
L-M+DR	100%	97% (86%-100%)	96% (88%-100%)	100%	100%	100%
M-L+DR	100%	100%	100%	100%	100%	100%
L-M+DR+ Mapping	100%	98% (90%-100%)	100%	100%	100%	100%
ME Gen (Pre/Post)	100%	100%	100%	100%	N/A	N/A
Tacts (Pre/Post)	N/A	N/A	100%	100%	N/A	N/A

Note. DR = differential reinforcement; Gen = generalization; HP = high-preferred; LP = low-preferred; L-M = least-to-most; ME = multiple exemplar; M-L = most-to-least.

APPENDIX B

FIGURES

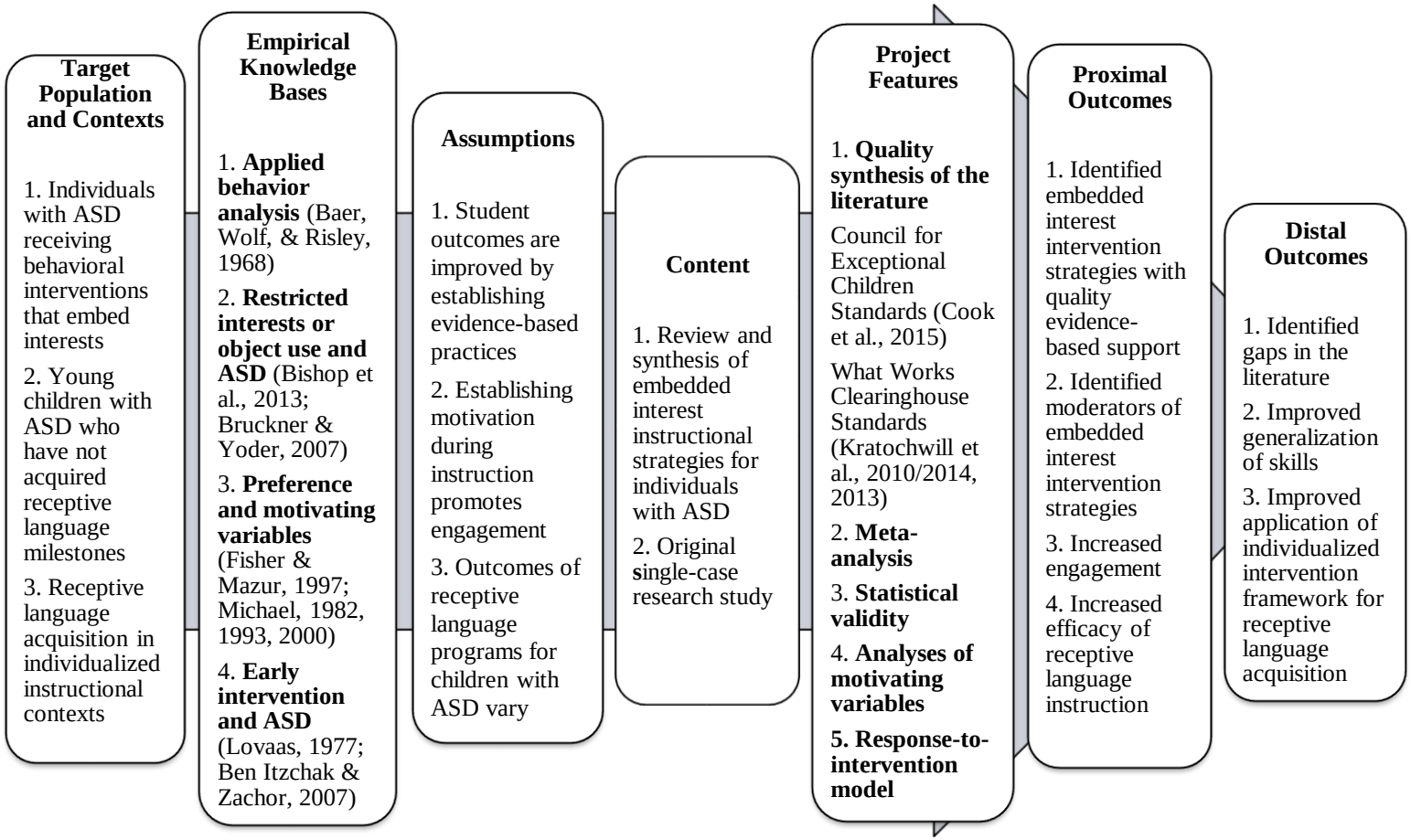

Figure 1. Embedding interests theory of change model.

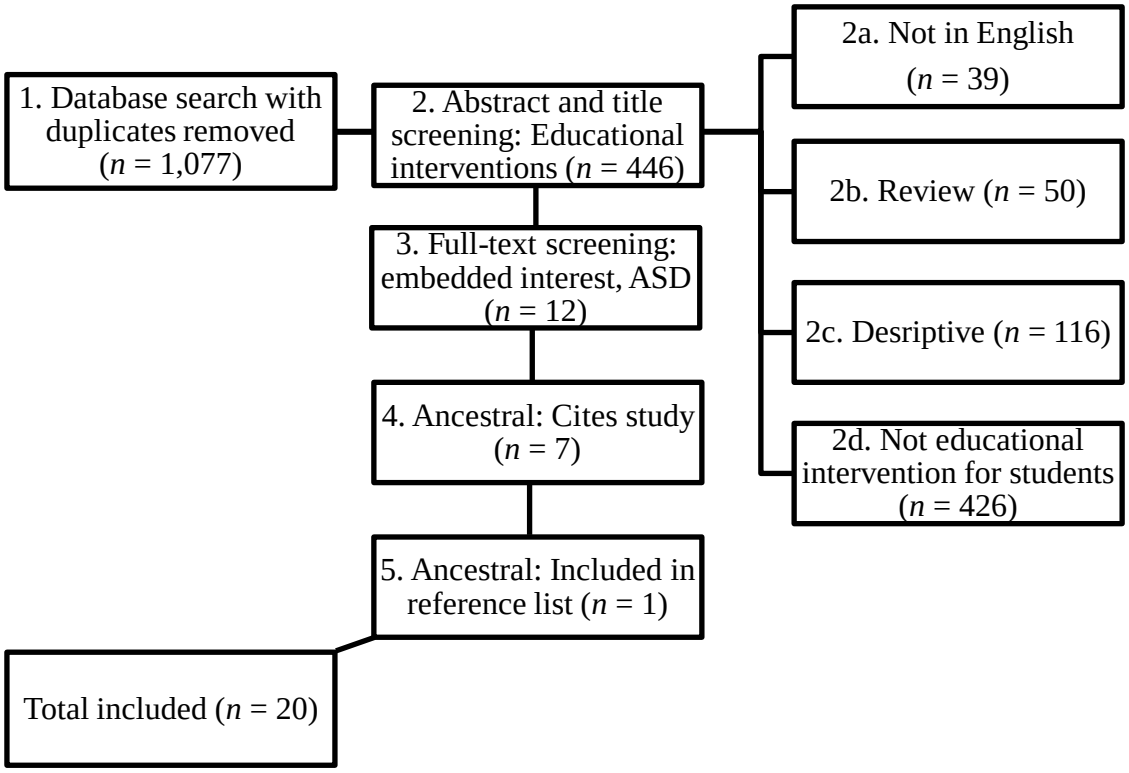

Figure 2. Systematic search procedures of the literature on embedding interests for individuals with ASD; *n* = number of studies.

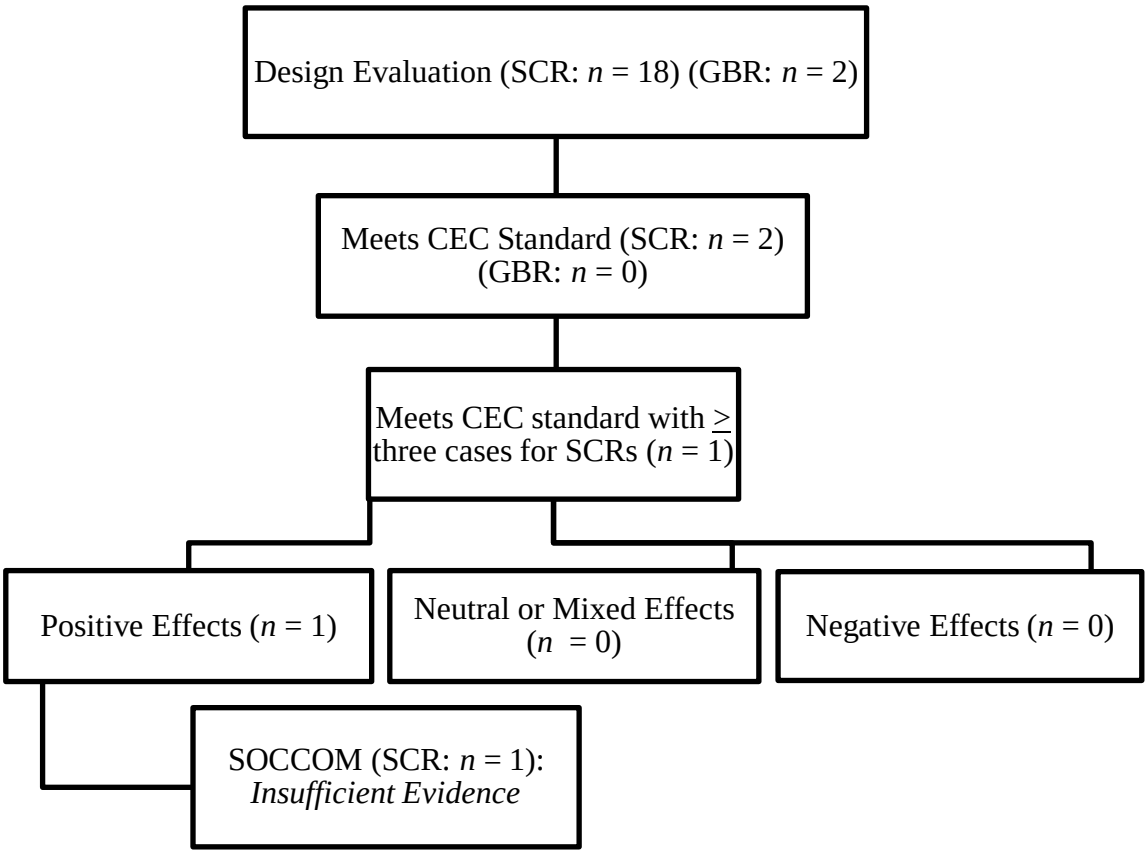

Figure 3. The *Council for Exceptional Children Standards for Evidence-Based Practices in Special Education* applied to the single-case research (SCR) literature and group-based research (GBR) literature on embedding interests for individuals with ASD, with Evidence-Based Classification applied per qualifying dependent variable category. *n* = number of studies; SOCCOM = social/communication.

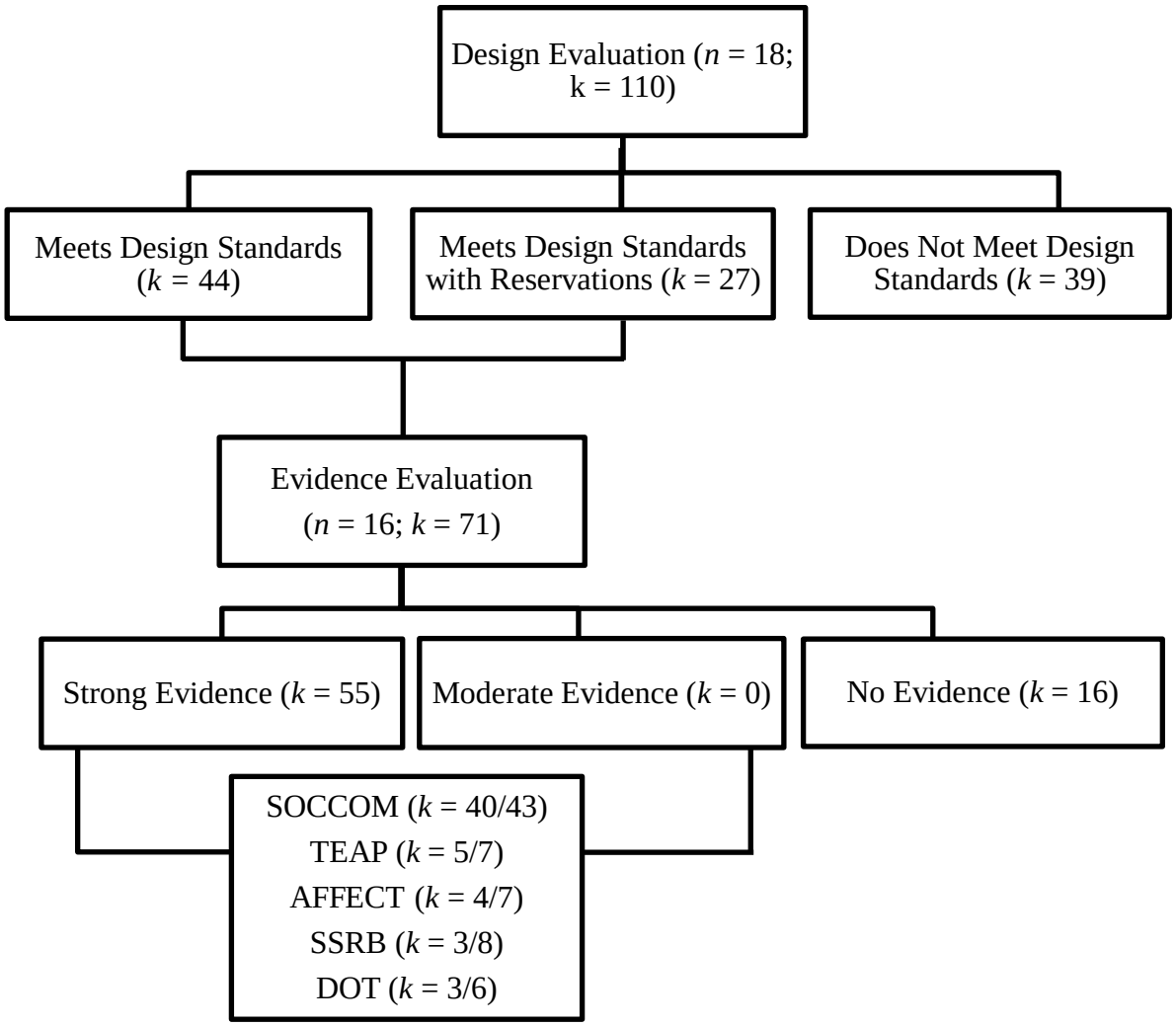

Figure 4. The *What Works Clearinghouse Standards for Single-Case Design and Evidence* applied to the literature on embedding interests for individuals with ASD, with Evidence Evaluation applied per qualifying dependent variable category. AFFECT = positive affect; DOT = disruptive/off-task behavior; *k* = number of dependent variables within cases, analyzed by design; *n* = number of studies; SOCCOM = social/communication; SSRB = self-stimulatory or ritualistic behaviors; TEAP = task-engagement/accuracy/productivity.

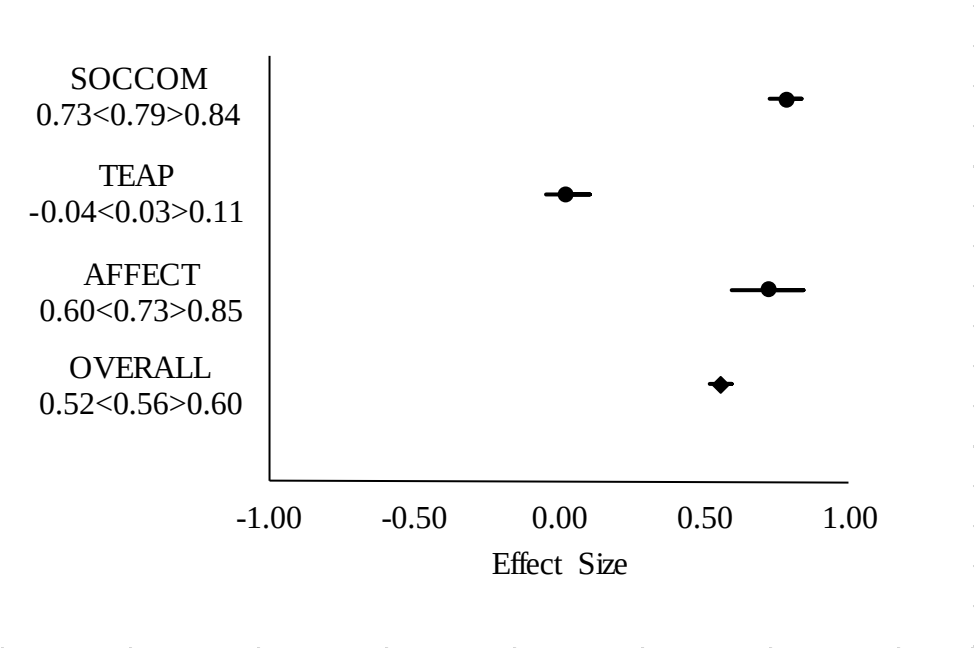

Figure 5. Dependent variables targeted for increasing in single-case studies with confidence intervals set to 83.4% upper and lower limits. AFFECT = positive affect; SOCCOM = social/communication; TEAP = task-engagement/accuracy/productivity.

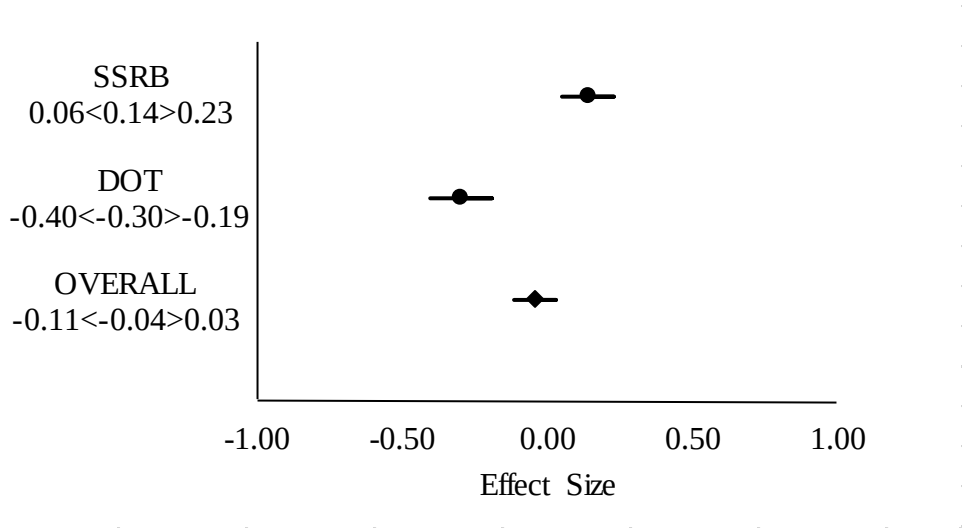

Figure 6. Dependent variables targeted for decreasing in single-case studies with confidence intervals set to 83.4% upper and lower limits. DOT = disruptive/off-task behavior; SSRB = self-stimulatory or ritualistic behaviors.

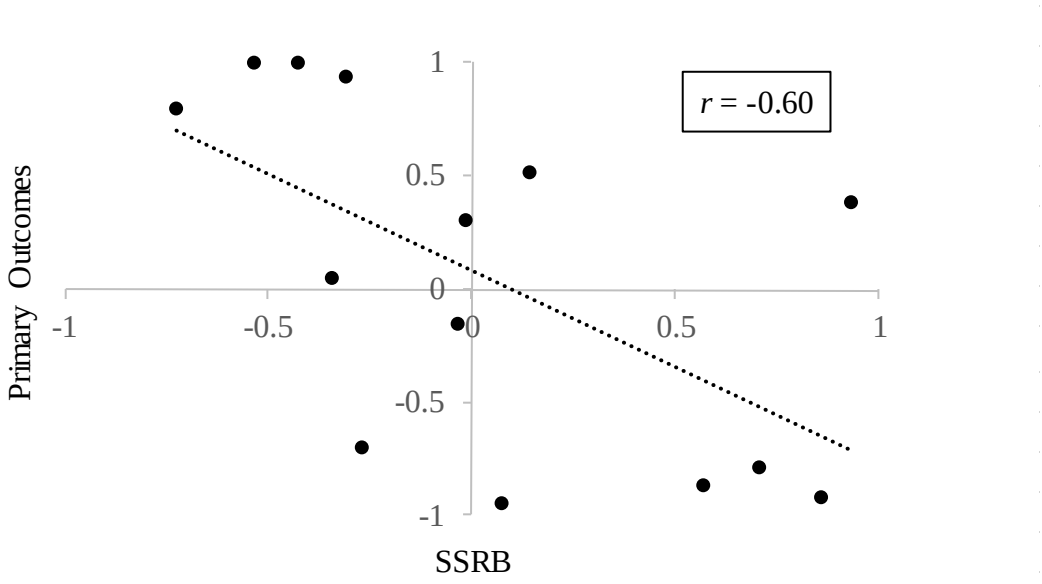

Figure 7. Correlation between self-stimulatory or ritualistic behaviors (SSRB) and primary outcomes.

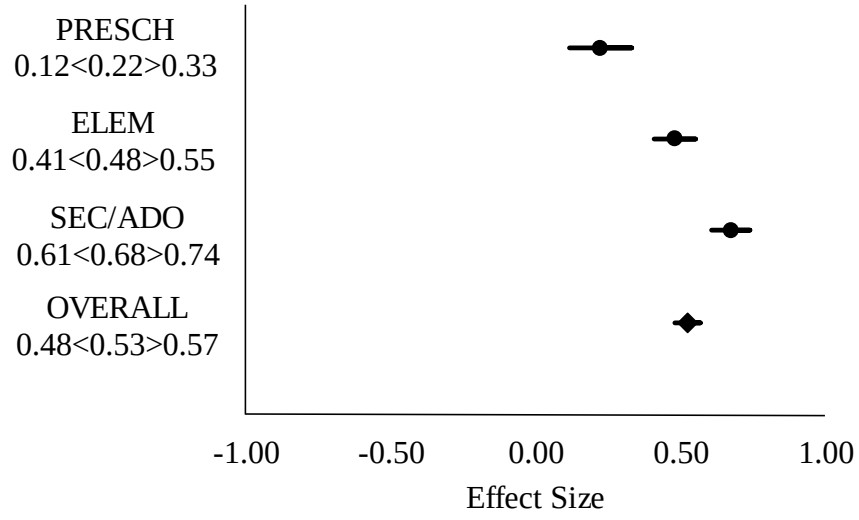

Figure 8. Age levels targeted in single-case studies with confidence intervals set to 83.4% upper and lower limits. ELEM = elementary; PRESCH = preschool; SEC/ADO = secondary/adolescent.

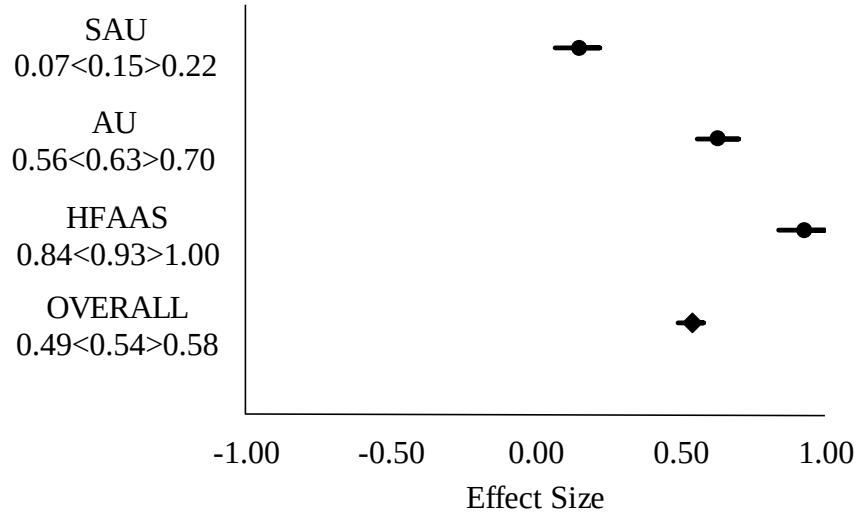

Figure 9. Functioning levels targeted in single-case studies with confidence intervals set to 83.4% upper and lower limits. AU = autism; HFAAS = high-functioning autism/Asperger syndrome; SAU = severe autism.

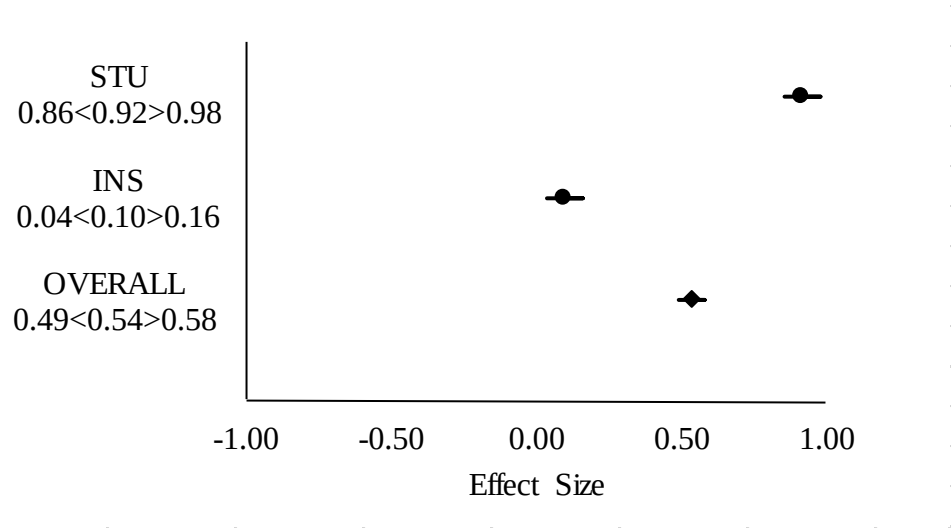

Figure 10. Contexts targeted in single-case studies with confidence intervals set to 83.4% upper and lower limits. INS = instructor-led; STU = student-led.

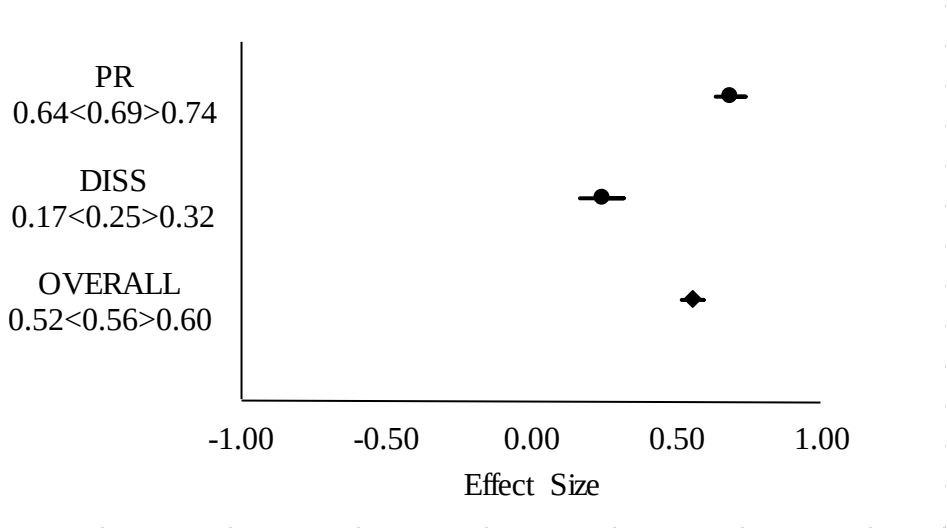

Figure 11. Publication types targeted in single-case studies with confidence intervals set to 83.4% upper and lower limits. DISS = dissertation; PR = peer-reviewed.

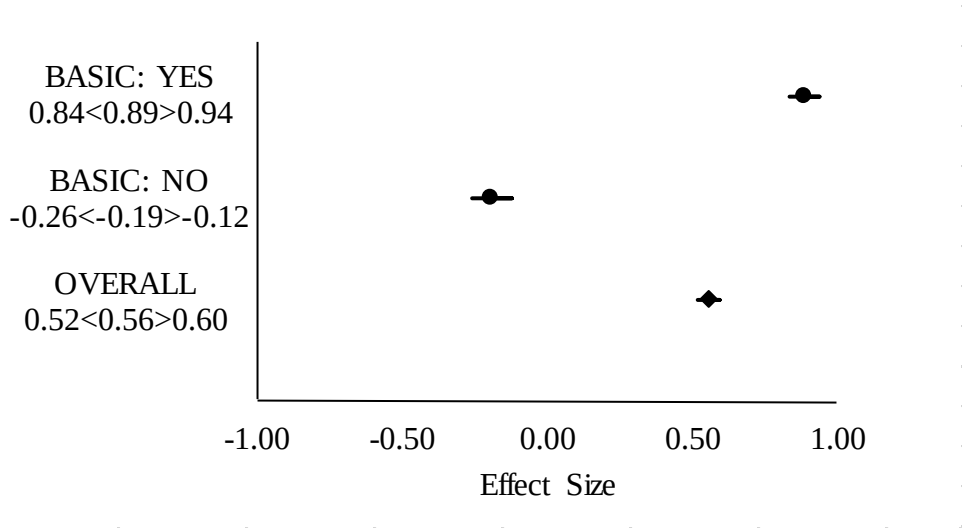

Figure 12. Presence of basic effects in single-case studies with confidence intervals set to 83.4% upper and lower limits. BASIC: NO = basic effects not present; BASIC: YES = basic effects present.

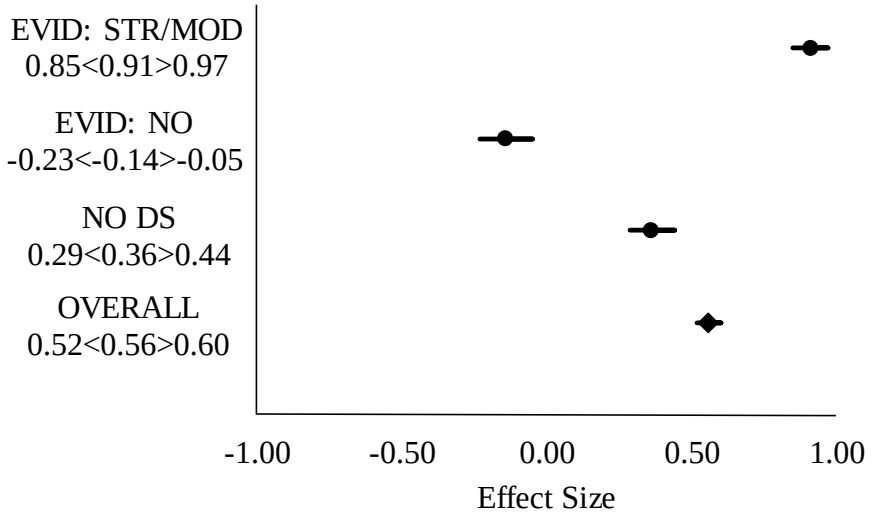

Figure 13. Presence of overall evidence in single-case studies with confidence intervals set to 83.4% upper and lower limits. EVID: NO = no evidence; EVID: STR/MOD = strong/moderate evidence; NO DS = does not meet design standards.

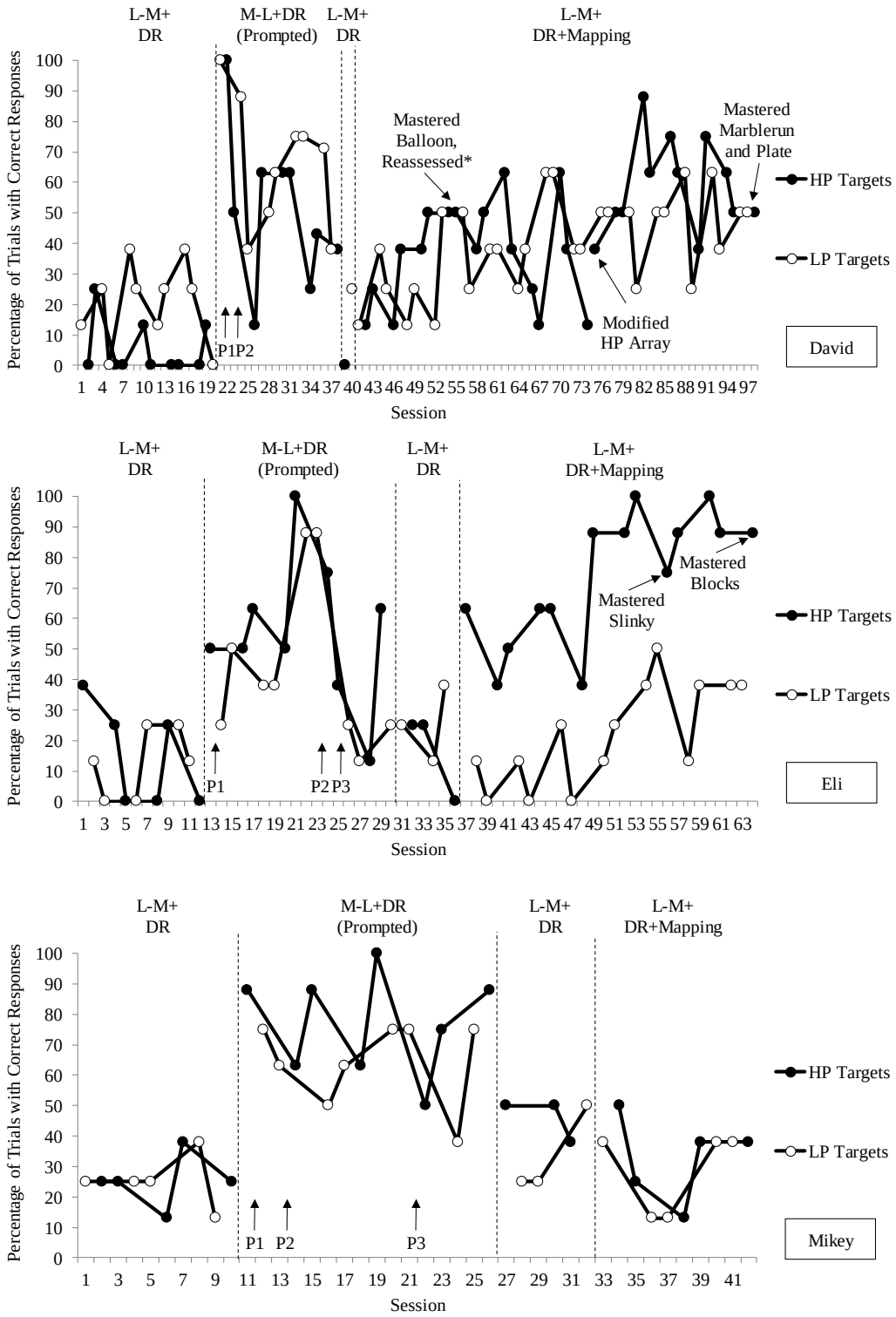

Figure 14. Correct receptive identification in HP and LP conditions. The L-M prompting phases represent independent responses and the M-L prompting phase represents prompted responses at the first (P1), second (P2), and third (P3) prompt levels.

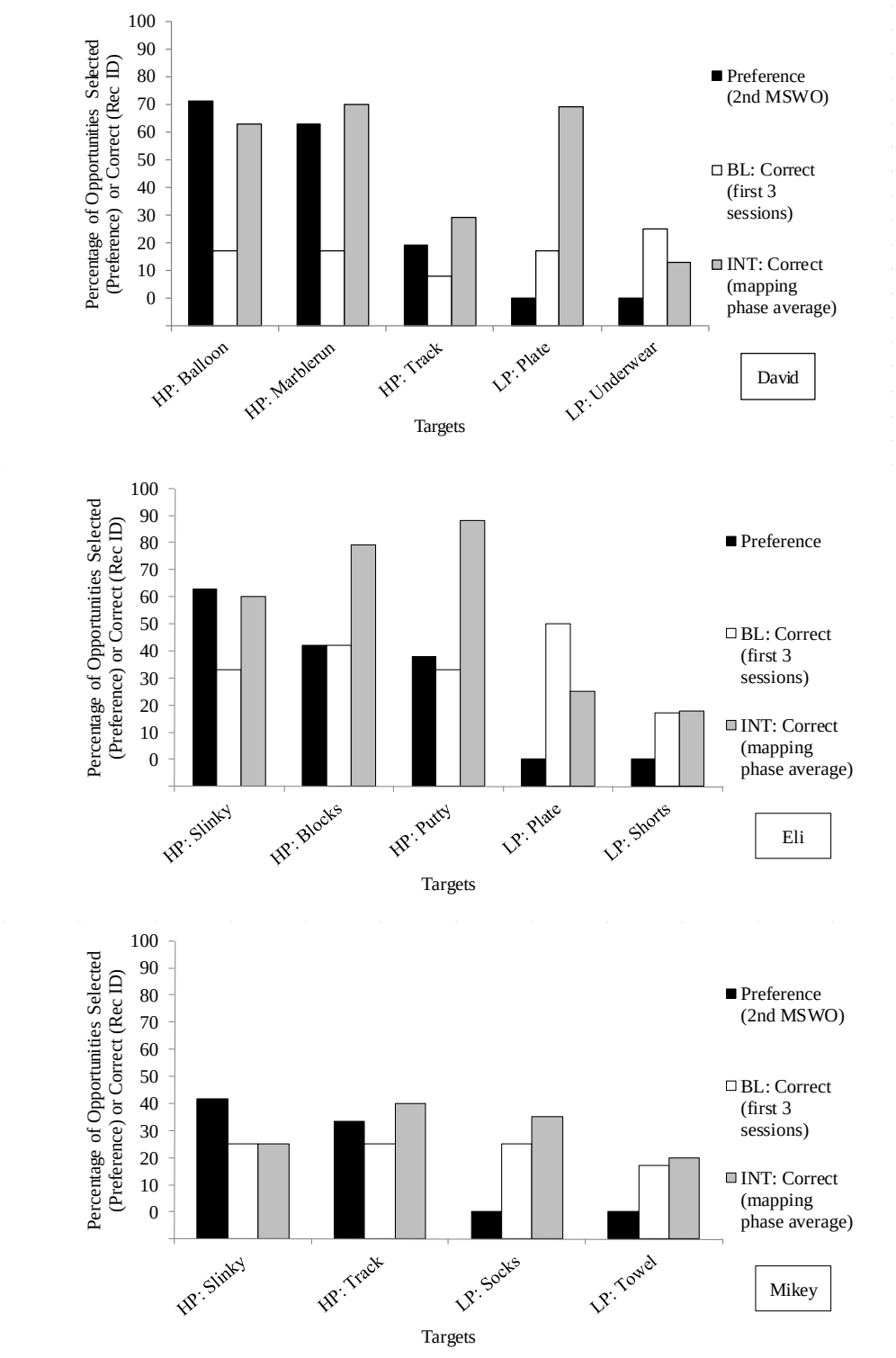

Figure 15. Percentage of opportunities selected during the preference assessment and percentage of trials with correct receptive identification of HP and LP targets in baseline and the last phase of the intervention (linguistic mapping).

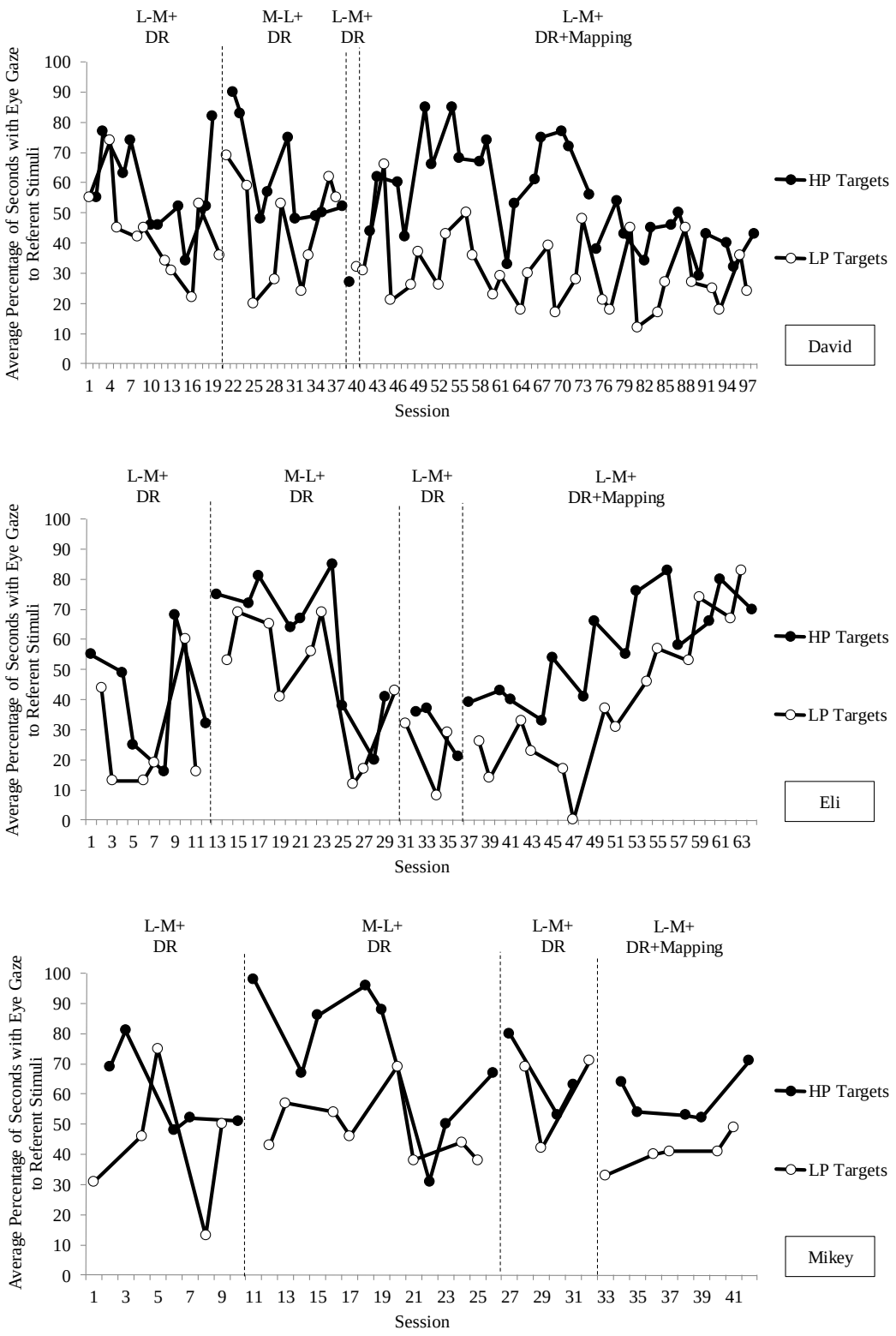

Figure 16. Average duration (in seconds) of eye gaze to HP and LP stimulus arrays.

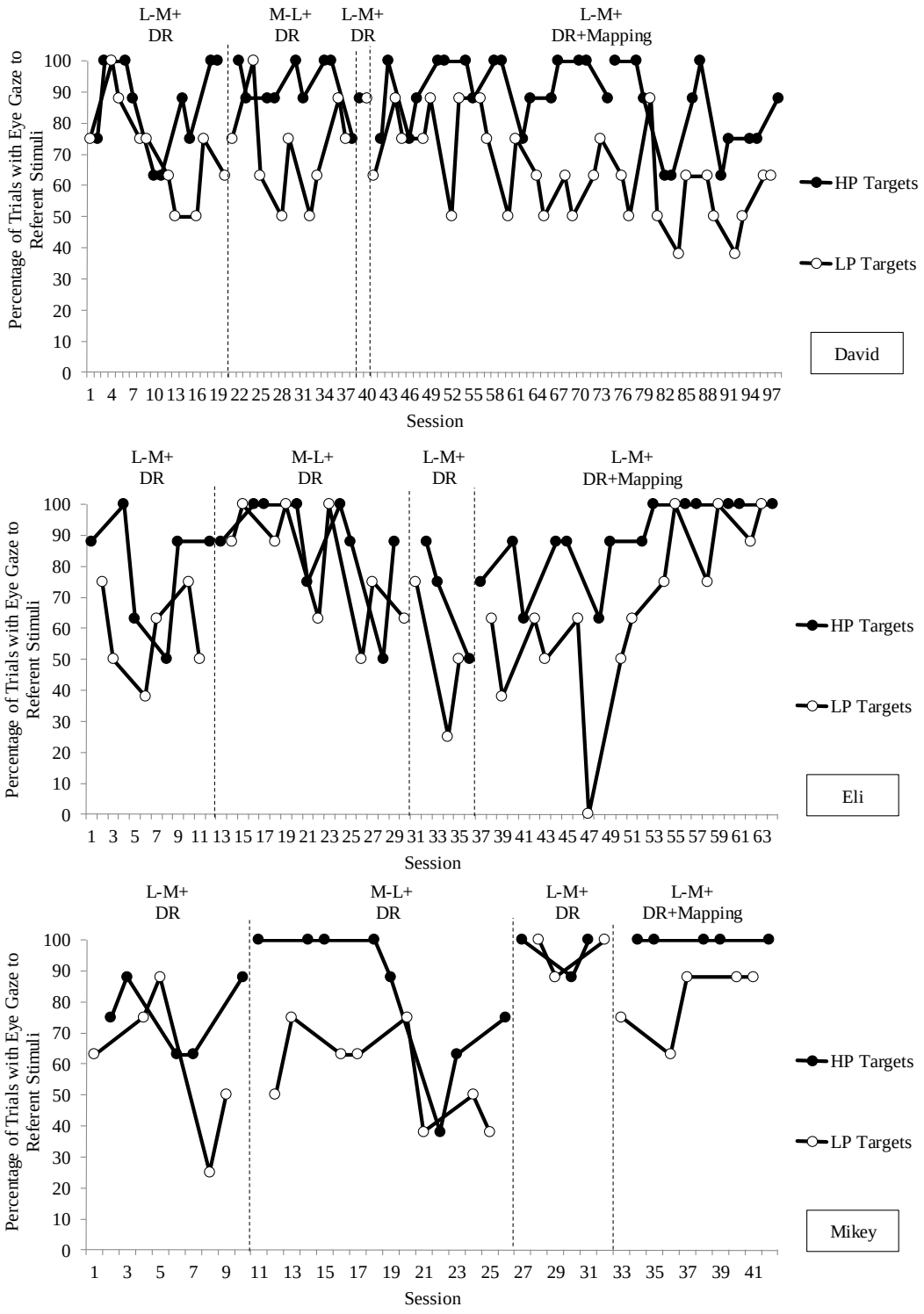

Figure 17. Average percentages of trials with eye gaze to referent stimuli in HP and LP conditions.

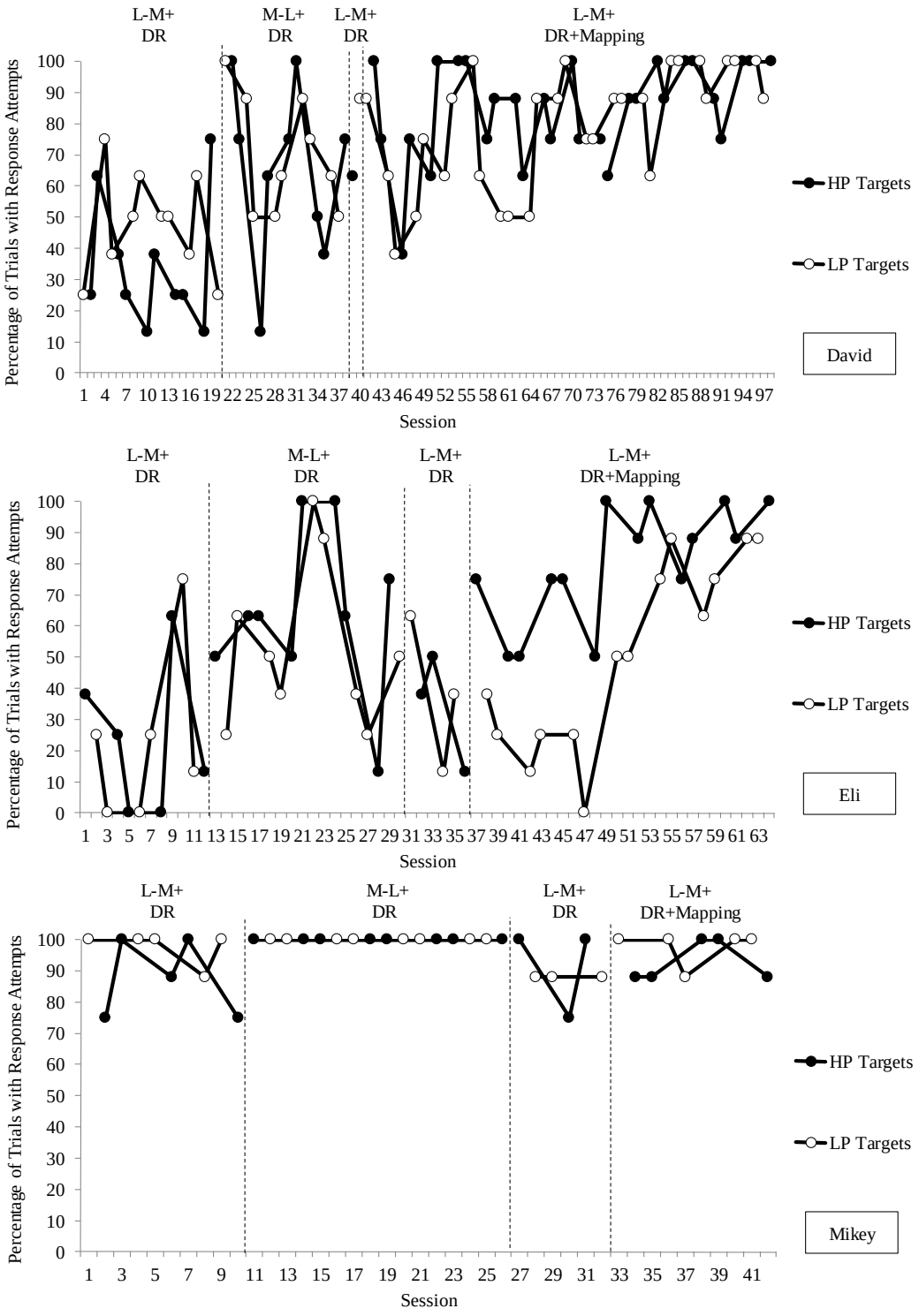

Figure 18. Average percentages of trials with a response attempt in HP and LP conditions.

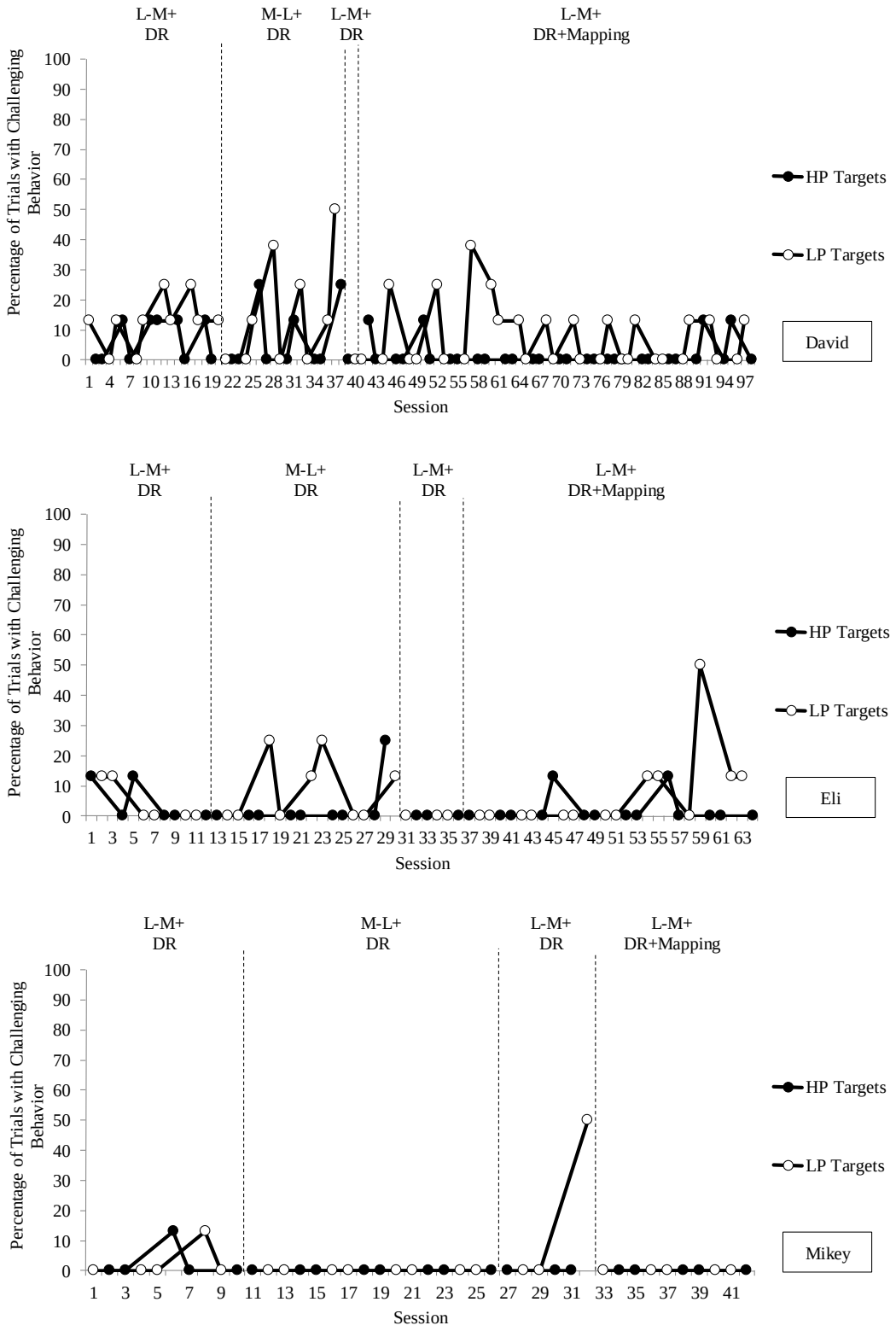

Figure 19. Average percentages of trials with challenging behavior in HP and LP conditions.

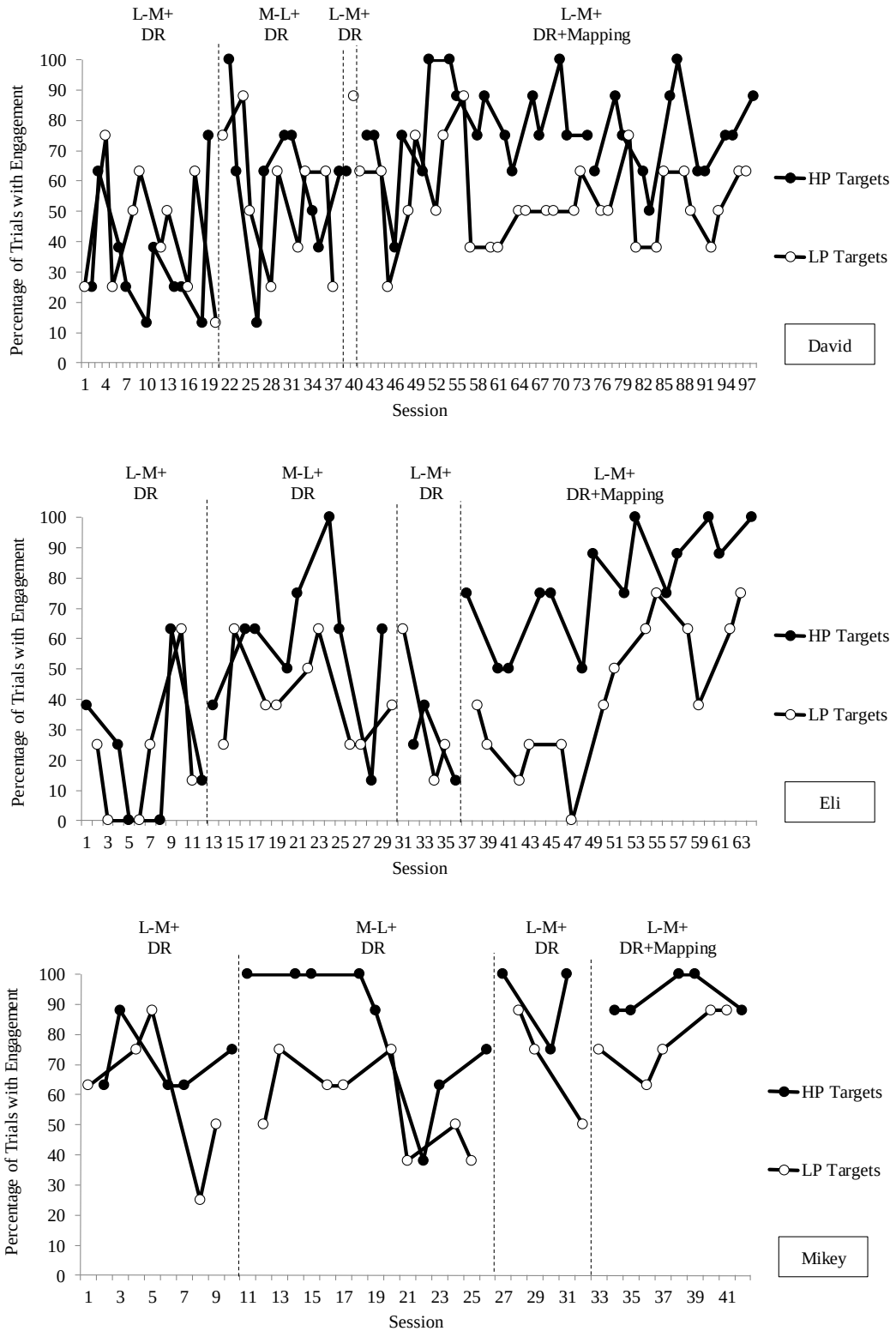

Figure 20. Average percentages of trials with engagement, defined as eye gaze to referent stimuli, a response attempt, and no challenging behavior in HP and LP conditions.

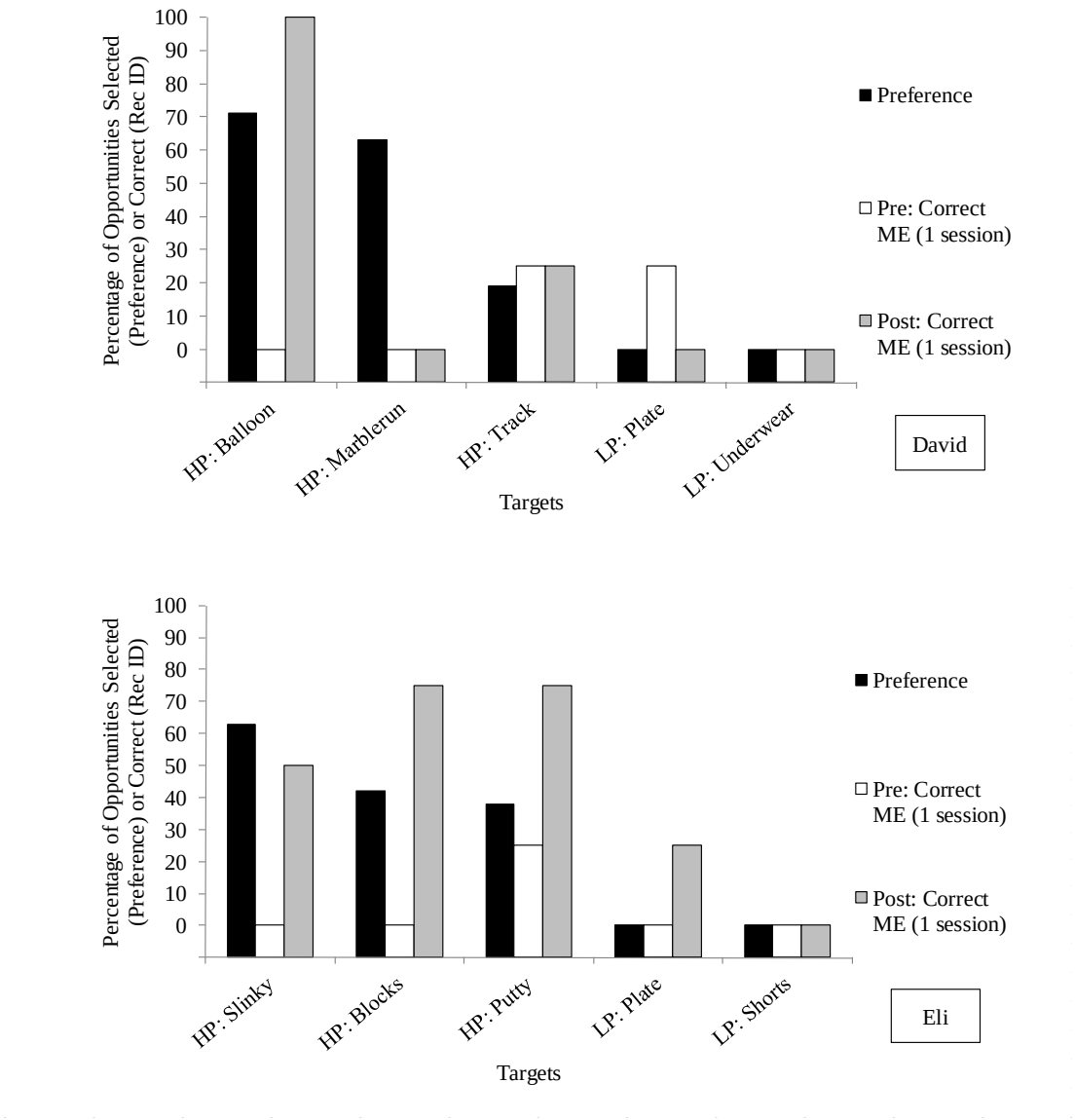

Figure 21. Average percentage of probe trials with correct receptive identification of multiple exemplars (ME) in HP and LP conditions pre- and post-intervention.

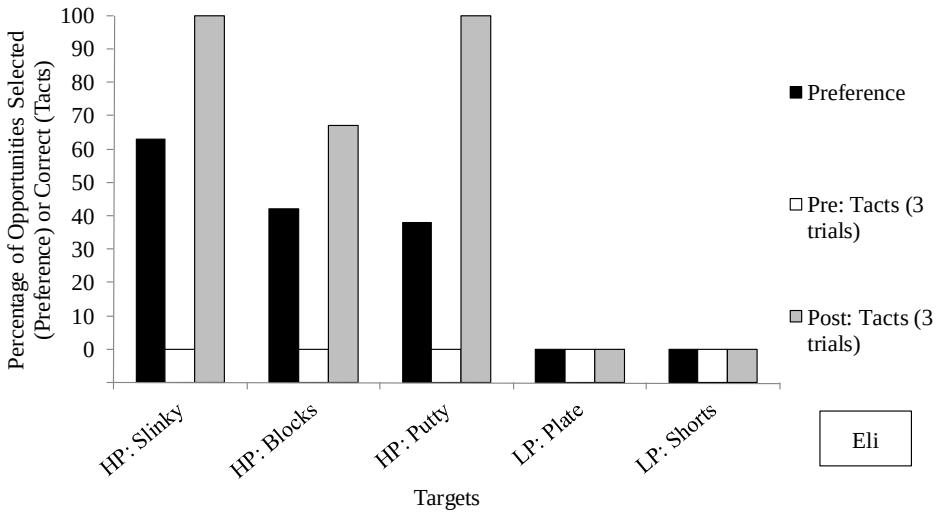

Figure 22. Average percentage of probe trials with correct tacts in HP and LP condition pre- and post-intervention.

APPENDIX C

COUNCIL FOR EXCEPTIONAL CHILDREN STANDARDS RUBRIC

Context and Participants	*Context and Setting* (1.0); *Participants* (2.0); *Intervention Agent* (3.0); *Description of Practice* (4.0)

- 1.1: Describes context/setting features critically relevant to the review (+/-)
- 2.1: Describes relevant demographics of participants (+/-)
- 2.2: Describes participant disability/risk status and reports how determined (+/-)
- 3.1: Describes interventionist role and relevant background variables (+/-)
- 3.2: Describes interventionist qualifications/training required for implementation (+/-)
- 4.1: Describes intervention procedures adequately (+/-)
- 4.2: Describes materials adequately (+/-)

Fidelity and Validity	*Implementation Fidelity* (5.0); *Internal Validity* (6.0)

- 5.1: Treatment adherence using reliable measures (+/-)
- 5.2: Uses direct and reliable measures to reveal dosage (+/-)
- 5.3: Regularity of fidelity assessment (+/-)
- 6.1: Systematic manipulation of the relevant independent variable (+/-)
- 6.2: Condition descriptions (+/-)
- 6.3: Limited or no access to treatment in baseline (+/-)
- 6.4: Group studies must include adequate description of group assignment (+/-)
- 6.5: Single-case studies must include three replications of experimental effect (+/-)
- 6.6: Single-case studies must include a minimum of three data points per phase with a predicatable pattern of undesired performance (+/-)
- 6.7: Single-case studies must use experimental design and control internal validity threats (+/-)
- 6.8: Group studies must have low overall attrition (+/-)
- 6.9: Group studies must have low differential attrition (+/-)

Outcomes and Analysis	*Outcome Measures/Dependent Variables* (7.0); Data Analysis (8.0)

- 7.1: Social importance of the dependent variables (+/-)
- 7.2: Provides details of dependent variables (+/-)
- 7.3: Reports all effects from all measures (+/-)
- 7.4: Frequency of measures (+/-)
- 7.5: Interobserver reliability (+/-)
- 7.6: Group studies must have adequate evidence of internal or social validity (+/-)
- 8.1: Group-based studies use appropriate procedures for data-analysis (+/-)
- 8.2: Single-case studies include clear visual representations of data (+/-)
- 8.3: Group-based studies use appropriate effect sizes (+/-)

APPENDIX D

WHAT WORKS CLEARINGHOUSE DESIGN AND EVIDENCE STANDARDS RUBRIC

Design Standards — *Meets Design Standards* (All 'Yes'); *Meets Design Standards with Reservations* (Per DS#4); *Does Not Meet* (Any 'No')

- DS#1: Independent variable isolated (Yes/No)
- DS#2a: IOA taken 20% (note if within phases; Yes/No)
- DS#2b: IOA $\geq$ 80% or .60 Kappa (Yes/No)
- DS#3: At least three replication attempts (Yes/No)
- DS#4: Minimum points per phase (Yes/Reservation/No)
  - Multiple-baseline and reversals necessitate five for 'Yes' and three for 'Reservation'
  - Alternating treatments necessitate five for 'Yes' and four for 'Reservation'

Visual Analysis — Proceed if *Meets Design Standards or Meets Design Standards with Reservations*

- Within-Phase Baseline/Control Analysis
  - Predictable
  - Level
  - Trend
  - Variability
- Within-Phase Intervention Analysis
  - Predictable
  - Level
  - Trend
  - Variability
- Between-Phase Analysis of Basic Effects (Yes/No)
  - Level change
  - Trend change
  - Variability change
  - Immediacy
  - Overlap
- Functional Relation Analysis
  - Consistency

Evidence Standards — *Strong Evidence* (All '2'); *Moderate Evidence* (Any '1'); *No Evidence* (Any '0')

- Number Effects Replicated: $\geq$ 3 or < 3 (2/0)
- Effects to non-effects ratio: No non-effects, at least 3 to 1, or not 3 to 1 (2/1/0)

APPENDIX E

PRE-SCREENING INTERVIEW

- Is the child able to identify items or pictures of items (such as a picture of a dog in a book) by pointing or handing you an item when you ask them to?
    - If so, what are some examples of items the child can identify and about how many items is the child able to identify?

- When you ask the child to "give me the…", "point to the…", or "find the…"—do they try or attempt to respond? If so, what does that look like? For instance, are they able to hand something to you if you say "give me the..." while holding your hand out? Alternatively, are they able to point or touch something if you direct them to "point to the…" or "touch the…"?

- Does the child have matching abilities? For instance, if you give them a picture, are they able to match that picture to an identical picture from a variety of other pictures?

Identify 5 to 10 of the most reinforcing items for the child (e.g., specific toys, outdoor activities, potential restricted interests).	Identify 5 to 10 things the child frequently encounters in their activities of daily living (e.g., bowl, shoes, cup, towel, toothbrush).
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

APPENDIX F

RECEPTIVE IDENTIFICATION ARRAY EXAMPLES

Note. Eli's original HP and LP targets (squared) and distractors.

APPENDIX G

IMPLEMENTATION FIDELITY CHECKLISTS FOR RECEPTIVE IDENTIFICATION STUDY

Multiple Stimulus Without Replacement Preference Assessment Implementation Fidelity

Participant: _____ Session #: _____

Data Collector: _____

Date: _____

Secondary Data Collector: _____

Criteria:	+ = yes — = no
Implementer allows participant to interact with each item prior to initiating the assessment	
Implementer randomly sequences items in a line about 5 inches apart	
Implementer instructs participant to "pick one"	
Implementer allows participant 30 seconds of access following choice	
In between choices, implementer rotates the remaining items by taking the item on the left end and moving it to the right end, then shifting the other items so that they are again equally spaced	
Implementer removes any items chosen from the item line up	
Following approximately 30 seconds of the participant not choosing, the implementer marks the remaining items as "no choice" and ends the assessment	
Implementer blocks any attempts to take more than one item	
All other appropriate or inappropriate behaviors besides choosing behaviors are ignored	
Total Correct:	
Percentage Correct:	

Baseline Implementation Fidelity

Participant: _____ Session #: _____

Data Collector: _____

Date: _____

Secondary Data Collector: _____

Criteria	+ = yes — = no
Implementer arranges pictures so that each target is presented in all the possible areas (of an array of 4 pictures)	
High-preferred targets are presented with high-preferred pictures, low-preferred targets are presented with low-preferred pictures	
Implementer ensures participant is seated and facing forward with calm hands near edge of table and is not engaging in challenging behavior prior to receptive identification instructions	
Implementer says, "Give me (item)." with an open hand when presenting receptive identification instructions	
After each receptive identification instruction, the implementer waits 7 seconds for a response	
Implementer does not correct errors to receptive identification response attempts	
Implementer does not reinforce receptive identification responses, whether correct or incorrect (proceeds to next trial)	
High-probability instruction unrelated to receptive identification targets are presented intermittently, followed by reinforcement	
Total Correct:	
Percentage Correct:	

Intervention Implementation Fidelity (Least-to-Most Prompting Phase)

Participant: _____ Session #: _____

Data Collector: _____

Date: _____

Secondary Data Collector: _____

Criteria	+ = yes — = no
Implementer arranges pictures so that each target is presented in all the possible areas (of an array of 4 pictures)	
High-preferred targets are presented with high-preferred pictures, low-preferred targets are presented with low-preferred pictures	
Implementer ensures participant is seated and facing forward with calm hands near edge of table and is not engaging in challenging behavior prior to receptive identification instructions	
Implementer says, "Give me (item)." with an open hand when presenting receptive identification instructions	
After each receptive identification instruction, the implementer waits 7 seconds for a response	
Instructor follows least-to-most hierarchy of prompting for incorrect receptive identification responses (first picture prompt, then physical prompt)	
Correct receptive identification responses are met with generalized reinforcement and praise, picture-prompted responses are met with praise only, and reinforcement is withheld for full-physical prompts	
High-probability instruction unrelated to receptive identification targets are presented intermittently, followed by reinforcement	
Total Correct:	
Percentage Correct:	

Intervention Implementation Integrity (Most-to-Least Prompting Phase)

Participant: _____ Session #: _____

Data Collector: _____

Date: _____

Secondary Data Collector: _____

Prompt level (circle one): 1 2 3

Criteria	+ = yes — = no
Implementer arranges pictures so that each target is presented in all the possible areas (of an array of 4 pictures)	
High-preferred targets are presented with high-preferred pictures, low-preferred targets are presented with low-preferred pictures	
Implementer ensures participant is seated and facing forward with calm hands near edge of table and is not engaging in challenging behavior prior to receptive identification instructions	
Implementer says, "Give me (item)." with an open hand when presenting receptive identification instructions	
Immediately before each receptive identification instruction, the implementer provides a prompt at the target level (1 = picture with label: "These are/This is a [item].", proximity to match, and gesture/point to match; 2 = picture with label and proximity to match; 3 = picture with label only)	
Instructor provides the next most intrusive prompt as necessary after 7 seconds with no or an incorrect receptive identification response attempt	
Correct receptive identification responses at the target prompt level are met with generalized reinforcement and praise, more intrusive picture-prompted responses are met with praise only, and reinforcement is withheld for full-physical prompts	
High-probability instruction unrelated to receptive identification targets are presented intermittently, followed by reinforcement	
Total Correct:	
Percentage Correct:	

Intervention Implementation Integrity (Linguistic Mapping Phase)

Participant: _____ Session #: _____

Data Collector: _____

Date: _____

Secondary Data Collector: _____

Criteria	+ = yes — = no
Prior to session, implementer ensures participant engagement (i.e., eye gaze in direction of picture), names the picture, and hands the participant the corresponding object (5 times per target)	
Implementer allows approximately 15 seconds with an item per mapping trial, and if the item is rejected or 3 seconds passes without item contact, the implementer removes the item and proceeds to the next trial	
Implementer arranges pictures so that each target is presented in all the possible areas (of an array of 4 pictures)	
High-preferred targets are presented with high-preferred pictures, low-preferred targets are presented with low-preferred pictures	
Implementer ensures participant is seated and facing forward with calm hands near edge of table and is not engaging in challenging behavior prior to receptive identification instructions	
Implementer says, "Give me (item)." with an open hand when presenting receptive identification instructions	
After each receptive identification instruction, the implementer waits 7 seconds for a response	
Instructor follows least-to-most hierarchy of prompting for incorrect receptive identification responses (first picture prompt, then physical prompt)	
Correct receptive identification responses are met with generalized reinforcement and praise, prompted responses are met with praise only, and reinforcement is withheld for full-physical prompts	
High-probability instruction unrelated to receptive identification targets are presented intermittently, followed by reinforcement	
Total Correct:	
Percentage Correct:	

Multiple Exemplar Generalization Implementation Fidelity

Participant: _____ Session #: _____

Data Collector: _____

Date: _____

Secondary Data Collector: _____

Criteria	+ = yes — = no
Implementer arranges pictures so that each target is presented in all the possible areas (of an array of 4 pictures)	
High-preferred targets are presented with high-preferred pictures, low-preferred targets are presented with low-preferred pictures	
Implementer ensures participant is seated and facing forward with calm hands near edge of table and is not engaging in challenging behavior prior to receptive identification instructions	
Implementer says, "Give me (item)." with an open hand when presenting receptive identification instructions	
After each receptive identification instruction, the implementer waits 7 seconds for a response	
Implementer does not correct errors to receptive identification response attempts	
Correct receptive identification responses are met with generalized reinforcement and praise, and reinforcement is withheld for incorrect responses	
High-probability instruction unrelated to receptive identification targets are presented intermittently, followed by reinforcement	
Total Correct:	
Percentage Correct:	

Tact Generalization Implementation Fidelity

Participant: _____ Session #: _____

Data Collector: _____

Date: _____

Secondary Data Collector: _____

Criteria	+ = yes — = no
Implementer ensures participant is seated and facing forward with calm hands near edge of table and is not engaging in challenging behavior prior to instructions	
Implementer holds a single target picture up in front of the participant and says, "These are/This is a…" to present tact instructions	
After each tact instruction, the implementer waits 7 seconds for a response	
Implementer does not correct errors to tact response attempts	
Correct tact responses are met with generalized reinforcement and praise, and reinforcement is withheld for incorrect responses	
High-probability instruction unrelated to tact probes are presented intermittently, followed by reinforcement	
Total Correct:	
Percentage Correct:	