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Harrop, Clare
Gulsrud, Amanda
Shih, Wendy
et al.

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Characterizing caregiver responses to restricted and repetitive behaviors in toddlers with autism spectrum disorder

Clare Harrop[1], **Amanda Gulsrud**[2], **Wendy Shih**[2], **Lilit Hovsepyan**[2], **Connie Kasari**[2]

[1]The University of North Carolina at Chapel Hill, USA

[2]University of California Los Angeles, USA

Abstract

Restricted and repetitive behaviors are a core feature of autism spectrum disorder. This descriptive study documented the presence of restricted and repetitive behaviors in 85 toddlers with autism spectrum disorder as they interacted with their caregiver in a play interaction. For each child restricted and repetitive behavior, a caregiver response/non-response was coded. Caregiver responses were rated as successful or unsuccessful. In all, 83 toddlers demonstrated at least one restricted and repetitive behavior in 10 min. The most common child restricted and repetitive behavior was repetitive object use with 72 children displaying at least one instance of this category of restricted and repetitive behavior. Overall, caregivers responded to fewer than half of their child's restricted and repetitive behaviors, and caregiver response varied by child restricted and repetitive behavior type. The most common response was redirection. Success varied by child restricted and repetitive behavior type and caregiver response—redirections were most successful for child verbal and motor restricted and repetitive behaviors, whereas physical or verbal responses were rated more successful for repetitive object use and visual restricted and repetitive behaviors. This study represents the first attempt to characterize how caregivers respond to restricted and repetitive behaviors. Toddlers with autism spectrum disorder are already demonstrating a variety of restricted and repetitive behaviors within the context of a free play sessions, and caregivers differentially and naturally respond to them.

Keywords

autism spectrum disorders; interventions—psychosocial/behavioral; repetitive behaviors and interests

Introduction

Restricted and repetitive behaviors (RRBs) are a core symptom of autism spectrum disorders (ASDs; International Classification of Diseases, 10 revision (ICD-10), World Health Organization, 1992; *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5), American Psychiatric Association, 2013). While research into this symptom domain has grown in recent years, considerably less is known about the function, treatment,

Corresponding author: Clare Harrop, Department of Allied Health Sciences, The University of North Carolina at Chapel Hill, Bondurant Hall, Suite 3093, 321 South Columbia Street, Chapel Hill, NC 27514, USA., clare_harrop@med.unc.edu.

and etiology of RRBs relative to social-communication impairments. While researchers have successfully involved caregivers within the delivery of treatment to intervene on the core deficit of social communication (Aldred et al., 2004; Bauminger and Kasari, 1999; Drew et al., 2002; Green et al., 2010; Ingersoll, 2010; Kasari et al., 2006, 2008, 2010; Schertz et al., 2013; Yoder and Stone, 2006), there have been fewer behavioral trials specifically addressing RRBs with most research either excluding caregivers in treatment delivery or utilizing single-subject designs (Boyd et al., 2011). Because there have been so few trials on RRBs relative to social-communication interventions (Harrop, 2014), we know comparatively little about how caregivers respond to these behaviors naturally or within an intervention framework. The purpose of this study was to operationalize how caregivers respond to RRBs within the context of a free play session (a context frequently used within early intervention (EI), particularly caregiver-mediated interventions (CMIs)) and explore whether caregiver response varied by RRB type. This study represents a first step in examining caregiver responses to RRBs displayed by toddlers with ASD.

RRBs in ASD

RRBs are defined as the expression of repetitive body mannerisms, overriding preoccupations with objects/parts of objects, sensory behaviors, and strict adherence to routines and rituals (Richler et al., 2007). While obligatory for a DSM-5 diagnosis of ASD, RRBs represent an extremely heterogeneous set of behaviors and there is vast variability between children in their frequency and intensity of expression (Harrop et al., 2014; Turner, 1999; Walker et al., 2004; Watt et al., 2008).

RRBs are also commonly observed in typically developing infants and toddlers, particularly repetitive object use and motor behaviors (Barber et al., 2012; Evans et al., 1997; Leekam et al., 2007; Thelen, 1981a, 1981b). There is much overlap between early behaviors commonly observed in typical development (Çevikaslan et al., 2014; Evans et al., 1997, 2014) and behaviors classified as RRBs in an ASD diagnosis. Repetitive object and motor actions are hypothesized to be vital for developmental mastery in typical development (Thelen, 1981a, 1981b). However, it is the increased frequency, persistence over time, and interference with development and learning that distinguish RRBs in ASD from those observed in typical development and other developmental disorders (Charman et al., 2005; Honey et al., 2007).

The impact of RRBs

Not all RRBs are perceived as negative or debilitating for an individual with ASD. Depending on the context and intensity, these behaviors may not interfere with a child's ability to function, engage socially, and learn from their environment. For example, intense circumscribed interests (typically *higher* order behaviors) may actually serve to allow a child to participate within social interactions with their peers through shared interests (Boyd et al., 2007; Dunst et al., 2011; Vismara and Lyons, 2007). Despite this, RRBs are frequently reported by caregivers as harder to manage than social-communication impairments (Bishop et al., 2007; Lecavalier et al., 2006; South et al., 2005). These behaviors exert a significant impact on family stress levels (Gabriels et al., 2005; Lecavalier et al., 2006; Lounds et al., 2007; Mercier et al., 2000), can lead to more negative parenting styles (Durand and Carr, 1987; Greenberg et al., 2004), and are perceived as stigmatizing for children and families

(Lam et al., 2008; South et al., 2005). RRBs can interfere with child functioning (Gabriels et al., 2005; Nadig et al., 2010) and are hypothesized to lead to negative developmental consequences through missed learning (Dunlap et al., 1983; Lewis et al., 2007; Pierce and Courchesne, 2001; Tanimura et al., 2008; Varni et al., 1979) and social interaction opportunities (Lee et al., 2007; Loftin et al., 2008). Additionally, when opportunities to engage in RRBs are interrupted, family members frequently report negative consequences (Mercier et al., 2000). However, much of this research is derived from small single-subject designs or with older children focusing on *higher* order behaviors such as restricted interests. Thus, addressing the impact of these behaviors within early social interactions is of paramount importance, especially given the current emphasis on EI and involving caregivers within treatment delivery.

CMIs and RRBs

EI is recognized as vital for developmental success and outcome in ASD. CMIs are increasingly popular within the field of EI in ASD, and there is growing evidence supporting this form of intervention (Oono et al., 2013). CMIs utilize the natural interaction that occurs daily between the primary caregiver and child, with generalization benefits outside the immediate treatment context (Diggle et al., 2002; McConachie and Diggle, 2007; Oono et al., 2013). Typically, CMIs focus on social-communication or cognitive impairments in ASD, potentially due to the perceived primacy of these impairments relative to RRBs (Boyd et al., 2012; Lord et al., 2000).

Despite the difficulty in addressing RRBs in ASD, a large body of well-controlled single-subject design studies using behavioral strategies have indicated that response interference and redirection have positive outcomes in reducing various forms of RRBs (Ahearn et al., 2007; Boyd et al., 2011; Liu-Gitz and Banda, 2010). However, only one of these studies trained caregivers. Boyd et al. (2011) trained parents to respond to RRBs by shaping behaviors into more functionally and socially appropriate alternatives. Using a multiple baseline design across five children, rates of RRBs decreased with intervention. However, there was no measure of how caregivers typically responded to these behaviors pre-intervention or post-intervention or differential success rates by response type. In a larger, but uncontrolled trial, Lovaas (1987) used caregivers and therapists to deliver a comprehensive behavioral intervention. More aversive responses (described by the author as *delivery of a loud "no" or a slap on the thigh*) to RRBs resulted in greater reduction in these behaviors; however, baseline or follow-up measures of response type were not gathered and it is unclear whether responses and success differed between therapists and caregivers. Thelen (1980) explored the contexts under which infant stereotyped behaviors occurred. Specifically, Thelen examined whether rates of stereotypy decreased or increased during particular caregiver behaviors, for example, holding or rocking, in typically developing infants but not in children with ASD. Thus, to our knowledge, no study has characterized the strategies caregivers use in direct response to these behaviors in young children with ASD.

Rationale and aims

RRBs are frequently highlighted as early *red flags* in the development of ASD (Chawarska et al., 2007; Elison et al., 2014; McConachie et al., 2005; Ozonoff et al., 2008; Wolff et al., 2014) and are reported by caregivers as difficult to manage (Bishop et al., 2007; Lecavalier et al., 2006; South et al., 2005). RRBs have been found to increase in early development (Guthrie et al., 2013; Wetherby et al., 2014) and remain constant or increase following intervention (Dawson et al., 2010; Wetherby et al., 2014). Caregiver involvement in treatment is now widely promoted in EI and recognized as an effective and popular method of implementing treatment. As RRBs are infrequently targeted within intervention and may be more resistant to change than social-communication or developmental variables (Dawson et al., 2010; Wetherby et al., 2014), understanding how caregivers naturally respond to these behaviors will help form the basis of addressing these symptoms more successfully within CMIs.

As RRBs are known to occur within naturalistic interactions, such as free play with the caregiver (Christensen et al., 2010; Harrop et al., 2014; Koegel et al., 1974), it is important to capture how these behaviors impact interactions and measure how caregivers respond to them. Through studying caregiver responses to RRBs, this study will provide a baseline to assess how caregivers may change in their response type and response success following a CMI.

Our aims were threefold. First, we sought to quantify caregiver responses to RRBs in young children with ASD. Second, we explored whether caregiver responses vary by child RRB type and, finally, whether these responses are successful in immediately reducing the child behavior. While descriptive, this study will explore the strategies caregivers naturally use with their children and provide a means to ascertain change following, for example, a caregiver-mediated treatment.

Method

Participants

Participants were recruited from the Greater Los Angeles Area. Inclusion criteria required a *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV) clinical diagnosis of ASD (confirmed by independent administrations of the Autism Diagnostic Observation Schedule (ADOS)-2, Lord et al., 2012; and Autism Diagnostic Interview–Revised (ADI-R), Le Couteur et al., 2003) and absence of other sensory or genetic disorders or medical conditions (e.g. seizure disorder). In all, 85 toddlers (male:female: 69:16; mean age = 31 months, standard deviation (SD) = 3 months) with ASD and their caregivers were included in the study. The majority of caregivers were mothers (n = 76). In addition to eight fathers, one grandmother also participated. Participant characteristics are reported in Table 1.

Measures

ADOS-2.—The ADOS-2 was administered by independent research-reliable testers to confirm the clinical diagnosis of the participants (Lord et al., 2012). The majority of children completed Module 1 (n = 80). One child completed a Toddler Module and two completed

Module 2. Two ADOS were missing due to recent clinical assessments confirming ASD being completed shortly before study enrollment.

ADI-R.—The ADI-R was completed with the same caregiver who also participated in the Caregiver Child Play Interaction (CCX) (Le Couteur et al., 2003). The ADI-R was administered by an independent research-reliable tester as further confirmation of the participants' diagnosis of ASD.

Mullen Scales of Early Learning.—The Mullen Scales of Early Learning (MSEL) was administered as an assessment of cognitive ability (Mullen, 1995). Developmental quotients and verbal and non-verbal age equivalents were used to characterize the sample (Table 1).

CCX.—Child RRBs and caregiver responses were coded from the CCX (see section "Coding"). The CCX was designed to represent a naturalistic play interaction between the child and their primary caregiver. Caregivers were provided with a standardized set of toys selected for developmental appropriateness and variety (Blocks, Peg Bus, Dump Truck, Animal Blocks, Small Figurines, Furniture, Bike and Ramp, two phones, Ball, Dinosaurs, Pop-Up, Utensils, Shape Sorter). Caregivers were instructed to play as they would at home and to use as many or as few toys as they wished. Interactions were filmed in a standardized observation room and later coded.

Coding

Three variable categories were coded from the CCX: (a) child RRBs, (b) caregiver responses, and (c) response success. Child RRBs was separated into four sub-categories (1, *motor/body*; 2, *visual*; 3, *repetitive object use*; and 4, *repetitive vocalizations/language*; Figure 1). Caregiver responses were first coded as *responses* versus *non-response*. Responses were then classified as one of three response types: (a) *verbal*, (b) *physical*, and (c) *redirection*. Non-responses were rated as *ignores* or *did not notice* (*DNN*). Success rate was scored as *successful* or *unsuccessful* (Figure 2).

Child RRBs.—Children RRBs were coded from the CCX using Noldus Observer® (Noldus, 1991). Observational coding was based on the coding scheme developed by Harrop et al. (2014) which drew from items included within validated questionnaire and observation measures (see Harrop et al., 2014 for further details). Items were selected from the original coding scheme based on the likelihood of being observed within a 10-min play session in young children with ASD and their occurrence within the original Harrop et al. study. RRBs encompass a wide range of behaviors, including strict adherence to rituals and routines, in-depth knowledge of a particular topic, and scripted and rote language. While these *higher* order behaviors are observed in children as young as 24 months (Lam and Aman, 2007; Mirenda et al., 2010), they are assumed to be less common in younger children (Militerni et al., 2002; Moore and Goodson, 2003) and may not be readily observed within a time-limited observation with unfamiliar toys. As such, this study focused specifically on *lower* order RRBs (Turner, 1999).

Modifications were made to the Harrop et al. (2014) coding scheme to render it suitable for this study. As the emphasis on this study was to examine caregiver responses rather

than individual child RRBs, we collapsed the coding scheme into four categories based on item overlap, endorsement within the Harrop et al. study, and grouping of behaviors in a recent observation study (Elison et al., 2014). The four categories were as follows: (a) motor/body behaviors, (b) visual behaviors, (c) repetitive object use, and (d) repetitive vocalizations/language (Figure 1). With the exception of visual behaviors that are frequently included in observational coding of RRBs (Boyd et al., 2011; Harrop et al., 2014; Ozonoff et al., 2008) and are commonly observed within this age range in children with ASD, this study did not code other forms of sensory *seeking* or *avoidance* behaviors. This was consistent with recent observational articles (Elison et al., 2014) that did not include sensory behaviors, such as sensitivity to noise, to allow for comparison between studies in early childhood and development of ASD. Mouthing was also excluded as, while reducing significantly after 24 months of age, it is often still observed in younger typically developing toddlers (Belsky and Most, 1981; Juberg et al., 2001; Tulve et al., 2002) and may not be viewed as idiosyncratic as other behaviors. Additionally, the conceptual debate as to whether sensory behaviors are separate from RRBs, despite their inclusion in DSM-5, is unclear (Boyd et al., 2010), and caregivers' understanding of what sensory behaviors are (Dickie et al., 2009), especially in early childhood, may lead to reduced responses.

Every RRB observed within the 10-min play session was coded as a frequency (followed by a code depicting the caregiver response—outlined below). For behaviors such as *hand flapping* or *spinning*, we did not count each individual action but instead each *burst* (for more information—see Harrop et al., 2014). All videos were coded by a graduate research assistant (L.H.), who was trained by the first author (C.H). In all, 40% of clips were double coded for inter-rater reliability (IRR) purposes by C.H. IRR was calculated using intra-class correlation (ICC) coefficients. For total RRBs, the ICC was 0.96. All ICCs for individual RRB categories were high (motor: 0.97; visual: 0.96; repetitive object use: 0.96; verbal: 0.86).

Caregiver responses to RRBs.—A caregiver response was coded using Noldus Observer® (Noldus, 1991) for each observed child RRB. A caregiver response was defined as any caregiver behavior that occurred within 10 s of the child's observed RRB. Caregiver responses were first coded as *response* or *non-response* (Figure 2). Caregiver responses were grouped into three categories based on what has been reported in behavioral literature (e.g. Boyd et al., 2011; Lovaas, 1987). The three categories were *verbal, physical*, and *redirection* (Figure 2).

Verbal responses were classed as the caregiver making comments such as *you like pressing that button don't you?* or *I wish you wouldn't do that so much* as well as direct requests for the child to stop engaging in the RRB (*please stop doing that*). If the parent labeled an action, for example, saying "open" as a child repeatedly opened and closed doors on toy furniture, this was scored as a verbal response. However, verbally responded with play suggestions that expanded on this action, this was coded as a *redirection* (see below). *Physical* responses included the parent physically preventing the RRB from continuing, such as placing their hand over the child's to stop flapping and physically stopping a child from completing an action such as repetitive button pressing or removing a toy that the child is persevering on. *Redirections* entailed the caregiver attempting to modify the child's

behavior into a more functional activity. Examples include introducing new toys/actions, rearranging the play environment, or making alternative play suggestions/building on the child's perseverative actions. If a caregiver removed a toy (*physical*) in order to introduce a new one, this was classed as a *redirection*.

We acknowledge that responses are not mutually exclusive and caregivers may employ multiple strategies in response to a single-child RRB. When multiple responses were identified, the coders selected the *dominant* code. Any multiple codes were re-watched and discussed with C.H. *Dominant* codes were classified as those that formed the majority of the caregiver response and/or it was the caregiver response that led to the rating of *successful* or *unsuccessful*. For example, a caregiver may have asked a child to stop engaging in repetitive object use; however, within a few seconds the caregiver removes the toy from the child, which in turn results in the behavior ceasing (therefore coded successful). In this instance, the physical response would be selected as the dominant code. Files requiring consensus coding were excluded from the random sample of tapes selected for IRR. A 10-s timeframe following the child RRB was considered before selecting the caregiver response. This also allowed the caregiver sufficient time to respond to the behavior. *Non-response* was coded if no caregiver response (as classified above) occurred during the 10 s following the behavior or if a response occurred outside the 10-s window (Figure 2).

When the caregiver made no active response within the 10-s window following the child-initiated RRB, the coder decided between two categories of *non-response—DNN* or *ignore* (Figure 2). The first category—*DNN*—was assigned when the caregiver did not observe the action, that is, they had their back turned or were engaged in another activity. Subtle behaviors could be scored as *DNN* if the coder determined the caregiver did not notice them. An example of this is discrete finger posturing that caregivers might not readily notice especially if brief or out of sight (e.g. blocked by a toy).

The other category of *non-response* was *ignore.* This code represented when the caregiver appeared to notice the behavior but not respond to it—that is, a behavior occurred directly in front of them, but they did not make an active response to this. Our coding scheme did not differentiate *active ignores*—a strategy that while not directly responding to the behavior verbally, physically, or through redirections may represent an active strategy in response to these behaviors. The difficulty in distinguishing between what is considered an *active* versus a more *passive* ignore is discussed further within section "Discussion." IRR was calculated on 40% of cases using ICC coefficients. All codes reached a high level of agreement. For total *responses* and *non-responses*, ICCs were 0.86 and 0.95, respectively. Similarly, high ICCs were found for individual categories (*Verbal*: 0.98; *Physical*: 0.96; *Redirection*: 0.82; *DNN*: 0.93; *Ignore*: 0.95).

Response success.—In the final stage of the coding scheme, the coder was required to select whether this response was *successful* or *unsuccessful* (Figure 2). Coding of success rate was drawn from both a behavioral framework, that is, behavior extinction, and a social-affective framework, that is, resulting in a positive rather than negative social outcome. Success was defined in two ways—the child disengaging from the RRB for at least 10 s or the child demonstrating an alternative *positive* behavior such as social communication

and engagement with the caregiver. The child could disengage from one behavior (e.g. motor/body behaviors) but begin another (e.g. repetitive object use), and this was classed as successful if the caregiver response reduced the first example of RRB. The subsequent RRB was then scored as a separate instance. If the child continued to engage in, for example, repetitive object use, but the caregiver response resulted in increased child engagement with their caregiver, the use of language/gestures, and/or eye contact around the RRB, this was coded as a *successful* response. An *unsuccessful* response was coded in two ways—the child did not disengage from the RRB or the child did disengage following a caregiver response but resulted in a significant negative reaction from the child. There was also an option to capture whether the child disengaged from the RRB prior to the caregiver response. We acknowledge our rating of success does not account for developmental appropriateness of the caregiver response. If the parent did not respond to the RRBs, success was not scored (Figure 2). Coders had high agreement on whether responses were *successful* (ICC: 0.94) or *unsuccessful* (ICC: 0.82).

Data analysis

Analysis was completed in three parts. First, a descriptive analysis was conducted to explore the distributions of (a) child RRB type, (b) caregiver responses versus non-responses, (c) response type, and (d) success of response. Second, our main analysis focused on whether caregiver response varied by child RRB category using generalized linear mixed models (GLMMs) (SAS Institute, 2011). To test this, we ran a mixed-effects ordinal logistic model with caregiver response as the outcome—(0) *ignore/DNN*, (1) *verbal/physical*, and (2) *redirection*—and the predictor child RRB type, controlling for the number of RRBs. We modeled both RRB type and number of RRBs as the main effect with subject-level random intercepts. Finally, we also ran a mixed-effects logistic regression to test whether response success (as defined above) varied by (a) child RRB type and (b) parent response type with subject-level random intercepts. We also tested for an interaction between these predictors in order to assess whether different combinations of child RRB type and caregiver response type affect the odds of successfully disengaging from the RRB or resulting in positive social interaction between the caregiver and child. We controlled for the number of RRBs and only analyzed data where the caregiver had responded to the RRB, rather than ignoring/not noticing the behavior. Predicted probabilities of successful redirection were calculated by taking the inverse logit function of the predicted values.

GLMM allows for correlated data or data with nonconstant variability whereby the responses are not necessarily normally distributed (i.e. binary outcomes such as caregiver response success—successful or unsuccessful— or ordinal outcomes—such as caregiver response—non-response, verbal/physical, or redirection). Furthermore, GLMM assumes random effects (i.e. clustering effects) with normal distribution. For example, in our study, each child could have multiple RRBs (motor, visual, object, or verbal). Hence, the data structure is clustered where we have multiple observations (i.e. RRB) within each child and given the clustering random effects.

Results

Child RRBs

In all, 83 children out of our total of 85 displayed at least one RRB during the 10-min free play session. There was large variability in the frequency of RRBs displayed, from 0 to 30 within the play session. An average of 10.81 RRBs (SD = 7.10) were displayed by children—a rate of 1.81 RRBs per minute. The most common RRB was *repetitive object use* with 72 children displaying at least one instance of this behavior (Figure 3). Verbal RRBs were the second most common behavior, followed by motor and visual RRBs (Figure 3). Two children did not display any RRBs and were excluded from the caregiver responses analysis.

Caregiver responses: overall and by RRB type

Caregivers responded to fewer than half of their child's RRBs (Figure 4). Over 80% of *non-responses* were *ignores.* The majority of *active* caregiver responses were *redirections.* Caregivers responded to an average of 5.51 (47.46%) of their child's RRBs. There was great variability with a range of 0–21 (0%–100%) responses within the 10-min play session. Seven caregivers responded to 100% of their child RRBs.

To explore whether there was a statistically significant difference in the type of caregiver response by child RRB type, responses were grouped into three categories: (a) *non-responses* (*ignore* and *DNN* combined), (b) *verbal/*physical, and (c) *redirections.* The responses were collapsed because certain responses had low prevalence in certain child's RRB category and estimates would be unstable for those categories.

Caregiver response varied by child RRB type ($F(3, 811) = 25.19$, $p < 0.0001$; Figure 5). Caregivers were more likely to redirect both *repetitive object use* and *visual* RRBs. Responses to *motor* and *verbal* RRBs did not vary, with caregivers more likely to not respond to these behaviors. Number of RRBs per child did not contribute to the variance in caregiver response type ($F(1, 811) = 0.31$, $p = 0.58$).

Success of caregiver response: child RRBs and caregiver response type

The following analysis was completed only among dyads where caregivers *actively* responded to RRBs. In cases where the child disengaged from the RRB prior to the caregiver response (nearly 25% of the time), we did not rate success. An interaction between RRB type and caregiver response was found ($F(3, 333) = 3.16$, $p = 0.02$)—success varied by the type of child RRBs and the type of caregiver response. Caregiver redirections were most successful for reducing *motor* RRBs (redirections = 0.73; verbal/physical = 0.60). Caregiver redirections were also more successful for *verbal* RRBs (redirections = 0.61, verbal/physical = 0.14). Caregiver physical or verbal responses were rated as more successful for *visual* RRBs (verbal/physical = 0.86; redirections = 0.41). This was also found for *repetitive object use* (verbal/physical = 0.61; redirections = 0.41). There was a negative effect of the number of child RRBs on caregiver responses success ($F(1, 333) = 4.97$, $p = 0.02$)—the more children engaged in RRBs, the less likely they were able to disengage from this behavior irrespective of caregiver response.

Discussion

This study represents the first attempt to characterize how caregivers respond to RRBs within the context of a naturalistic free play session. In all, 83 out of 85 toddlers with ASD demonstrated at least one RRB during the 10-min play session. Our sample showed a similar range in the frequency and distribution of RRB to both Barber et al. (2012) and Harrop et al. (2014), with highest endorsement for repetitive object use in this age range. Caregivers actively responded to fewer than half of their child's RRBs, with the majority of non-responses classified as ignores. When caregivers employed clear behavioral response strategies, they were most likely to employ redirection strategies; however, caregiver responses varied by RRB type. Caregivers were more likely to redirect repetitive object use and visual behaviors. Caregivers were more likely to not respond to verbal or motor behaviors. Success of response varied by child RRB and caregiver response—redirections were more successful for motor and verbal behaviors. Physically removing toys or asking a child not to engage in RRBs resulted in the immediate stoppage of visual RRBs and repetitive object use.

Caregivers did not respond uniformly to all RRBs. Instead, there appeared to be a distinct response pattern, suggesting that caregivers responded to categories of RRBs that may be perceived as more interfering to their ability to interact and engage in play with their child—namely, repetitive object use and visual behaviors. Caregivers did not actively respond to the majority of verbal and motor RRBs suggesting that these behaviors may not interfere with the interaction between a caregiver and a child to the same degree as a child who is solely engaged in repetitive solitary play. Most of the toddlers were preverbal; thus, caregivers may have not wanted to squash any verbal attempts of the child, whether repetitive or not. Similarly, motor RRBs often are expressed during times of high excitement for children and thus may not be perceived as negative to the interaction or the caregivers' ability to engage with their child within play. There was no association between the percentage of caregiver responses and the frequency of child RRBs suggesting that a third variable may be contributing to the caregivers' decision to respond to RRBs rather than simply the volume of these behaviors. Potential factors could be caregiver responsiveness, engagement, and the perceived impact the behaviors are having on the interaction. Future research would benefit from exploring the role of moderating variables, such as child social-communication impairments and caregiver responsiveness (Patterson et al., 2013) in explaining when and how caregivers choose to respond to their child's RRBs.

Success of caregiver responses varied by child RRB type. Children were more likely to disengage from repetitive object use and visual RRBs when caregivers responded verbally or physically—essentially stopping the child from engaging in these behaviors. Verbal and motor RRBs were more likely to be reduced when the caregiver employed redirection strategies, indicating that these two categories may either be easier to redirect or may be less concerning to the caregiver so that less direct means are employed to stop the behavior. It is possible that caregivers perceive repetitive object use and visual RRBs as more impacting the interaction than motor and verbal behaviors. Therefore, removing items (physical) or requesting children to stop (verbal) engaging in these particular RRBs may be seen as a *last attempt* after less intrusive strategies such as redirections have proved

unsuccessful. An alternative explanation, however, is that caregivers may have learnt over time that intervening with particular behaviors (verbal and motor) has a negative impact on the interaction (Mercier et al., 2000) or has no durable effect on reducing the behavior in the long term. Studying caregiver responses over time will allow us to explore whether caregivers change their approach with experience or whether these observed patterns persist and remain constant over time.

Our data did not allow us to explore how caregiver strategies may change over the course of the interaction and how subsequent responses may be influenced by earlier attempts. Bakeman and colleagues' (1997, 2011) sequential analysis is an alternative method to establish temporal association between actor behaviors within an observation and would be worthwhile to pursue in future studies. However, we chose to use GLMM as our method of analysis because of the clustering of behaviors within individuals and the flexibility to incorporate random effects in our models.

Caregivers in our sample did not respond to over half of child RRBs, with caregivers *ignoring* most RRBs. Active ignoring is frequently discussed clinically, and thus, we cannot discount that our caregivers may have been employing an *active* strategy when choosing not to respond to child RRBs. Within this data set, we could not interpret whether caregivers were *actively* ignoring RRBs as a purposeful and selective strategy. Research has shown that when a child is prevented from engaging in RRBs, negative behavioral consequences are often observed (Mercier et al., 2000); thus, ignoring RRBs may have more positive implications for the interaction. Future research would benefit from attempts to distinguish between ignoring as an active strategy, such as asking caregivers their intention following the CCX session.

While descriptive, our findings have potential implications for EI research. Consistent patterns of response emerged suggesting that caregivers already enter treatment with strategies for dealing with RRBs, but these strategies are inconsistently implemented resulting in fewer than half of the RRBs being responded to. Future studies will want to examine the effect of CMIs on core impairments in RRBs in addition to core social-communication impairments. In addition, further research is required to disentangle the impact of certain caregiver responses, such as removing toys, on the quality of the interaction.

Our data represent the first attempt to quantify caregiver responses to RRBs in young children with ASD; however, there are a number of limitations worthy of discussion. We did not assess caregiver knowledge of ASD or intervention training prior to entering the study. From our data, we also lack an understanding of why caregivers pick certain *response* (or *non-responses*), and future research should explore how potential moderating variables such as ASD severity, caregiver responsiveness, and caregiver stress inform response type. Additionally, it would have been beneficial to ask caregivers how and why they typically respond to these behaviors to provide further knowledge as to the complexity of caregivers' responses to RRBs.

While a number and range of RRBs were observed within a 10-min observation, this timeframe may be insufficient to fully capture the behaviors we were aiming to study. Additionally, multiple measurement sessions might be necessary to provide reliable estimates of these behaviors, particularly within unstructured contexts. These modifications may increase the likelihood of observing behaviors classified as *higher* order RRBs, which were excluded from the current coding scheme due to their lower rate of occurrence in toddlers with ASD.

These data were limited by the use of a single time point, which did not allow for an exploration of change over time in both caregiver's response and child RRBs. While we classified caregiver responses as *successful* or *unsuccessful*, these ratings only provide a short-term arbitrary measure of *success*, and our study lacks the ability to examine whether caregiver responses to RRBs decrease the future occurrence of the behaviors both over the course of the CCX and beyond the immediate context of the interaction. While descriptive, this study provides a means to explore the impact of a caregiver-mediated treatment approach on both child RRBs and caregivers' responses to these behaviors.

Conclusion

Child RRBs were commonly observed within a free play session with their caregiver. Caregivers actively responded to fewer than half of these behaviors. Caregiver response varied by child RRB type, with more redirection strategies for visual RRBs and repetitive object use. Despite more attempts to redirect these behaviors, verbal or physical responses were rated as more successful. Redirection strategies were rated as more successful for verbal and motor RRBs, although caregivers more commonly ignored these behaviors. Given the popularity of caregiver-mediated interventions for EI in ASD, more research is required into the field of RRB management, particularly large-scale trials to evaluate the heterogeneity in child presence of RRBs, caregiver responses, and long-term outcomes of child behaviors and caregiver responses.

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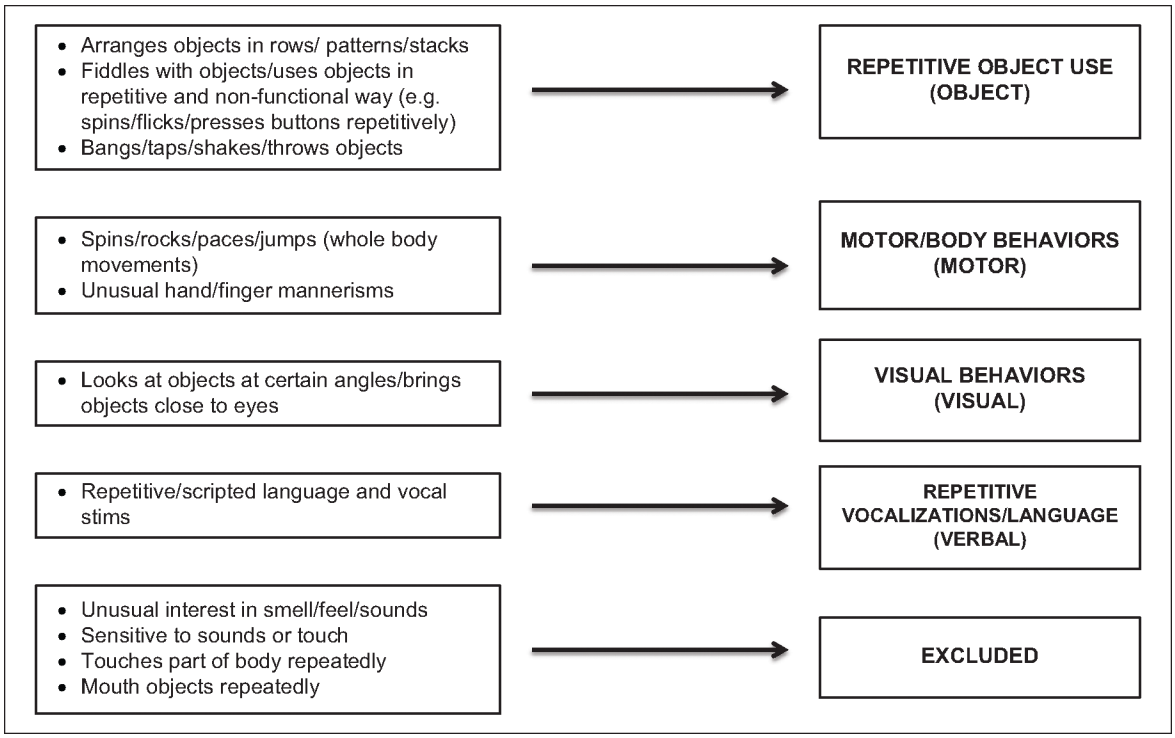

Figure 1.
Adaption to Harrop et al.'s (2014) coding scheme.

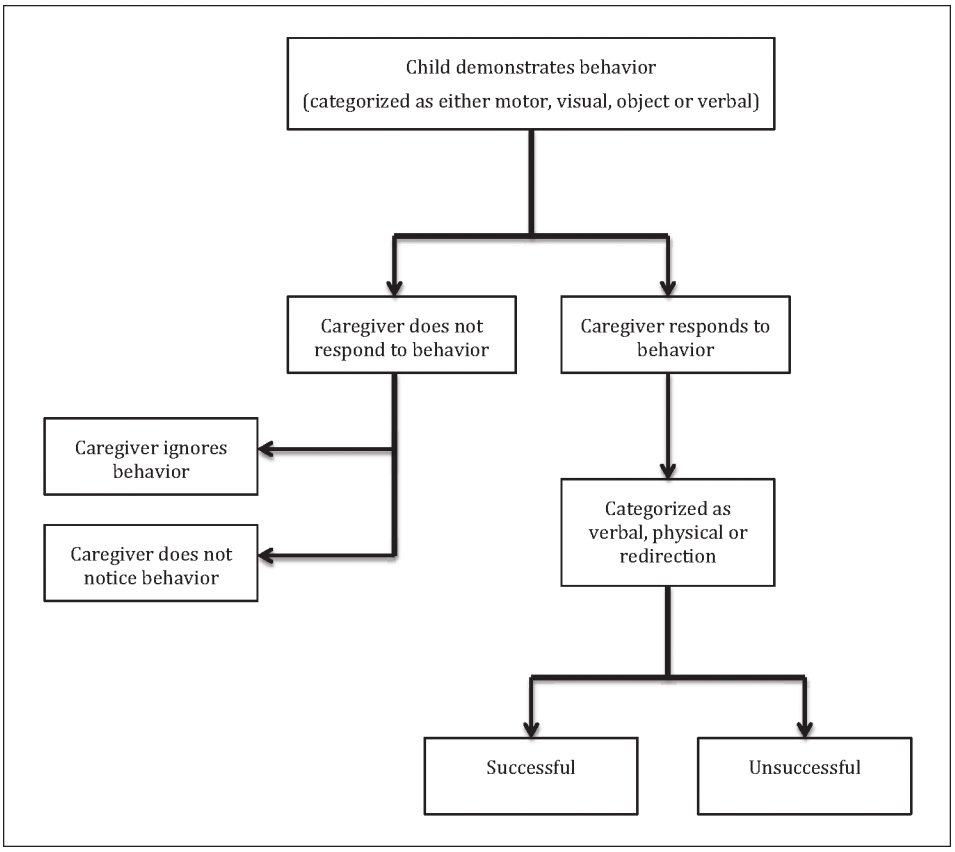

Figure 2.
Child repetitive behaviors and caregiver response.

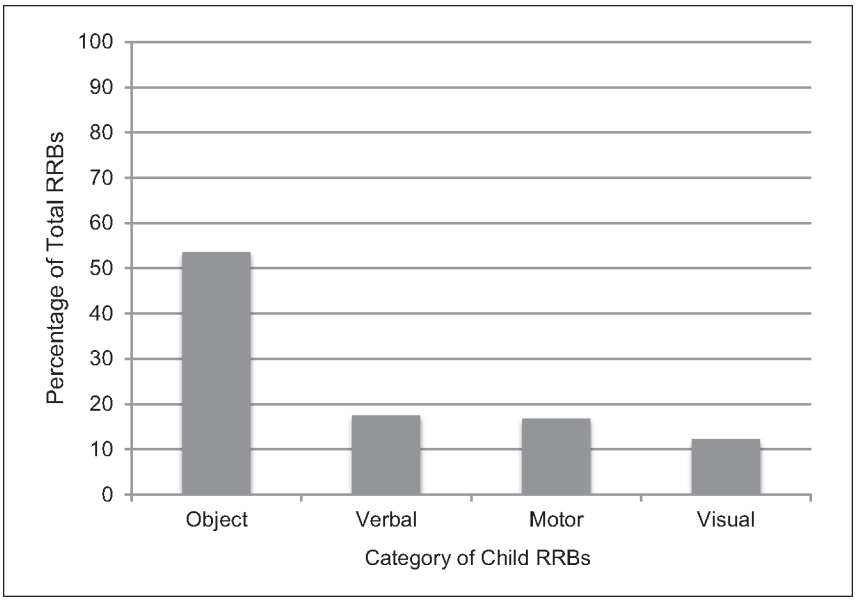

Figure 3.
Percentage of child RRBs by type.

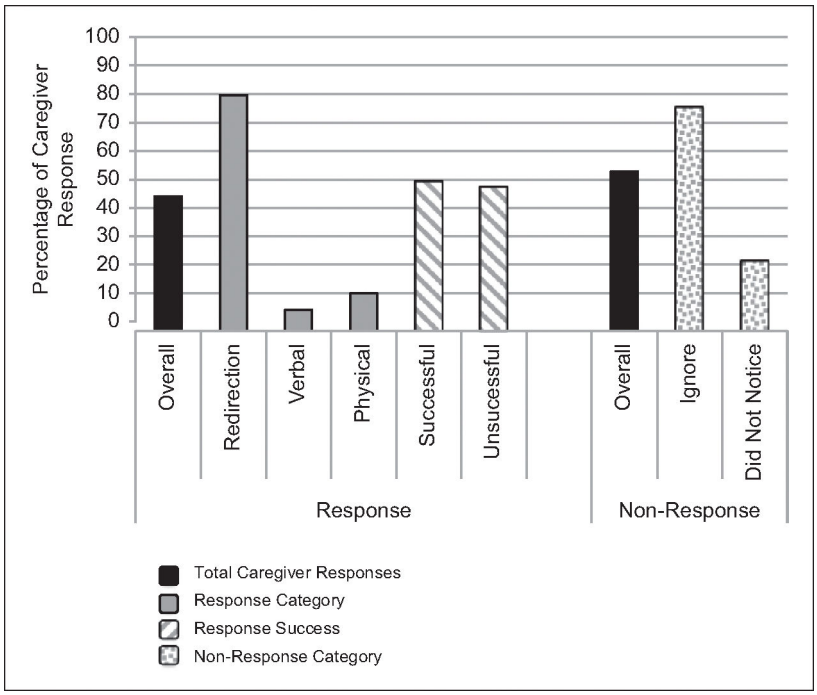

Figure 4.

Caregiver responses to child RRBs: response versus non-response; response category and response success.

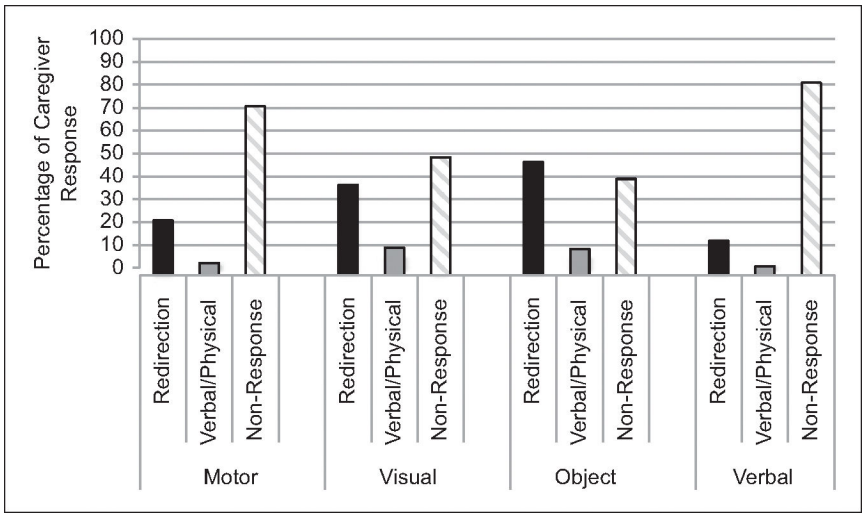

Figure 5.
Distribution of caregiver response by child RRB category.

Table 1.

Sample characteristics.

Gender (boys:girls)	69:16
Chronological age (months)	31.52 (3.21)
ADOS-2 Algorithm score	16.19 (5.07)
ADOS-2 Social Affect Algorithm score	12.82 (3.92)
ADOS-2 RRB Algorithm score	3.37 (1.97)
Developmental quotient	68.16 (20.41
Non-verbal age equivalent	23.30 (6.72)
Verbal age equivalent	17.78 (9.68)
Ethnicity	
African American	2
Caucasian	53
Hispanic	7
Asian	10
Other/multi-racial	13
Maternal age (years)	35.9 (4.6)
Maternal education (years)	16.8 (2.4)

ADOS-2: Autism Diagnostic Observation Schedule; RRB: restricted and repetitive behavior.