# Chapter 13
# Early Intervention and Restricted, Repetitive Behaviours and Interests


**Maya Yaari and Cheryl Dissanayake**

## Background

Restricted and repetitive behaviours and interests (RRBI) are a core feature in Autism Spectrum Disorders (ASD), and their presence is required for a diagnosis, according to the Diagnostic and Statistical Manual for Mental Disorders (DSM-5: American Psychiatric Association, 2013). This category of behaviours is very broad, defining a wide range of idiosyncratic actions, including:

1. Stereotyped, repetitive movements (e.g., hand-flapping), repetitive use of objects (e.g., spinning wheels, lining up toys), or repetitive language (e.g. echolalia, idiosyncratic language).
2. Insistence on sameness (e.g. inflexible adherence to routines such that the child may become distressed in response to changes in routine or environment), and ritualized patterns of behaviour (e.g., greeting rituals).
3. Highly restricted, fixated interests that are unusual in their intensity or content (e.g., strong attachment to or preoccupation with unusual objects, excessively interest in bus schedules).
4. Hyper- or hypo-reactivity to sensory input (e.g., apparent indifference to pain/temperature, adverse response to specific sounds or textures) or unusual interests in sensory aspects of the environment (e.g. excessive smelling or touching of objects, visual fascination with lights or movement).

In this chapter we discuss RRBI in the context of ASD early intervention (EI) research. RRBI may impede children's learning, decrease social interaction and cause substantial parental distress. However, while EI research in ASD has substantially progressed over the last years, its main focus remains on social-communication

M. Yaari (✉) · C. Dissanayake
Olga Tennison Autism Research Centre, School of Psychology and Public Health, La Trobe University, Melbourne, VIC, Australia



E. Gal, N. Yirmiya (eds.), *Repetitive and Restricted Behaviors and Interests in Autism Spectrum Disorders*, Autism and Child Psychopathology Series,
https://doi.org/10.1007/978-3-030-66445-9_13

difficulties and outcomes, with much less known about intervention effects on RRBI, and how these behaviours are addressed in the context of EI. The neurodiversity movement has spurred an increase in the number of first-person accounts of autism than previously available (Pellicano & Stears, 2011). These testimonies regarding personal experiences, including the use of RRBI have increased our understanding of these behaviours and the functions they may serve for children with ASD (Baron-Cohen, 2017; Kapp, Gillespie-Lynch, Sherman, & Hutman, 2013). Subscribing to a partnership-based approach to intervention in which therapy goals are driven by the family and individuals in collaboration with the therapist informs and questions the approaches to reduce RRBI in ASD.

## RRBI in Childhood: Functions in Typical and Atypical Development

RRBI are observed in typically developing infants and toddlers, at an age in which they are considered common and developmentally appropriate (Barber, Wetherby, & Chambers, 2012; Harrop et al., 2014; Leekam et al., 2007). Repetition of movements and actions and ritualistic behaviours are considered part of the process of skill acquisition, usually reducing over time and development, as the child attains mastery of the skill (Leekam et al., 2007; MacDonald et al., 2007; Wolff et al., 2014). These behaviours may also serve other functions such as self-soothing, reducing of anxiety by increasing predictability of routines, regulation of arousal and energy levels, or self-stimulation (Larkin, Meins, Centifanti, Fernyhough, & Leekam, 2017).

The RRBI associated with ASD differ from those observed among typically developing children (and those with other developmental difficulties) in the increased frequency, intensity, variety, and persistence over time of these behaviours, such that they can interfere with learning and daily functioning (Bodfish, Symons, Parker, & Lewis, 2000; Harrop et al., 2014; Matson, Dempsey, & Fodstad, 2009). RRBI in ASD have been documented as a cause of parental concern and distress and perceived as more challenging for parents to manage than social-communication difficulties (Boyd, McDonough, & Bodfish, 2012; Harrop, McBee, & Boyd, 2016).

The ASD literature categorizes RRBI as lower- and higher-order (Leekam, Prior, & Uljarevic, 2011; Turner, 1999). Lower-order RRBI involve motor stereotypy such as hand flapping or rocking, and object stereotypy such repetitively opening and closing a door and spinning or lining objects, with these behaviours considered as more common among younger children and those with developmental delay. Higher-order RRBI, considered more common in older aged children and among those without cognitive impairments, include obsessive engagement in odd interests and hobbies, insistence on sameness and the repetitive use of language (Leekam et al., 2011). Assessment of RRBI is conducted via caregiver questionnaires and

interviews, teacher reports, structured and unstructured observations of children and coding of videotaped material (Leekam et al., 2011; McConachie et al., 2015). RRBI are commonly assessed as part of the diagnostic process, to determine if they are present and meet diagnostic criteria. This is usually conducted via the well-established ASD diagnostic measures, the Autism Diagnostic Interview (ADI) in which caregivers are questioned about their child's current and past behaviours, and the Autism Diagnostic Observation Schedule (ADOS), which is an observational measure. RRBI are also assessed in the context of early intervention, to monitor the progress of children over time, and examine outcomes and efficacy of intervention programs (Leekam et al., 2011).

### *RRBI and Social Learning*

Prospective high-risk infant sibling studies have been useful in charting the presence and early emergence of RRBI, even prior to social-communication impairments (Baranek, 1999; Ozonoff et al., 2008; Rogers, 2009). RRBI in very young children with ASD may impact learning and hence the acquisition of social, cognitive and adaptive skills. Learning in young children occurs within social contexts, via social attention, imitation, and joint engagement with other people (Dawson, 2008). When children preferentially engage with objects, often in repetitive ways, as in the case of ASD, their opportunities to learn are limited. Take, for example, a child with ASD repeatedly flicking a doll's eyes or lining blocks in a particular way instead of engaging in social play by showing the toy to his/her parents, or engaging in turn-taking with them, which can limit his/her ability to learn from others and the relational activity itself. On the other hand, the social-communication difficulties and delayed functional play skills evident in ASD may further contribute to limiting the range of behaviours the child engages in, leading to RRBI becoming increasingly prominent in the child's repertoire. Findings regarding the association between RRBI in early years and poorer later social and cognitive outcomes (Ausderau et al., 2016; Larkin et al., 2017; Ozonoff et al., 2008; Ray-Subramanian & Ellis Weismer, 2012; Troyb et al., 2016), indicate their possible impact on learning. These findings coupled with a lack of understanding of the function of these behaviours for children with ASD has led to approaches aimed at reducing them.

## Early Intervention and RRBI

There is a distinction in the intervention literature between comprehensive treatment models (CTM) and focused intervention practices (FIP). CTMs are designed to achieve broad developmental gains across multiple domains, and are usually intensive, and delivered over an extended period of time. The efficacy of these interventions is usually assessed via standardised measures of ASD symptoms and

cognitive and adaptive functioning (Odom, Boyd, Hall, & Hume, 2010). In FIPs, on the other hand, strategies are employed for a limited period of time in order to target specific behavioural symptom/s or to attain a particular skill. Examining the efficacy of such targeted intervention is done usually via case series/studies, with the outcome being child specific - attaining a particular target. These FIPS can be integrated within CTMs or employed individually as targeted interventions. Focusing on young children in the pre-school years, we will first examine the different theoretical and clinical approaches to RRBI within CTMs, followed by evidence on the effects of these interventions on RRBI and how RRBI features may predict the treatment outcome. We will then describe the specific FIPs targeting RRBI, their evidence-base and potential "spill-over" effects on other behavioural domains.

## *Early Intervention Frameworks*

Early interventions (EI) for children with ASD, in general, vary with regards to the theoretical approach, which generally informs the service delivery model and strategies employed. The main EI frameworks are behavioural, developmental, relationship-based, and sensory-motor (Raulston & Machalicek, 2017), with many incorporating more than one framework. Within the behavioural framework and the Applied Behaviour Analysis (ABA) approach, behaviours – including RRBI – are maintained because they serve a function or, in other words, the behaviour is maintained by the consequences that follow it. Reinforcers can be social or non-social, positive or negative, or a combination of different types. Social positive reinforcers can be attention or access to an attractive object or activity; social negative reinforcers can be avoiding a task or activity; non-social (often called automatic) positive reinforcers can be a sensory stimulation which is independent from social mediation; and non-social negative reinforcers can be removal of a distressing sensory stimulus (Rapp & Vollmer, 2005). Using a Functional Behavioural Assessment, the practitioner explores antecedents and reinforcers of the unwanted behaviour, and employs appropriate Positive Behavioural Support strategies, Discrete Trail Training (DTT) or Pivotal Response Treatment (PRT) techniques to reduce behaviours that are considered to interfere with learning and adaptive functioning, and shape and reinforce more adaptive behaviours (Harrop, 2015; Odom, Collet-Klingenberg, Rogers, & Hatton, 2010).

Interventions based on developmental or relationship-based approaches (e.g. the Developmental, Individual-differences, & Relationship-based model, DIR) usually emphasize the child's social-emotional development and skills, and the caregiver's responsivity to the child's cues. Subscribing to "follow the child's lead", the practitioner does not attempt to directly change or shape the child's behaviours but rather joins the child in his/her activity to enhance motivation and facilitate the development of his/her communication skills to express and articulate his/her needs (Harrop, 2015). The approach to RRBI within integrative, Naturalistic Developmental Behavioural Interventions such as the Early Start Denver Model (ESDM) includes both ABA and a relationship-based approaches. Extension of the child's functional

behavioural repertoire, enhancing his/her communication skills and increasing the reinforcing value of social interactions are considered the ways to reduce RRBI. The practitioner applies behavioural strategies to manage behaviours considered destructive or disruptive, emphasizing the replacement of repetitive behaviours with more adaptive, communicative, developmentally mature ones (Rogers & Dawson, 2010).

Other interventions, which focus mainly on parent-child joint attention and communication (e.g., Green et al., 2010; Kasari et al., 2014) do not specify their theoretical and clinical approach to the child's RRBI. In Harrop's (2015) review of 29 evidence-based, parent-mediated EIs in the context of RRBI, none of these parent-mediated interventions focused primarily on RRBI as a primary intervention target or outcome. Additionally, the majority of these interventions did not even include strategies to address RRBI.

## Measuring RRBI Outcomes in Comprehensive Early Interventions

Comprehensive EI models attempt to reduce RRBI that interfere with learning by focusing on expanding social and communicative skills and behaviours so that stereotyped and repetitive behaviours within the child's repertoire are reduced as a result of social interactions becoming more rewarding. Thus, as the RRBI are not a direct target of the intervention, they are typically not assessed or reported as outcome measures in intervention studies (Harrop, 2015). The improvements documented among children in early intensive interventions are mainly in social-communication skills, overall ASD symptomatology and change in diagnostic status; other commonly reported outcomes are language and cognition abilities and adaptive behaviours (French & Kennedy, 2018; Harrop, 2015).

A systematic review on measures to assess intervention outcomes (McConachie et al., 2015) allows insights regarding how RRBI related outcomes are assessed in the context of early intervention. Measures of RRBI and Sensory processing were examined separately. The measures to assess outcomes of interventions that met inclusion criteria of the review were the RRB scale of the ADOS, which is an observational measure, the RRB scale of the Autism Diagnostic Interview (ADI) and the Repetitive Behaviours Scale-Revised (RBS-R) to collect parent reports on child's RRBI. Measures to assess sensory-related behaviours included in the review were the Sense and Self-Regulation Checklist, Sensory Profile and Short Sensory Profile. Examining the psychometric properties of these measures, the ADOS was the measure with documented moderate sensitivity to change. There is limited evidence suggesting sensitivity to change of the ADI, and there is no available evidence for the RBS-R or sensory measures regarding sensitivity to change (McConachie et al., 2015). Thus, RRBI are measured in interventions as part of the diagnostic process, or as part of an autism severity outcome; yet, in order to measure RRBI and potential changes in them following intervention, there is a clear need to develop and utilise measures that are more individualised and (more) sensitive to change.

Evidence for changes in RRBI in the context of EI is limited compared to other outcomes. The ADOS total algorithm score is comprised of the Social Affect (SA) and Restricted Repetitive Behaviour (RRB) scales. Interestingly, ASD symptomatology outcomes in EI studies usually include total ADOS algorithm scores or the SA scales while changes in the RRB scales are less commonly reported (French & Kennedy, 2018; Harrop, 2015). Next, we will review the evidence from therapist and parent delivered EI on RRBI.

### *Therapist-Delivered Early Interventions and RRBI*

In the ESDM randomised controlled trial (RCT), 48 toddlers with ASD were randomised to intensive ESDM or to a typical community treatment (e.g. developmental preschool which typically includes special education and related services such as speech and language therapy and occupational therapy). The RRBI outcomes were assessed via parent reports on the RBS. While finding significant improvements in children's cognitive and adaptive functioning and change in their ASD diagnosis, there was little evidence of change in parent reported RRBI (Dawson et al., 2010). In a 2-year follow-up, the SA and RRB scales of the ADOS served as separate outcome measures. Here, demonstrating long-term efficacy, the ESDM intervention groups showed significantly lower ADOS total scores (indicating less symptoms) compared to the treatment as usual group; the intervention group had also lower RRB scores – an unexpected result that was not observed in the short-term follow up. Scores on the parent-reported RRBI, as in the early follow-up study, did not differ between groups in the 2-year follow up (Estes et al., 2015).

Boyd et al. (2011) conducted a multi-site longitudinal study involving 198 children who were participating in three different CTMs. Overall significant gains and improvements in social-communication skills and ASD severity were reported among all children. However, RRBI across all groups remained constant over time, based on both parent and teacher reports on the RBS (Boyd, McDonough, Rupp, Khan, & Bodfish, 2011). Different results were observed in a study involving 86 children who received intensive EI services in Greece (average of 24 hours per week). Makrygianni and Reed (2010) found reductions in RRBI following 9 months of EI, as assessed via parental reports with the RBS (Makrygianni & Reed, 2010).

Effects of PRT on RRBI were documented in an open-trial involving 15 children, who received 16 weeks of PRT. RRBI were assessed with parental report on the RBS-R and the Stereotypy subscale of the Aberrant Behaviour Checklist. Regardless of initial severity, significant reductions in RRBI from baseline to the endpoint were documented for a variety of RRBI. Interestingly, this improvement was independent of the improvements in the social-communication domain - thus suggesting a more direct effect of the PRT on RRBI, although this EI explicitly targets social-communication behaviours (Ventola et al., 2016).

### *Parent-Mediated Interventions and RRBI*

In the Early Social Interaction (ESI) trial (Wetherby et al., 2014), 82 children with ASD and their caregivers were randomised to two different types of intervention delivery – i.e., individual versus group ESI. Improvements from baseline to the end of the 9-month interventions were documented in all children's social-communication behaviours, measured with the ADOS-SA scale. No difference was found between the two interventions on RRBI, measured by the ADOS-RRB scale, which were found to increase over time similarly in both groups (Wetherby et al., 2014). This increase in RRBI, regardless of intervention, resonates with evidence from observational studies, documenting trajectories of increasing RRBI over time among young children with ASD (Richler, Huerta, Bishop, & Lord, 2010; Wolff et al., 2014).

In the pilot study of the parent-mediated communication trial (PACT), 28 preschool children were randomized to the intervention, involving psycho-educational sessions for parents comprising six monthly treatment sessions and six maintenance sessions versus routine care alone (Aldred et al., 2004). The intervention focus is on parental communication behaviour during interaction with their child, aimed at enhancing shared attention and parental responsivity. The results indicated a non-significant ($p = .086$) improvement on the ADOS-RRB scale in the intervention group compared to the control group. However, in the later PACT RCT, ASD severity was assessed with the ADOS-SA scale and total algorithm score, with small intervention effects; results were not reported separately for the ADOS-RRB scale (Green et al., 2010).

In a pilot study of another parent-mediated intervention for one-year-old children at risk for ASD, 16 children were randomised into the intervention group versus referral to community services (Baranek et al., 2015). The Sensory Processing Assessment, a play-based measure, and the parental report on the Sensory Experience Questionnaire were used to measure children's hyper- and hypo-responsiveness to sensory stimuli. Compared to children who were referred to community services, children in the intervention group showed better receptive language skills, their parents showed less directive interaction behaviour and reported better communication and socialisation adaptive skills thus demonstrating positive effects of the intervention with regards to child social communication. Parents in the intervention group reported *higher* levels of their child's hyper-responsiveness and *lower* levels of hypo-responsiveness than parents in the control group thus demonstrating mixed results with regards to parental report on child sensory responsivity. Observed-based child responsivity did not significantly change following the intervention. However, these outcomes were not replicated in a recent RCT, including 87 children, that showed minimal evidence of intervention efficacy on children's outcomes (Watson et al., 2017).

Harrop et al. (2016), Harrop, McBee, et al. (2016) examined the effects of a 10-week caregiver-mediated JASPER (Joint Attention, Symbolic Play, Engagement, and Regulation) intervention on RRBI. This study is one of the first to use a detailed behavioural coding of videotaped parent-child interactions, before, after and 6 months post-intervention to assess RRBI related outcomes. The videos were

coded for three RRBI variables: the occurrence and type of child RRBs; parental response to the child RRB (i.e., did the parent respond to the child behaviour and if so was it a verbal, physical, or redirection response); and success of parental response (i.e., was it followed by the child stopping the behaviour or engaging in a positive, communicative behaviour). As the intervention, targeting social-communication behaviours, has previously shown effects on child joint engagement, play, and parental behaviour, 'spill-over effects' were expected on RRBI. This study involved 86 child-caregiver dyads already receiving intensive intervention, randomised to additional active JASPER coaching or to additional parent-education weekly sessions. Based on coding of the videos, all children, regardless of intervention group, showed stable rates of RRBI during the intervention, and an *increase* in the 6-months follow-up. The authors suggest that this trend is in line with previous studies on trajectories of RRBI in children with ASD, and the relative lack of change in child RRBI is understood in light of the focus of the intervention on social-communication behaviours. Although there was no improvement in the child's observed RRBI, changes in parental behaviour in the parent-child interaction in regards to RRBI was observed. An improvement in caregiver's responses to the child's RRBs was observed for both groups, but was larger for the JASPER group, who responded to more child RRBI - i.e., more of the child's RRBI were followed by a parental response and not ignored or un-noticed. The success rates of parental responses improved for both groups as well, to a slightly larger extent in the JASPER group (Harrop et al., 2016).

To summarise, as apparent from the studies reviewed, there is limited evidence regarding effects of EI on child's RRBI. The results also appear mixed, with initial results differing from follow up studies (e.g. Dawson et al., 2010; Estes et al., 2015) and pilot results not replicated in the main studies (e.g. Baranek et al., 2015; Watson et al., 2017). Some studies show decreases in RRBI following intervention, whilst others show stability or increased RRBI over time. Parent-mediated interventions, which are increasingly common, often do not include strategies for parents to respond to their child's RRBs. Notably, these interventions are designed around parent-child interactions. Child RRBI occur frequently during parent child interactions, and are commonly followed by various parental responses, which are not always successful in stopping or redirecting the child (Harrop et al., 2016; Harrop, Tu, Landa, Kasier, & Kasari, 2018) resulting in increased parental distress (Harrop, McBee, et al., 2016). Thus even if the parent-mediated intervention does not explicitly target reduction of RRBI, it is important to include strategies to support and direct parents regarding how to respond to their child's behaviour, including RRBI, in a way that will enhance communication, joint engagement and learning opportunities (Harrop, 2015).

## *RRBI as Predictors of Early Intervention Outcomes*

Behavioural characteristics related to RRBI were examined in several EI studies as potential predictors of treatment outcomes, identifying behavioural profiles of children who may be more or less responsive to a specific intervention. In a study com-

paring two social-skills interventions (Shih et al., 2016), different 'responder profiles' were identified by conducting assessments at baseline, mid- and end-points of the intervention. These profiles were determined by the initial levels of social engagement and the extent and rate of progress in social engagement during the intervention. These responder-groups differed on several baseline characteristics, including the RRB domain of the ADOS. The group of children who entered the study with low initial engagement and who did not make substantial progress in the intervention had the highest initial levels of RRBI compared to children in the other sub-groups (Shih, Patterson, & Kasari, 2016), again indicating that RRBI may interfere with learning.

Vocal repetitiveness/stereotypy was examined as a potential predictor of response to PRT intervention in two studies, yielding conflicting results. Using a single subject design, Sherer and Schreibman (2005) examined videos of the baseline assessments of six children receiving PRT to identify behavioural differences between responders and non-responders. The results showed that appropriate engagement with toys, less avoidance of people, and more stereotyped and repetitive vocalizations/verbalizations at baseline characterized children who made more gains in the intervention – i.e., 'responders' (Sherer & Schreibman, 2005). Different results with regards to vocal repetitiveness were reported in a later study, with a community sample of 57 children who participated in a 1-year intervention. The children who showed greatest gains in the expressive language domains were characterized at baseline by higher expressive language and cognitive skills, more positive affect and appropriate toy engagement, less social avoidance and **less** stereotyped and repetitive vocalizations (Fossum, Williams, Garon, Bryson, & Smith, 2018). The authors suggest that the discrepancy between the studies may be explained by the different baseline characteristics of the participating children and the outcome measure. In the 2005 study, children had lower cognitive and spoken language skills relative to those in the later study. It may be that among these children, any vocal production, even repetitive, provided interaction and teaching opportunities and thus were associated with improved gains. For the children in the later study, in which outcomes were measured in terms of gains in expressive language, more repetitive vocalizations may have reduced progress in expressive language acquisition (Fossum et al., 2018).

## Measuring RRBI Outcomes in Focused Intervention Practices

Several reviews on FIPs addressing RRBI are available (DiGennaro Reed, Hirst, & Hyman, 2012; Odom, Boyd, et al. 2010; Odom et al. 2010; Patterson, Smith, & Jelen, 2010; Rapp & Vollmer, 2005; Raulston & Machalicek, 2017). In general, many of these EIs stem from behavioural science and ABA. Strategies to reduce unwanted behaviours, also called Positive Behavioural Support, are conceptualised as antecedent-based or consequence-based. Antecedent-based strategies change the conditions before the targeted behaviour occurs by modifying the environment and/

or the child's repertoire in a way that will reduce the likelihood of the unwanted behaviour to occur. Consequence-based strategies focus on what happens after the unwanted behaviour occurs, attempting at un-coupling or disrupting the association between the behaviour and the reinforcing consequence.

Antecendent-based strategies for RRBI's include enriching the child's environment with competing alternative reinforcers – i.e., more adaptive toys that he/she likes, removing positive reinforcers of the non-adaptive behaviour, or providing "matched" alternatives such as more adaptive objects for RRBI (environment modification/stimulus control). Notably, it may be insufficient to simply introduce alternative objects and activities, so that the practitioner prompts the child to engage with the alternative objects and to engage in other behaviours. Antecendent-based strategies may also include expanding the child's behavior and play repertoire and teaching him/her alternative ways to communicate his/her needs (skills enrichment, functional communication training). Other antecedent based startegies may include visual cues and schedules or video guided technologies to indicate times when a child is allowed or not to engage in specific behaviours and to guide transitions between activities (Boyd et al., 2012; Odom, Boyd, et al. 2010; Odom et al. 2010). Another strategy that has shown some promise in reducing stereotyped behaviour, yet not fully understood, is physical exercise (Boyd et al., 2012). Bremer, Crozier, and Lloyd (2016) recently conducted a comprehensive systematic review to examine effects of a range of exercise interventions (jogging, horseback riding, martial arts, swimming or yoga/dance) on various outcomes amongst children with ASD. In six studies involving RRBI-related outcomes, children engaged in physical activity prior to an activity in which RRBI commonly occur. A significant decrease in RRBI was documented in five out of the six studies. In one study in which RRBI were assessed at post-intervention and 30 days post-intervention, significant reductions in RRBI were observed from pre to post-intervention, but not at the follow-up. Thus, it seems that while showing immediate effects, there is still a need to maintain these effects. It has been hypothesized that the physical activity may provide the child with a similar, competing intrinsic reinforcer as the stereotypic behaviour, or that it changes the child's arousal levels and thus decreasing the child's need to engage in RRBI as a means of regulating his/her arousal (Boyd et al., 2012).

Consequent-based interventions include stopping the child from engaging in the RRBI by physically or verbally interrupting and redirecting his/her to another behaviour (response interruption/redirection), uncoupling the behaviour-reinforcer association by removing or terminating the reinforcer (extinction), and reinforcing alternative behaviours (differential reinforcement). The intervention may build opon the child's restricted play and expand it. For example, the pratctioner may imitate the child's repetitive behaviour of driving a car back and forth, or lining up cars, and gradually expand the child's repertoire to include more symbolic and social elements – such as two cars crashing or chasing, cars having a driver and passengers, lining up to go into a garage to be fixed, etc. (Koegel & Koegel, 2006; Rogers & Dawson, 2010). Different interventions have been recommended for different types of RRBI as listed below (Boyd et al., 2012; Lanovaz

& Sladeczek, 2012; Odom, Boyd, et al. 2010; Odom et al. 2010; Raulston & Machalicek, 2017).

For *repetitive body movements, vocalisations and object manipulation (stereotypies*), the recommended antecedent-based strategies include environmental modification and enrichment, skill enrichment, functional communication training, visual cues and schedules, and physical exercise. Consequence-based strategies include extinction, response blocking, interrupting or redirecting, and differential reinforcement. For *insistence on sameness,* differential reinforcement is suggested to expand behaviours and encourage novel interests, and visual schedules and video-based technologies are recommended to ease difficulties in tolerating changes and uncertainties in routine. For *circumscribed interests*, as an intense interest in an area may not necessarily interfere with functioning, but could actually be a strength, interventions are generally not deemed as necessary. Rather, the child's motivation in the circumscribed area is commonly built upon and capitalised for teaching new skills and improving social and comunication skills. These intersets can be used in antecedent-based strategies, including the child's interest in an activity to increase motivation or as a consequence; for example using the Premack principle with a child's interest – when teaching a child to sort toys, pack-away or to perform an activity he/she does not want to, the practiotioner can offer the motivating activity/interest after the child has completed the less-desired activity.

Odom and collegues (Odom, Boyd, et al. 2010; Odom et al. 2010) identified 24 practices (FIPs) adressing a range of targets for children with ASD that met predefined criteria for evidence-based practice. The Positive Behavioural Support strategies that were identified as established evidence-based practices included: functional behavioural analysis, stimulus control/environmental modification, response interruption/redirection, functional communication training, extinction, and differential reinforcement. Addional evidence-based practices identified by Boyd et al. (2012) in a review that focused on the higher-order RRBI were cognitive behaviour therapy techniques of cognitive reframing and exposure, and visual schedules, however these are only suitable for older and more able individuals with ASD.

In their review, DiGnennaro and colleagues (2012) provide a descriptive overview of empirical studies using behavioural interventions to treat stereotypy (motor, vocal repetitive behaviours and non-functional manipulation of objects) in 3- to 18-year old children with ASD. Summarising evidence of assessment and intervention practices for a total of 128 individuals, the authors note that the majority of the intervention studies did not include a functional behavioural assessment to identify the function of the behaviour. The common strategies were consequence-based and despite its critical importance, most studies did not include a measurement of treatment integrity (DiGennaro Reed et al., 2012).

Given the potential association between RRBI and social learning, Lanovaz, Robertson, Soerono, and Watkins (2013) conducted a systematic review exploring the 'spill-over' effects of reduction of RRBI on other behaviours (Lanovaz et al., 2013). The review included 60 studies, mostly case studies, in which strategies to reduce RRBI were effective, and another behavioural outcome was measured,

including a total of 218 individuals with ASD and other developmental disabilities. The results of this review suggest that, in general, the reduction of stereotyped behaviours may be associated with an increase in other behaviours. Notably, sometimes these are adaptive behaviours, but sometimes the targeted reduced behaviours are replaced by other non-adaptive behaviours. Thus, it is important, in planning the intervention, to purposefully strengthen alternative adaptive behaviours. Focusing on eliminating the RRBI in itself may not be sufficient without introducing new alternative activities (Lanovaz et al., 2013).

## *Parent-Mediated Focused Interventions for RRBI*

Several parent-delivered interventions have been developed to specifically target RRBI. Boyd et al. (2011) developed the Family-Implemented Treatment for Behavioural Inflexibility (FITBI) co-implemented by a therapist and parents of five children with ASD over 12 weeks. A significant decrease in RRBI was documented for all participants at post-intervention, and maintained for most of them (Boyd et al., 2011). In another single case pilot study involving three young children with ASD, Lin and Koegel (2018) used an intervention based on self-management and PRT principles, specifically designed to address high-order RRBI. The intervention aims at expanding children's interests and improving behavioural flexibility, with gains noted in observed and parent-reported child flexibility and an increased variety of activities engaged in by the children. An increase in positive parent and child affect during interaction was also observed, as well as overall reduction in parent ratings on the Repetitive Behaviour Questionnaire (Lin & Koegel, 2018).

The 'Managing Repetitive Behaviours' program (Grahame et al., 2015) is an 8-week group intervention for parents, specifically targeting RRBI. It is designed to help parents understand RRBI and apply functional analysis and behavioural strategies to effectively address their child's RRBI. The intervention was developed in consultation with parents, incorporating evidence-based practices, video feedback, interactive activities and emphasis on mutual support and knowledge-sharing among parents, to build their confidence and capacity in managing their child's behaviour. A pilot RCT of the program involving 25 families assessing feasibility, acceptability and initial outcomes has shown promising positive results. A larger-scale RCT is now needed to establish the efficacy of the program (Grahame et al., 2015).

## *Sensory-Based Interventions*

Although evidence suggests that most individuals with ASD have sensory related difficulties, which have substantial effect on learning and daily functioning (Lane, Young, Baker, & Angley, 2010; Weitlauf, Sathe, McPheeters, & Warren, 2017), the

evidence base for the diagnosis and intervention of sensory difficulties is still developing (Uljarević et al., 2017), particularly given their recent inclusion as diagnostic criteria (APA, 2013). Sensory -focused strategies commonly target sensory aversions (e.g. sensitivity to light and sounds), and address processing deficiencies (e.g. prolonged visual examination, sensory seeking, hypo-responsivity). Broadly, interventions targeting sensory challenges involve the incorporation of sensory experiences (e.g. sounds, texture, pressure), and are largely dominated by Sensory Integration therapy and Sensory-based approaches. Sensory Integration therapy is a clinic-based approach using combinations of sensory and kinetic stimuli in child-directed activities to improve the child's adaptive responses. Sensory-based interventions are characterized as classroom-based interventions that use single-sensory strategies such as balls, vests, or swings to influence a child's state of arousal (Case-Smith, Weaver, & Fristad, 2015).

There is some promising evidence on the efficacy of sensory-based interventions in goal attainment and the reduction of negative response to sensory activities (e.g., Fazlioğlu & Baran, 2008; Schaaf et al., 2014; see Weitlauf et al., 2017 for a review) but mixed results are also apparent (Barton, Reichow, Schnitz, Smith, & Sherlock, 2015; Watling & Hauer, 2015). The evidence to support the use of sensory-integration therapy is only moderate to date. Despite substantial progress over the last years and initial promising results, considerable heterogeneity in study design and populations, restricted study quality with high risk of bias, limited follow-up periods, and lack of treatment fidelity- limits the evidence base for these interventions. It remains unclear how these interventions work, what the underlying mechanisms targeted are, as well as how generalizable any improvements may be over time to other settings (Barton et al., 2015; Case-Smith et al., 2015; Weitlauf et al., 2017). Larger studies are needed with adequate samples, using fidelity measures, and longer-term follow-ups with carefully operationalized definitions and systematic methods to address the efficacy of sensory integration therapy for children with ASD.

Other interventions to address a range of sensory related difficulties in ASD have been identified in a recent systematic review. These include interventions based on environmental enrichment, auditory integration, music-therapy, massage, tactile-based tasks and weighed blankets (Weitlauf et al., 2017). These strategies and techniques are usually employed in conjunction with other interventions, with mixed evidence so far, from relatively small and potentially biased studies to support efficacy for these approaches. Environmental enrichment strategies involve exposure to the sensory stimuli the child shows aversion to, in order to promote his/her tolerance of them. Evidence from two small RCTs involving the same protocol, suggests efficacy in improving sensory reactivity as well as ASD symptomatology, receptive language and non-verbal IQ following an environment-enrichment protocol (Weitlauf et al., 2017; Woo, Donnelly, Steinberg-Epstein, & Leon, 2015; Woo & Leon, 2013). Interventions incorporating auditory components, such as filtered sound to ameliorate sensory processing challenges show some evidence of improvement in parent-reported hearing sensitivity from several studies, with relatively small samples with potential risk of bias (Weitlauf et al., 2017). Music therapy-

based interventions, involving playing or singing music, or movement to music, show mixed evidence, with improvements in social-communication outcomes documented in several small RCTs, however RRBI or sensory behavioural outcomes were not reported (e.g., Gattino, Riesgo, Longo, Leite, & Faccini, 2011; Srinivasan, Eigsti, Gifford, & Bhat, 2016). As these interventions varied in their techniques and strategies, and sample sizes were relatively small it is difficult to generalise conclusions regarding music-therapy based interventions across the different studies (Geretsegger, Elefant, Mössler, & Gold, 2014; Weitlauf et al., 2017). Massage-based interventions incorporate touch-based approaches by a therapist or caregiver. Studies involving massage compared either massage intervention versus no massage, or massage intervention added to other treatments versus treatment without massage intervention. Results from these studies show promising evidence that massage can improve ASD symptom severity and sensory-related difficulties (Lee, Kim, & Ernst, 2011; Weitlauf et al., 2017). Various alternative and complementary therapies and techniques are in wide use for children with ASD for a variety of difficulties, including RRBI (Höfer, Hoffmann, & Bachmann, 2017; Perrin et al., 2012). However, there is insufficient evidence regarding their efficacy in improving children's outcomes despite their extensive use, and therefore further research is needed.

## Summary and Conclusion

While there has been much progress in measuring social, communication, cognitive and adaptive functioning in the context of ASD early intervention, there is relative paucity of evidence on the outcomes of interventions on RRBI. There may be a few reasons accounting for this lack of outcome data. First, social communication deficits are considered primary to ASD while RRBI are also evident in other conditions. The heterogeneity in RRBI in terms of their clinical significance, functions and underlying mechanisms may also contribute to the relative lack of EI research on RRBI. Finally, the availability of standardised tools to assess RRBI, based on behavioural observation and parental report that are sensitive to change is limited.

The evidence from studies in which RRBI related outcomes were reported has yielded mixed results regarding the effects of intensive EI programs on children's RRBI, suggesting the need for more well-designed research in this area. It is also important to consider the association between parental stress and children's RRBI, which indicates the need to support parents so that they can appropriately and effectively respond to and manage their child's RRBI. Indeed, it is important to increase knowledge about RRBI more generally amongst both parents and professionals.

Both prospective observational and intervention studies provide valuable information on how child baseline features may serve as prognostic factors or moderating factors in intervention. With large heterogeneity in intervention outcomes, it is understood that intervention is not a "one size fits all" such that a specific intervention will be more effective for children with specific characteristics (e.g. age, lan-

guage abilities). Hence, the importance of individualised treatment plans is increasingly acknowledged. Given emerging evidence that children's RRBI characteristics may impact intervention outcomes, RRBI characteristics, their context, functions, and interference with learning should be considered as potential moderators/mediators of intervention outcomes. These topics deserve more research, and the assessment of RRBI is thus important in the process of choosing and planning an intervention.

Assessing RRBI as part of planning an intervention differs from assessing the RRBI for diagnostic purposes where the focus is on the presence of these behaviours. Knowing that RRBI are present (as needed for a diagnosis) is not sufficient information for planning an intervention. It is important to assess how the RRBI relate to the other difficulties, which are the particular RRBI behaviours that impede social relatedness, and which should be targeted with the appropriate strategies to reduce, expand, constrict to specific times or replace with more adaptive or socially acceptable behaviours. If behaviours serve a function, alternative ways to address the need should be considered. RRBI can also be identified as potential reinforcers to be used to facilitate learning and skill acquisition, while other behaviours that do not disrupt learning and daily function should be accepted, tolerated, and perhaps even encouraged to facilitate better outcomes for people with ASD.

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The Boyd (2001) citation is an error, it should be the same reference as above from 2011.

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