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ORIGINALPAPER

Interventions for Repetitive Behavior in Young Children with Autism: A Survey of Behavioral Practices

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Abstract

Children with autism spectrum disorder (ASD) display social-communication deficits and present with rigid and repetitive patterns of behavior and/or interests (RRBIs). Compared to interventions for social-communication skills, less attention has been given to RRBIs, especially with regard to interventions for young children. We surveyed 128 behavior analysts who implemented interventions for young children with ASD on their use of 16 practices and one assessment for the treatment of RRBIs. The majority of our sample perceived the practices to be effective in producing sustainable behavior change. Behavior analysts generally responded in the same way to items about reinforcement-based practices, punishment-based practices, and a group of commonly packaged antecedent and consequence-based package components. Implications and future directions are discussed.

Keywords Autism spectrum disorder · Repetitive behavior · Restricted interests · Stereotypy · Young children · Behavioral treatment

Core features of autism spectrum disorder (ASD) include deficits in social-communication skills and the presence of clinically significant rigid and repetitive behavioral patterns (American Psychiatric Association 2013). Repetitive behaviors are maladaptive patterns of behavior such as stereotypy, insistence on sameness, and restricted interests. For instance, a child with ASD may attend only to certain parts of toys (e.g., car wheels, doll eyes) or insist that toys be manipulated in a very specific order or manner (Cunningham and Schreibman 2008). Compared to the literature for social-communication skills, the research base focused on repetitive behavior in children with ASD is less well-established, not only in terms of available evidence-based interventions, but also in the field's understanding of the etiology and developmental trajectories (Boyd et al. 2011).

Typically-developing infants and toddlers engage in a variety of repetitive behavior including stereotyped motor movements, rigidity or adherence to routine, perseverative interests, and unusual sensory interests (Evans et al. 1997; Leekam et al. 2007). These behaviors are hypothesized to be adaptive (e.g., self-soothing) during early developmental periods (Cunningham and Schreibman 2008; Evans et al. 1997; Harrop et al. 2014). By the end of toddlerhood, typically-developing young children usually no longer exhibit these topographies of repetitive behavior (Barber et al. 2012). Young children with global developmental delays also display repetitive behavioral patterns, yet some researchers have found that children with ASD display higher rates and different types of repetitive behavior than those with global developmental delays (Goldman et al. 2009; Harrop et al. 2014; Honey et al. 2007; Richler et al. 2010; Wolff et al. 2014).

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Topographies of Repetitive Behavior in ASD

Rigid and repetitive patterns of behavior and/or interests (RRBIs) in ASD encompass four different topographical categories: (a) stereotypy; (b) insistence on sameness, inflexible adherence to routines, or ritualized patterns of verbal or nonverbal behavior; (c) perseverative interests; and (d) hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment (American Psychiatric Association 2013). Stereotypy includes repetitive motor movements (e.g., rocking, toe walking), object use (e.g., lining up of toys, flipping pages of a book), as well as repetitive vocal responses (e.g., echolalia, scripting, idiosyncratic phrases). Insistence on sameness includes frequent instances in which a child experiences difficulty with changes in routines and may be exceptionally difficult to redirect or comfort during these changes. Further, the child may engage in ritualized behavior chains, experience difficulty with transitions, need to take the exact same route, or eat the same food every day. The third category, perseverative interests, involves preoccupation with unusual objects or circumscribed interests in topics, and in particular, those that are not age appropriate. Finally, hyper- and hyporeactivity involves unusual reactions to sensory stimuli such as over sensitivities or adverse reactions to smells, tastes, and textures, or a fascination with light, reflections, or movement. Conversely, a child may display under reactivity to sensory experiences such as an unusually high pain tolerance or no apparent sense of temperature.

Impact of RRBIs

Aberrant RRBIs in ASD present early in a child's development and impede social, occupational, or other critical areas of functioning (American Psychiatric Association 2013). Chronic RRBIs are often associated with co-occurring challenging behavior (e.g., self-injury, aggression) and other conditions including anxiety and mood disorders, which can impede a child's social learning opportunities and negatively affect family quality of life (Machalicek et al. 2016). For example, a child with ASD may become physically aggressive if a ritual is interrupted (Rispoli et al. 2014). In fact, parents have rated repetitive behavior as one of the most difficult aspects of ASD (South et al. 2005).

RRBIs can also hinder children's learning opportunities (Koegel and Covert 1972; Varni et al. 1979; Pierce and Courchesne 2001) or compromise socialization with peers (Loftin et al. 2008; Nadig et al. 2010). While some repetitive behaviors are common in toddlerhood (e.g., insistence on sameness during routines), failure to develop behavioral flexibility during early childhood can interfere with learning opportunities and result in aberrant levels or increased severity of challenging behavior (Dominick et al. 2007). As such, repetitive behaviors are often targeted for reduction, especially in behavior analytic treatment for young children with ASD (Raulston and Machalicek 2018).

Interventions for RRBIs in ASD

There is a small, but growing, literature base focused on the treatment of RRBIs in ASD (Boyd et al. 2012; Lanovaz and Sladeczek 2012; Patterson et al. 2010; Rapp and Vollmer 2005). Focused interventions (i.e., practices targeting one or a few behaviors as opposed to comprehensive treatments) include antecedent-based strategies, such as environmental enrichment and exercise, as well as consequence-based strategies, such as various types of differential reinforcement and punishment procedures (e.g., response interruption and redirection). Little is known regarding which interventions practitioners commonly implement in practice to treat RRBIs. As most intervention studies for RRBIs in children with ASD have been single-case studies and short in duration (Raulston and Machalicek 2018), the durability and sustainability of these focused interventions is also unknown.

The Current Study

We utilized an implementation science conceptual framework to design the current study. Implementation science is the study of factors that influence the adoption and integration of evidence-based interventions into practice (The National Implementation Research Network 2015). In order to understand more about more about current status of implementation of evidence-based practices for young children with ASD, an initial step is to survey practitioners. As such, we gathered data on what practices are currently being implemented to address RRBIs in infants and young children, defined as birth to 8 years old. Because in most states children with medical ASD diagnoses receive applied behavior analytic therapy (National Conference of State Legislatures 2018), we chose to survey Board Certified Behavior Analysts (BCBAs) who indicated that they supervised and/or implemented interventions for children with ASD. Specifically, we were interested in answering the following research questions: (1) What evidence-based and emergent practices are BCBAs implementing to treat repetitive behavior in infants and young children with ASD; (2) What are the most and least frequently used behavioral

practices implemented by BCBAs to treat repetitive behavior in infants and young children with ASD; (3) How effective do BCBAs perceive the available behavioral practices to produce durable, sustainable behavior change (4) Are there significant relations between behavioral practice use and perceived effectiveness; and (5) Is there a greater likelihood of practice use or perceived effectiveness depending on demographic factors including: educational background (e.g., psychology, special education), training and supervision (e.g., home, center, hospital), and geographical location (rural versus urban)?

Method

Item Creation

The first author conducted a selective literature review using ERIC and PsycNET online library databases, pairing various key terms related to repetitive behavior (e.g., stereotyp*, rigid*) with auti* (see Raulston and Machalicek 2018). Studies that included young children with ASD were included in this selective review. From the results of this selective review, 16 focused interventions and 1 assessment (functional analysis) were identified as evidence-based or emerging practices to reduce RRBIs in young children with ASD. Specifically, the following practices were identified: antecedent-based embedded perseverative interest, consequence-based embedded perseverative interest, differential reinforcement of incompatible behavior (DRI), differential reinforcement of other or zero rates of behavior (DRO), differential reinforcement of variable behavior (DRV), environmental enrichment, functional communication training (FCT), non-contingent or time based schedules of reinforcement (NCR), overcorrection, physical exercise, response blocking, response cost, response interruption and redirection (RIRD), sensory extinction, skill enrichment, and visual and/or verbal cues. Additionally, because sensory integration therapy (SIT) is a commonly used treatment, albeit not evidence-based, and sensory differences were added as a subcategory or RRBIs in the Diagnostic Statistical Manual of Mental Disorders—Fifth Edition, we also included an item related to SIT in the current survey.

Expert Review of Items

The first author developed brief definitions of each aforementioned practice. The third and fourth authors, who held PhDs and BCBA-Ds (doctoral designation) and each had more than 15 years of experience in clinical practice and intervention research for young children with ASD, independently reviewed the practices and definitions. Next, the first and second authors solicited feedback from members at the Oregon Association for Behavior Analysis (ORABA) quarterly meeting by providing a paper copy of the practices and definitions and receiving written feedback (e.g., confusing language) from the meeting attendees, who were mostly BCBAs working in the field with children with ASD. The definitions were revised based on feedback. Table 1 displays the final brief definitions for each of the 18 practices.

Frequency of Use and Perceived Effectiveness

For each practice, we asked respondents to rate the frequency with which they used the practice as well as their perception of its effectiveness. In the instance where the respondent rated never using the practice, we still asked about the perceived effectiveness.

For each practice, respondents were asked to indicate on a four-point Likert scale (never = less than approximately 10% of cases, rarely = approximately 10–25% of cases, sometimes = approximately 25–50% of cases, or often = more than approximately 50% of cases) the frequency with which they implemented or supervised interventions for RRBIs with infants, toddlers, and young children with ASD (birth to age eight) for each practice. Next, respondents were asked to rate how effective they perceived each of the listed interventions to produce durable, sustainable behavior change on a four-point Likert scale (1 = highly ineffective, 2 = ineffective, 3 = effective, 4 = highly effective).

Procedure

Distribution

Following development and conformation of face validity through expert review, revised questionnaires were distributed to behavior analysts of all levels, who included BCBA-Ds (i.e., doctoral designation), BCBAs at the master's level, and BCaBAs at the assistant level. An email invitation was distributed by the Behavior Analyst Certification Board (BACB) to certificants who indicated that they worked within the following emphasis areas: autism, behavior analysis, behavior therapy, children, counseling, developmental disabilities, education, health, infants, mental health, positive behavior support, psychology or social work.

An accurate response rate was not possible to calculate because the exact number of people who received the email invitation is unknown. A Qualtrics® link to the anonymous online survey was embedded within the email invitation. Qualtrics® is a survey hosting website available to faculty that allows for de-identified responses. Qualtrics® indicated that the survey should have taken approximately 10 min to complete. The survey link was active for 2 weeks in January of 2017. A reminder email was sent via Qualtrics® 1 week after the initial email.

Table 1 Brief practice definitions

Practice	Description
Assessment	
Functional analysis	A functional analysis is an experimental analysis that involves manipulating the antecedents and/or consequences to identify the function of a behavior
Antecedent-based practices	
Antecedent-based embedded PI	Antecedent-based embedded perseverative interest interventions involve embedding a perseverative interest into a task or activity to increase the child's motivation to engage in a desirable behavior
Environmental enrichment	Environmental enrichment involves providing non-contingent access to appropriate, competing sources of reinforcement, such as preferred objects
FCT	Functional communication training (FCT) involves teaching an alternative communication behavior to obtain the same reinforcer as the repetitive behavior
NCR	Non-contingent reinforcement or time-based schedules of reinforcement involve providing access to a sensory stimulus (e.g., music) at set intervals to reduce the need for the repetitive behavior
Physical exercise	Physical exercise involves having the child engage in an exercise routine prior to an activity that has been associated with high rates of repetitive behavior
Skill enrichment	Skill enrichment involves teaching the child more adaptive skills to replace the need to engage in repetitive behavior
Visual and/or verbal cues	Visual and/or verbal cues involve providing a warning about a change in activity or allowing the child to engage in a calming or highly preferred activity before a less preferred one
Consequence-based practices	
Consequence-based embedded PI	Consequence-based embedded perseverative interest interventions involve delivering a perseverative interest or perseverative interest-based item (e.g., token) contingent on a desired behavior
DRI	Differential reinforcement of incompatible behavior (DRI) involves reinforcing a behavior that the child is not able to engage in at the same time as the repetitive behavior
DRO	Differential reinforcement of other or zero rates of behavior (DRO) involves reinforcing zero rates at set intervals of a repetitive behavior
DRV	Differential reinforcement of variability (DRV) involves reinforcing the child varying his/her behavior with the reinforcement linked to novel behavior
Overcorrection	Overcorrection involves requiring the child to repeatedly practice an alternative behavior to reduce the repetitive behavior
Response blocking	Response blocking involves physically blocking a child from engaging in a repetitive behavior
Response cost	Response cost involves the removal of a desired stimulus contingent upon repetitive behavior
RIRD	Response interruption and redirection (RIRD) involves physically or verbally interrupting a repetitive behavior and redirecting the child to engage in a different behavior
Sensory extinction	Sensory extinction involves disrupting the contingency between the stereotyped response and the sensory effects it produces (e.g., gloves to block repetitive skin touching)
Non-evidence-based practice	
Sensory integration therapy	Sensory integration therapy (SIT) involves the use of play and sensory-enhanced interactions to enhance a child's sensory processing and motor planning skills that activate the vestibular and somatosensory systems.

This table displays the brief definitions provided to respondents for each practice

Participants were asked to provide an email address if they wished to be entered into a lottery for a $20 Amazon gift card. Emails were only retained if the participant elected to submit their email for a chance to win a gift card. At the end of the 2-week period, 50 emails (from completed surveys) were randomly chosen using a random number generator. Amazon gift cards in the amount of $20 were sent to these 50 email addresses.

Survey Design

The Qualtrics® welcome page included a brief description of the study and contact information of the first, third, and fourth authors. Participants were asked: "Do you work with infants, toddlers, or children with autism spectrum disorder ages birth to eight?" If "yes" was selected, the participant provided informed consent within Qualtrics®. Participants

who answered "no" to this question were sent directly to a thank you page that exited them from the survey. The next page of the survey described the definition of RRBIs as outlined in the DSM-V (American Psychiatric Association 2013) (i.e., descriptions for stereotypy, insistence on sameness, perseverative interests, and sensory differences were provided). The purpose of this was to orient the behavior analyst to the topographical behavioral profile of interest in the current survey.

The next section of the survey displayed one practice per page with the brief definition at the top. The respondent was asked to indicate how often they implemented or supervised the implementation of the practice to treat an RRBI using a Likert scale for frequency of use (allowed to select one). Next, the respondent was asked to rate the perceived effectiveness (allowed to select one) of the practice to produce desirable, sustainable change in behavior. The Likert scales were presented vertically with the aforementioned anchors listed next to the descriptor. Each practice was presented on a separate page and followed the same predictable format. One exception to this was for the one assessment (functional analysis), wherein the respondent was asked to select the most common behavioral function revealed from the functional analysis in cases where the RRBI was considered a challenging behavior. Finally, the demographics questions were presented at the end of the survey.

Participants

A total of 128 behavior analysts completed surveys. Descriptive statistics were calculated for demographic questions to yield frequency, mean, and range for (a) education (b) gender (c) race/ethnicity, and (d) training and practice environments (i.e., clinic, school, hospital). Our sample was comprised of mostly Caucasian (81.25%) female (85.94%) respondents. The majority of respondents were certified at the BCBA level (82.81%) working in schools (63.28%), homes (58.59%), or clinic/center based (36.72%) settings. Respondents were most likely to have an undergraduate degree in psychology (57%), although some reported undergraduate degrees in education (12.5%), special education (8%), and unrelated undergraduate degrees (25%). Eighty-four percent of respondents had a master's level degree in a related field. Of those respondents, master's degrees were in psychology (29%), special education (23%), education (14%), ABA (10%) and school psychology (8.5%). Table 2 displays demographic information.

Table 2 Participant demographic characteristics

	$N = 128$ (%)
Participant sex	
Female	85.94
Male	12.50
Participant race	
White/Caucasian	81.25
Asian	4.69
American Indian or Alaska Native	3.91
Multiracial	3.13
Black or African American	1.56
Participant ethnicity	
Non-Latino/a or Hispanic	86.72
Latino/a or Hispanic	4.69
BCBA level	
Board Certified Behavior Analyst (BCBA)	82.81
Board Certified Behavior Analyst-Doctoral (BCBA-D)	12.50
Board Certified Assistant Behavior Analyst (BCaBA)	2.34
Undergraduate Degree	75.00
Psychology	57.00
Education	12.50
Special education	8.00
Master's Degree	84.00
Psychology	29.00
Special education	23.00
Education	14.00
Applied behavior analysis	10.00
School psychology	8.50
PhD	13.00
Psychology	5.00
Special education	5.00
Education	3.00
Setting	
Urban (density of at least 1,000 per square mile)	71.09
Rural (all population, housing, and territory not included within an urban area)	42.19
Practice setting	
School	63.28
Home-based	58.59
Clinic or center-based	36.72
Other	1.56
Hospital	0.78

Data Analysis

Resulting data were transferred to Statistical Package for Social Sciences (SPSS, 24th Edition) and cleaned by two trained research assistants. Eighteen test and incomplete survey responses were eliminated, and data were reorganized for analysis. Data evaluation and analysis was completed by the first and second authors.

Frequency of Use

Similar descriptive statistics were collected for participants' reported use of practices. Frequencies were calculated for

each rating per practice. Additionally, responses *never used* and *rarely used* as well as *sometimes used* and *often used* were grouped respectively, and frequencies were recalculated to obtain a percentage of respondents who used the practice. Percentages were calculated by dividing the number of respondents who reported using the practice by the number of total respondents and multiplying by 100.

Perceived Effectiveness Ratings

Regardless of whether the respondent reported using the practice, the respondent rated the effectiveness of each practice using a Likert scale. Frequency counts for each effectiveness rating per practice were calculated, and percentages were calculated by dividing the number of respondents who rated the practice for each effectiveness rating by the number of total respondents and multiplying by 100.

Relations Between Use and Effectiveness

In order to evaluate whether there were significant relations between frequency of use and effectiveness ratings, we recoded both variables into bivariate variables. To do this "have not used" and "rarely used" were collapsed, "sometimes used" and "often used" were collapsed, "highly ineffective" and "ineffective" were collapsed, and "effective" and "highly effective" were collapsed. Chi-squared tests were then run on these values for each practice using the cross-tabs function in SPSS.

Principal Component Analysis

Basic Pearson's *r* correlations were calculated between frequency of use and effectiveness ratings. In order to assess the core features of the questionnaire, a principal component analysis (PCA) was conducted on the results. Results of the PCA yielded a three-factor model, indicating similar responding patterns for items about reinforcement-based strategies, punishment-based strategies, and common components of packaged interventions.

Odds Ratio Calculations

Odds ratios, or the increase or decrease in likelihood of occurrence B given occurrence A, were calculated using data from contingency tables of demographic variables (i.e., education, training, practice site) and frequency of use ratings across the three types of practices: antecedent-based, reinforcement-based, and punishment-based.

Results

Descriptive Results

Frequency of Use

Forty-two respondents (33%) reported conducting functional analyses *sometimes* (approximately 25–50% of cases) or *often* (more than approximately 50% of cases). Of those 42 respondents, the most common behavioral function revealed was automatic (55%); followed by social positive (i.e., attention or tangible, 24%); and social negative (i.e., escape, 22%). Respondents reported using all 16 evidence-based practices. More than half of our sample reported *sometimes* or *often* using the following practices: skill enrichment (81.4%), visual and/or verbal cues (75.2%), FCT (75.2%), environmental enrichment (68.3%), RIRD (65.9%), DRI (62.8%), consequence-based embedded perseverative interests (57.4%), and response blocking (56.2%). More than half of our sample reported *often* using the following three practices: FCT (62.8%), skill enrichment (60.5%), and visual and/or verbal cues (52.7%). Less than half of our sample reported *sometimes* or *often* using the following eight practices: NCR (48.9%), antecedent-based PI (43.4%), DRO (43.4%), physical exercise (21.8%), response cost (13.2%), overcorrection (9.4%), sensory extinction (9.4%), and DRV (7.0%). Figure 1 displays a visual representation of the most commonly used (i.e., respondents reported using *sometimes* or *often*) practices.

Some portion of our sample reported *never* or *rarely* using the 16 evidence-based practices. More than half of our sample reported *never* or *rarely* using the following eight practices: DRV (92.2%), sensory extinction (90.7%), overcorrection (89.9%), response cost (86.0%), physical exercise (77.5%), antecedent-based perseverative interests (55.8%), DRO (55.8%), and NCR (50.4%). More than half of our sample reported *never* using the following four strategies: DRV (73.6%), sensory extinction (57.4%), response cost (51.9%), and physical exercise (50.4%). Less than half of our sample reported *rarely* or *never* using the following eight strategies: response blocking (48.9%), consequence-based perseverative interests (41%), DRI (36.4%), RIRD (33.3%), environmental enrichment (29.4%), FCT (24.0%), visual and/or verbal cues (24.0%), and skill enrichment (17.8%).

Perceived Effectiveness Ratings

More than half of our sample rated the following 15 practices as *effective* or *highly effective*: FCT (89.9%), skill

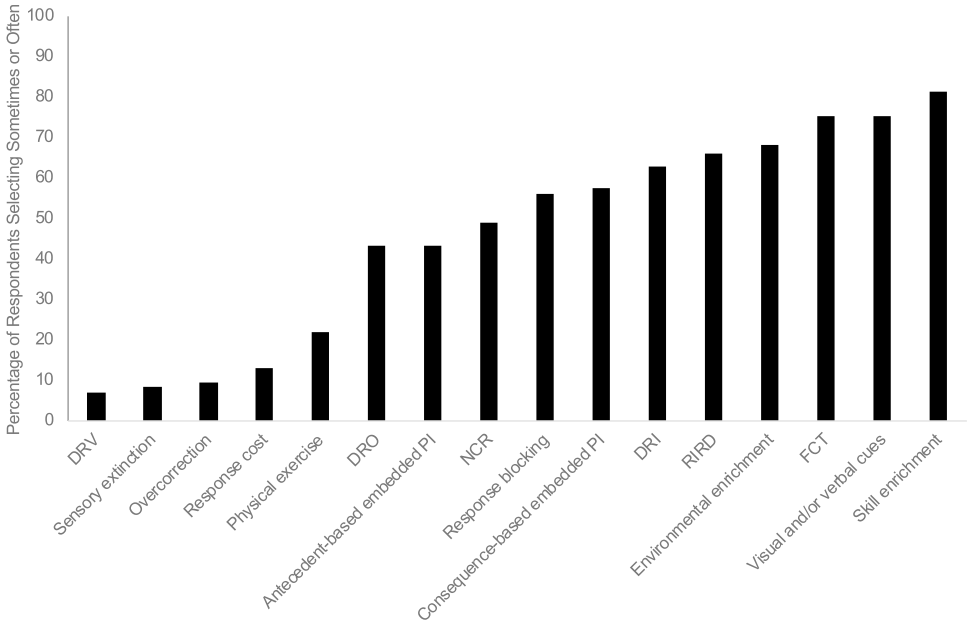

Fig. 1 Percentage of respondents who reported *sometimes* or *often* using each evidence-based or emergent practice

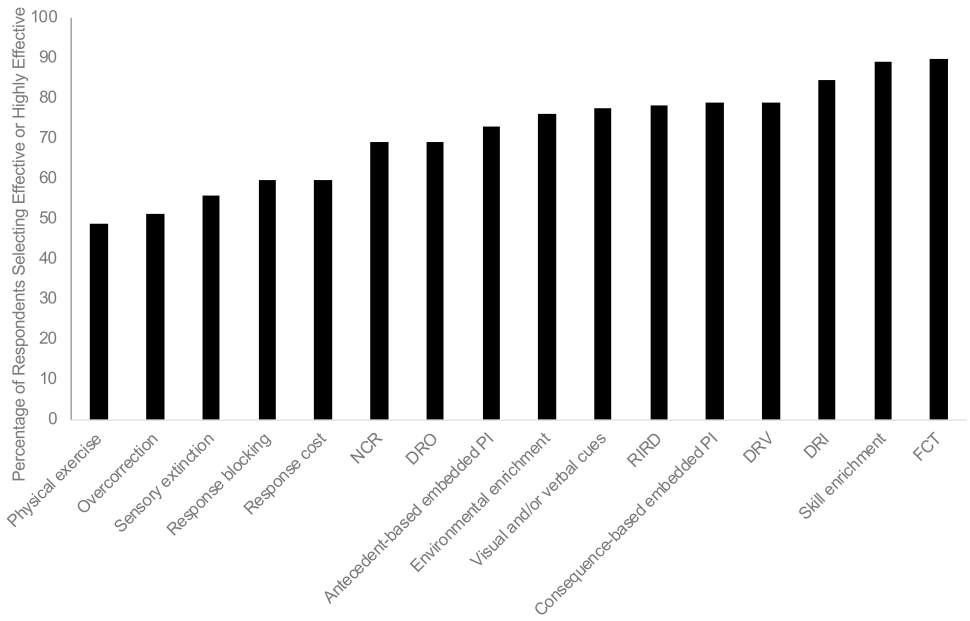

Fig. 2 Percentage of respondents who rated each evidence-based or emergent practice as *effective* or *highly effective*

enrichment (89.2%), DRI (84.5%), consequence-based embedded perseverative interests (84.5%), DRV (79.0%), RIRD (79.0%), RIRD (78.3%), visual and/or verbal cues (77.5%), environmental enrichment (76.0%), antecedent-based embedded perseverative interests (72.0%), NCR (69.0%), DRO (69.0%), response cost (59.7%) response blocking (59.7%), sensory extinction (55.8%), and overcorrection (51.2%). Less than half of our sample rated physical exercise (48.8%) as *effective* or *highly effective*. No practice was rated as *highly effective* by more than half of the sample, although FCT (49.6%) came close. More than a quarter of our sample rated RIRD (26.4%) as *highly effective*. The remaining 14 practices were rated as *highly effective* by less than a quarter of our sample. Figure 2 displays a visual representation of the practices most commonly rated as *effective* or *highly effective*.

More than half of our sample rated the following three practices as *ineffective* or *highly ineffective*: physical exercise (50.4%), overcorrection (48.1%), and sensory extinction (43.5%). More than a quarter of our sample rated the following five practices as *ineffective* or *highly ineffective*: response blocking (39.6%), response cost (39.5%), NCR (30.2%), DRO (30.2%), and antecedent-based embedded perseverative interests (26.4%). Less than a quarter of our

sample rated the following eight practices as *ineffective* or *highly ineffective*: visual and/or verbal cues (21.7%), RIRD (21.0%), consequence-based embedded perseverative interests (20.1%), DRV (20.1%), environmental enrichment (19.4%), DRI (14.8%), skill enrichment (10.1%), and FCT (9.3%). The practices rated as *highly ineffective* most frequently were: response cost (15.5%), overcorrection (14.0%), physical exercise (12.4%), consequence-based embedded perseverative interests (11.6%), DRV (11.6%), and sensory extinction (10.9%).

Frequency of Use and Perceived Effectiveness Rating for SIT

In addition to the 16 evidence-based strategies, we also asked respondents about their frequency of use and perceived effectiveness of SIT, as it is commonly used in intervention for young children with ASD (Mandell et al. 2005). The majority of our sample reported *never* using SIT (64%). Fourteen percent of our sample reported *rarely* using SIT, 12% reported *sometimes* using SIT, and 9% reported *often* using SIT. We asked respondents to rate their perceived effectiveness of SIT regardless of whether or not they reported implementing it or not. Twelve percent of respondents reported SIT as *highly effective*, 21% as *effective*, 41% as *ineffective*, and 28% as *highly ineffective*.

Relations Between Use and Effectiveness

Results of the Chi-squared tests indicated significant relations between respondents' frequency of use and effectiveness ratings for all practices. That is, respondents were more likely to report using a practice if they reported rating it as effective and more likely to rate it as effective if they also reported using it.

Primary Component Analysis

In order to gather initial information about the content validity of the survey tool, we conducted a Primary Component Analysis (PCA) on the respondent data for strategy effectiveness. Results of the PCA indicated three initial survey components: (a) reinforcement-based practices (e.g., consequence-based embedded perseverative interests); (b) punishment-based practices (e.g., RIRD); (c) and commonly packaged components likely used in tandem with a group of practices (e.g., visual verbal cues plus NCR; skill enrichment plus FCT). The results of the PCA indicated that respondents answered similarly on these groups of practices. All except seldomly-used practices (i.e., exercise and SIT) loaded strongly on one factor, indicating the likely three factor model.

Odds Ratios

We calculated odds ratios on practice use and demographic factors to better understand the predictors of frequency use of certain practices. SIT was not included in the odds ratio analyses because it is not an evidence-based practice, and functional analysis was not included as it is an assessment and does not fall into antecedent, reinforcement, or punishment categories. An odds-ratio demonstrates the rate at which likelihood is increased, where an odds-ratio result of 1.0 indicates the group is two times as likely to use the strategy, an odds ratio of 2.0 indicates the group is 4 times more likely, and so forth. Results indicated that antecedent strategies were used more often than other groups of strategies in clinical settings, and in both urban and rural settings. Reinforcement-based strategies were more than three times as likely to be used than other categories of strategies by behavior analysts working in urban settings. Finally, punishment-based procedures were more likely to be used more

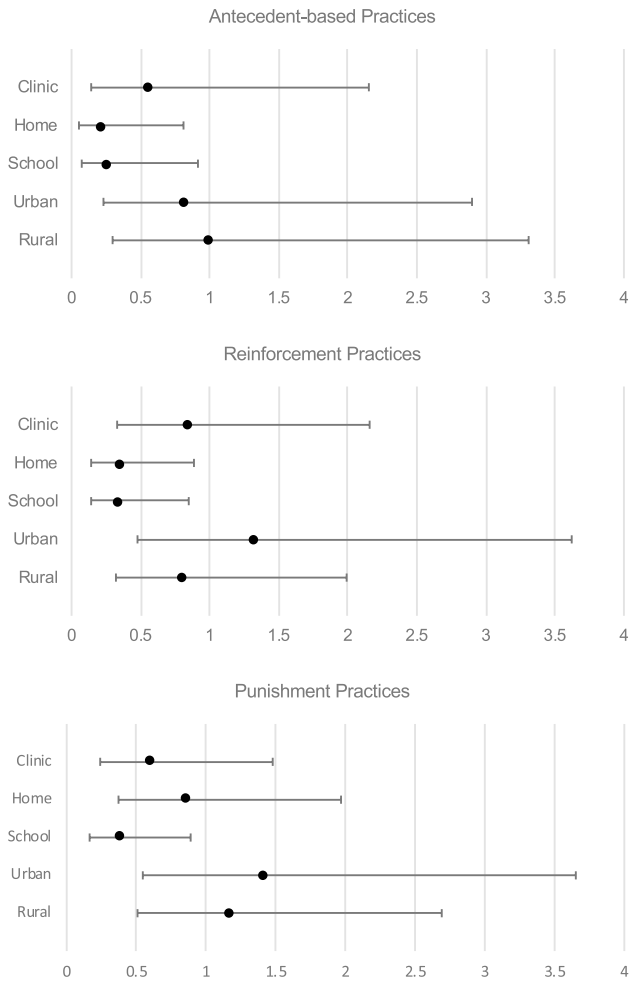

Fig. 3 Odds ratios for antecedent-based, reinforcement, and punishment practices

than other groups of practices in home and urban settings. Overall, all three groups of practices were more likely to be used in urban settings compared to rural settings (Fig. 3).

Discussion

We surveyed 128 behavior analysts implementing or supervising interventions with young children with ASD on their use of treatments for RRBIs. Overall, our findings support the hypothesis that behavior analysts are implementing a variety of evidence-based and emergent strategies with the most frequently utilized practices being skill enrichment, visual and/or verbal cues, FCT, environmental enrichment, RIRD, DRI, consequence-based embedded perseverative interests, and response blocking. The least utilized practices were DRV, sensory extinction, overcorrection, response cost, physical exercise, antecedent-based perseverative interests, DRO, and NCR. Fifteen of the 16 evidence-based and emergent practices were reported to be perceived as effective or highly effective by more than half of our sample. Physical exercise was the only evidence-based strategy reported to be perceived as effective or highly effective by less than half (48.8%), albeit barely, of our sample. Thus, the majority of the behavior analysts we surveyed perceived the evidence-based practices to be effective in producing sustainable behavior change for RRBIs in young children with ASD. Of note, physical exercise, overcorrection, and sensory extinction were rated as ineffective or highly ineffective by more than half of our sample. Further, the following six strategies were rated as highly ineffective: response cost, overcorrection, physical exercise, consequence-based embedded perseverative interests, DRV, and sensory extinction.

Respondents were significantly more likely to report using a practice if they reported rating it as effective and vice versa. A PCA indicated that practitioners generally responded in the same way to items about reinforcement-based practices, punishment-based practices, and a group of commonly packaged antecedent and consequence-based package components. Infrequently used practices included both the non-evidence-based practice (i.e., SIT) and practices that may be difficult to implement with young children, such as DRO.

Implications and Future Research

First, it is not surprising that behavior analysts reported using a variety of behavioral interventions to treat the broad category of RRBIs, which encompasses a range of topographical behavioral categories including motor and object stereotypy, vocal stereotypy, insistence on sameness, preoccupation and perseveration, and sensory differences. It is interesting to note that a range of effectiveness ratings were given, with some respondents reporting these practices as effective in producing sustainable behavior change, and others indicating the contrary. Given that these are perceptions and that these practices have mainly been evaluated via single-case studies that are inherently short in duration, there is a need to evaluate distal outcomes of these interventions. It could be that some of the practices work well to suppress an RRBI in the short term, but do not necessarily produce durable and desirable behavior change. Future research should measure the long-term outcomes of the available evidence-based behavioral practices on both decreasing undesirable RRBIs and increasing behavioral flexibility, more generally. Moreover, implementing antecedent-based strategies (e.g., environmental enrichment, functional communication training) is recommended in early childhood (Division for Early Childhood 2014), but such approaches might not systematically target behavioral flexibility, the ASD symptom of interest. As a field, we may not be applying the same rationale as is the case for intervention for social-communication skill deficits in young children with ASD, which aim to activate social motivation and systematically shape social behaviors by carefully programming caregivers to deliver reinforcement such as frequent, contingent attention for eye contact, communicative gestures, and other early social behaviors (Hansen et al. 2018).

The majority of our sample (73.6%) reported never using differential reinforcement of variability (DRV). DRV involves shaping and increasing children's novel engagement with repetitive behavior stimuli and is designed to target perseverative interests (Boyd et al. 2011). Seventy-nine percent of respondents rated DRV as effective or highly effective. It is unclear why this practice is not implemented more often, especially given that the majority of our sample rated it favorably. One reason could be that it is not one of the more common forms of differential reinforcement, such as DRI, and thus, may not be explicitly covered in behavior analysts' course work (Cooper et al. 2007). Future studies should aim to understand more about the lack use of this promising practice. Additionally, because invariant behavioral patterns are a core symptom of ASD, more studies testing the efficacy of DRV and other interventions targeting behavioral flexibility, rather than suppression of RRBIs for children with ASD, are warranted. This approach may yield additional effective and contextually valid interventions for young children with or at risk for ASD.

Another interesting finding was that more than half of our sample (50.4%) rated physical exercise as ineffective or highly ineffective. Physical activity and exercised-based interventions have been associated with improvements in cognitive, social, and behavioral characteristics of ASD (Tan et al. 2016). Reductions in stereotypy for brief periods of time following exercise is one of the most commonly

reported beneficial outcomes reported (Lang et al. 2010; Neely et al. 2015). These reductions appear to be temporary, which may be a reason that the behavior analysts in our sample tended to rate them as ineffective; however, little is known about the potential long-term distal benefits of continued physical exercise on RRBIs. Thirty-three percent of our sample reported conducting functional analyses (including rarely, sometimes, and often) when the RRBI was deemed challenging. Of those who did conduct functional analyses, the most common function revealed was automatic (55%), meaning that the reinforcer maintaining the behavior was non-social (i.e., sensory seeking or avoiding). The underlying behavioral mechanism of physical exercise is arguably also automatic reinforcement. Engaging children in physical exercise in the early years may be a powerful replacement behavior for some RRBIs, especially motor stereotypies and hyperreactivity to sensory input. Exercise is likely to have collateral benefits such as preventing obesity, which children with ASD are at an increased risk of developing (Curtin et al. 2014).

It is also interesting to note that 11.6% of respondents rated consequence-based embedded perseverative interests as highly ineffective. Embedding perseverative interests into interventions (e.g., incorporating a child's perseverative interest into a token economy system) has been found to increase on-task behavior and decrease problem behavior (Carnett et al. 2014; Ninci et al. 2018). However, as suggested by Ninci et al. practitioners should closely monitor outcomes when incorporating perseverative interests into interventions to avoid inadvertently reinforcing perseveration. Studies examining distal outcomes of embedding perseverative interests into interventions for children with ASD would be useful.

The only two practices rated as highly effective by more than a quarter of our sample were RIRD (26.4%) and FCT (49.6%). It is likely that behavior analysts are combining these practices, along with others focused on social-communication skills, to individualize behavioral programs for children with ASD. Comprehensive treatment models and packaged curricula that explicitly guide practitioners to assess and choose curricular targets to address behavioral flexibility for individual children, but also for small and whole groups would be beneficial. These packages exist for social-communication skills and pre-academics (e.g., Early Start Denver Model, Pivotal Response Training). Given that these packages are specially designed for children with ASD, incorporating lesson plans for behavioral flexibility would potentially enhance these models. Additionally, assessments for young children with ASD would benefit from being more comprehensive (Gould et al. 2011), which includes providing practitioners with (a) validated assessment points that flag when an RRBI is developmentally aberrant, and (b) linking assessment results of RRBI behavioral excesses to a developmentally appropriate curricular target. Such efforts could include teaching children skills to self-soothe and manage intense emotions. Adapting age-appropriate mindfulness-based curricula, such as The Kindness Curriculum (Flook et al. 2015) for children with ASD, who may have complex communication needs, is a logical next step. Further, mindfulness training could be applied within the context of caregiver-child interactions—caregivers broadly encompassing parents, teachers, paraprofessionals, or behavior therapists—by focusing on increasing attention to the breath and sensory experiences (e.g., tastes, sounds, textures). This type of training may serve as a means to target requisite skills for psychological flexibility needed later on when children are working through difficult emotions. Further, teaching overt (i.e., observable) mindful behaviors within the context of children's natural routines (e.g., parents and children practicing labeling sensations together) may be beneficial in programming behavioral flexibility.

Results from several comprehensive reviews have concluded that SIT does not have sufficient evidence to support its use with children with ASD (Barton et al. 2014; Lang et al. 2012; National Autism Center 2015). Yet, 21% of our sample indicated that they implemented or supervised SIT sometimes or often, and 33% of respondents rated SIT as effective or highly effective. This was a surprising finding that warrants further inquiry. It may be the case that practitioners do not have ample behavioral treatments specifically designed for sensory sensitivities. Results from the odds ratio calculations indicated that practitioners operating in urban clinics were more likely to use all practices, suggesting that resources available to practitioners may influence selected practices (i.e., higher resourced settings such as clinics in urban areas may be better equipped to implement best practice). These findings may highlight a need for improvement in dissemination and implementation of practices in lower-resourced areas.

Finally, there is little known about parent and stakeholder preference and the social validity of the available evidence-based practices for RRBIs. Future research should aim to understand more about how parents and other caregivers view these practices to be acceptable, feasible, and developmentally appropriate. Finally, few studies have investigated parent-implemented interventions for RRBIs (cf. Boyd et al. 2012; Grahame et al. 2016; Lin and Koegel 2018). The available evidence-based practices arguably lack developmental appropriateness for young children (Raulston and Machalicek 2018). One reason for this may be that most studies have included participants from various ages, and as repetitive behavior is not unique to ASD (i.e., other individuals with intellectual and developmental disabilities also commonly display repetitive behavior), the focus has often been on developing efficacious interventions to reduce RRBIs within the context of

challenging behavior. However, it is also important that behavior analysts consider developmental appropriateness and understand that some stereotypies and other RRBIs are age appropriate to avoid suppressing behaviors that may actually be adaptive for young children.

Limitations

There are several limitations worth noting. First, the odds ratio calculations were limited by multiple responses, which may have inflated relative differences (i.e., high resource settings with highly trained professionals likely selected a range of evidence-based practices, making it difficult to determine the moderating effect of setting on results). Additionally, high rates of correlation between strategy use may indicate these respondents are using packages of interventions. Future research should explore how practitioners are combining practices for maximum behavior change, and what child, family, or system variables are considered when deciding which practices to use. An understanding of practitioner use of combined practices may support the development of curriculum or efficient treatment packages that would allow for intervention on RRBIs to occur across settings.

Our sample size was small, meaning there were likely many shared characteristics between respondents. Further, we purposefully surveyed a homogenous group of behavior analysts on their use of primarily emerging and evidence-based behavioral interventions. Certainly, our findings are not representative of practices being implemented by other disciplines, including early intervention and early childhood (EI/ECSE) practitioners, speech-language pathologists, occupational therapists, psychologists, psychiatrists, or developmental-behavioral pediatricians for the treatment of RRBIs in young children with ASD. Various fields conceptualize the etiology and functions of these behaviors differently, and as such, treat them differently. For example, a speech-language pathologist may treat vocal stereotypy, or an occupational therapist might treat hyperreactivity to sensory stimuli differently than a behavior analyst. Future research should survey these aforementioned specialists to shed light on commonalities and differences in the practices with an eye toward understanding more about best interdisciplinary practice.

To more fully address thebroad range of behaviors encompassed within the RRBI section of the DSM-V, we did not ask respondents to rate each practice based on operant function. It is imperative to consider function when treating challenging behaviors, which could explain why FCT was the only practice where almost half of our sample rated as highly effective.

Conclusion

In sum, we surveyed 128 behavior analysts their use of 16 practices and one assessment for the treatment of RRBIs in young children with ASD. The majority of our sample perceived the practices to be effective in producing sustainable behavior change for RRBIs in young children with ASD, yet some practices were reported to be implemented less often than expected. Future research should emphasize treating behavioral flexibility from a developmentally appropriate lens.

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Compliance with Ethical Standards

Conflicts of interest There are no potential conflicts of interest to report.

Research involving human participants All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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