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Evidence-Based Behavioral Interventions for Repetitive Behaviors in Autism

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Abstract

Restricted and repetitive behaviors (RRBs) are a core symptom of autism spectrum disorders (ASD). There has been an increased research emphasis on repetitive behaviors; however, this research primarily has focused on phenomenology and mechanisms. Thus, the knowledge base on interventions is lagging behind other areas of research. The literature suggests there are evidence-based practices to treat “lower order” RRBs in ASD (e.g., stereotypies); yet, there is a lack of a focused program of intervention research for “higher order” behaviors (e.g., insistence on sameness). This paper will (a) discuss barriers to intervention development for RRBs; (b) review evidence-based interventions to treat RRBs in ASD, with a focus on higher order behaviors; and (c) conclude with recommendations for practice and research.

Keywords

Autism spectrum disorders; Evidence-based practices; Repetitive behaviors

Introduction

A clinician, who has little knowledge of a child’s social functioning or communication abilities, when told a child repetitively flaps his arms, spends hours lining up toy cars, will not tolerate changes in routine, and has a peculiar fascination with electric fans—is highly likely to suspect the child has autism. Such restricted and repetitive behaviors (RRBs) are a core diagnostic feature of autism spectrum disorder (ASD) (ICD-10, World Health Organization 1990; DSM-IV, American Psychiatric Association 2000). This symptom domain has been conceptually and empirically grouped into at least two categories—“lower order” and “higher order” behaviors (Szatmari et al. 2006; Turner 1999). Lower order motor actions (i.e., stereotyped movements, repetitive manipulation of objects, and repetitive forms of self-injurious behaviors) are characterized by repetition of movement, and more complex or “higher order” cognitive behaviors (i.e., compulsions, rituals and routines, insistence on sameness, and circumscribed interests) are characterized by a rigid adherence to some rule or mental set (e.g., needing to have things “just so”) (Turner 1999). Although research on

repetitive behaviors in autism appears to be growing, this is largely in the area of phenomenology and mechanisms. A focused program of research on intervention practices for repetitive behaviors in ASD seems to be lagging behind similar research efforts for other core features of the disorder. In this paper, we will review the existing literature on interventions for repetitive behaviors in ASD with an emphasis on (a) some features of the phenomenology of repetitive behaviors in ASD that may present barriers to the development of focused intervention practices; (b) a summary-level description of what we do know about evidence-based practices for RRBs at this time, as well as a discussion of what we don't know in terms of gaps in the current intervention literature; and (c) future directions for clinical practice and research.

There is evidence that the presence of repetitive behaviors can negatively impact the learning (Koegel and Covert 1972; Varni et al. 1979; Pierce and Courchesne 2001) and socialization (Loftin et al. 2008; Nadig et al. 2010) of individuals with ASD. Further, a growing body of research provides evidence that these behaviors also affect family functioning and well-being, often leading to increased stress levels (Bishop et al. 2007; Lounds et al. 2007; Shattuck et al. 2007) and engendering more negative parenting styles (Greenberg et al. 2006). When the research on child and family well-being is coupled with evidence that repetitive behaviors present *atypically* early in the lives of young children with ASD (Morgan et al. 2008; Ozonoff et al. 2008; Watt et al. 2008), there is the potential for any cascading effects to be detrimental to later developmental outcomes. Thus, there appears to be a clear need to develop and evaluate the effectiveness of interventions to offset the impact of repetitive behaviors on the child and family. Yet, when compared to the burgeoning number of evidence-based, behavioral interventions to treat social-communication symptoms of ASD (Kasari et al. 2006; Schertz and Odom 2007), there remains a lack of a focused program of research in the field to address the RRB symptom domain.

Phenomenology of Repetitive Behaviors in ASD

Some of the potential barriers that may be associated with the relative paucity of research on behavioral interventions for RRBs in ASD include: (a) the assumed primacy of social deficits relative to repetitive behaviors as defining features of the disorder; (b) the fact that repetitive behaviors do not appear to be a unitary construct in ASD as there are a variety of forms which may differ in clinical significance, function, and underlying mechanism; (c) the fact that a host of factors such as age, cognitive ability, and family factors can moderate the expression of repetitive behaviors in ASD; and (d) the potential phenotypic overlap between repetitive behaviors and other features of the ASD behavioral phenotype, such as sensory-motor features or comorbid psychiatric symptoms (e.g., anxiety and hyperactivity).

Primacy of Social Deficits Versus Repetitive Behaviors in ASD—Lack of social reciprocity is commonly assumed to be the central and defining feature of autism (Lord et al. 2000). Thus, the universality of social deficits and their relative specificity to ASD create an obvious focus and motivation for intervention research efforts. Repetitive behaviors, on the other hand, are not specific to ASD, being common in individuals with a variety of other neurodevelopmental (e.g., Fragile X syndrome, Rett's syndrome), psychiatric (e.g., Obsessive-Compulsive Disorder, Impulse Control Disorders), and neurological disorders (e.g., Tourette syndrome, Parkinson's Disease) (Lewis and Kim 2009). However, the occurrence of repetitive behaviors in ASD appears to be characterized by an elevated pattern of occurrence, co-occurrence, and severity relative to other neurodevelopmental disorders (Bodfish et al. 2000), which highlights the need for behavioral interventions that take into account the specific types and patterns of these behaviors found in individuals with autism. In addition, repetitive behaviors have been found to be highly related to parental stress

among families of children with ASD (Gabriels et al. 2005), and parents commonly report that repetitive behavior symptoms are among the most difficult aspects of the disorder they have to tackle on a daily basis (South et al. 2005).

Heterogeneity of Repetitive Behaviors in ASD—An important aspect of the clinical phenomenology that has likely stifled intervention research and practices for this symptom domain is the sheer heterogeneity of repetitive behaviors in ASD. As previously mentioned, there have been a number of studies demonstrating that the RRB symptom domain is comprised of at least two subtypes—“higher order” and “lower order” behaviors (Bishop et al. 2006; Cuccaro et al. 2003; Szatmari et al. 2006; Richler et al. 2007, 2010), with some studies finding more than two subtypes (Lam et al. 2008). The subtyping studies that yielded more than two RRB factors have found evidence for circumscribed or fixated interests, preoccupations, and attachments as a distinct subtype (Honey et al. 2008; Lam et al. 2008). This subtype may be of particular interest in autism, because unlike motor stereotypies and compulsions (which are found in other disorders such as OCD, Tourette’s syndrome, and mental retardation), these behaviors may be particularly characteristic of the disorder. Emerging evidence also suggests a differential genetic basis for the RRB subtypes (Cannon et al. 2010), with higher order behaviors thought to run in families more often than lower order ones (Cuccaro et al. 2003; Hus et al. 2006; Lam et al. 2008; Szatmari et al. 2006). It is also possible that these subtypes differ with respect to underlying neural circuitry (Langen et al. 2010).

Moderators of Repetitive Behaviors in ASD—Several factors appear to moderate the clinical expression of repetitive behaviors in ASD. Chronological age is one such moderating factor associated with the expression and severity of repetitive behaviors. It is now clear that both lower and higher order forms of repetitive behavior are present in many cases of ASD by 2–3 years of age (Bishop et al. 2006; Honey et al. 2007; Militerni et al. 2002; Mooney et al. 2006) and manifest with sufficient severity to warrant early intervention (Bishop et al. 2006). Further, in childhood, lower order behaviors have been found to remain stable or decrease over time (Kim and Lord 2010; Murphy et al. 2005; Richler et al. 2010), whereas higher order behaviors have been found to increase in severity over time (Richler et al. 2010); however, the co-existence of an intellectual disability may alter the developmental trajectory of repetitive behaviors (Esbensen et al. 2009; Shattuck et al. 2007).

In fact, there is a growing body of research on the role IQ plays in the expression of repetitive behaviors. In young children, non-verbal IQ (NVIQ) has been found to be associated with lower order repetitive behaviors. The relationship between NVIQ and higher order behaviors is less clear with some studies finding a positive relationship for specific repetitive behaviors (i.e., circumscribed interests; Bishop et al. 2006) or when controlling for particular variables (i.e., the shared variance between higher and lower order behaviors; Cannon et al. 2010), and other studies finding no such relationship (Lam et al. 2008; Richler et al. 2010). Further, social-communication deficits do not appear to account for the expression of RRBs in ASD. For example, Lam et al. (2008) found that the presence of circumscribed interests was unrelated to IQ or severity of social-communication symptoms (although other studies have found a modest relation in younger samples; Richler et al. 2010). Overall findings on the relationship between IQ and repetitive behaviors appear to indicate that cognitive and social-communication deficits do not fully account for the expression of repetitive behaviors in ASD, which suggests that intervention approaches solely focused on improving cognitive or social-communication skills are unlikely to fully impact the repetitive behaviors found in ASD. In support of this notion, a recent landmark study of an early behavioral intervention for young children with ASD found significant treatment-related improvements in both cognitive and social-communicative skills but no corresponding improvement in the RRB symptom domain (Dawson et al. 2010).

It is also clear that family factors can play a role in the expression of repetitive behaviors. Smith et al. (2008) found that in adolescence and adulthood, the parents of individuals with ASD can impact RRB symptoms, with mother–child dyads having a higher relationship quality, more warmth and praise associated with reductions in these symptoms over time. This suggests that behavioral interventions targeting this core feature of ASD should include psychoeducation and training for caregivers.

Phenotypic Overlap of Repetitive Behaviors with Associated Features of ASD

—It also seems likely that phenotypic overlap between RRBs and other autistic features can serve as a barrier to the development or implementation of intervention practices. For example, a common conceptualization of RRBs in ASD involves a hypothesized link between repetitive behaviors and sensory features. The assumption is that atypical sensory processing (e.g., hypersensitivity or hyposensitivity) leads to arousal states (e.g., over or under arousal) and that RRBs can serve as a compensatory strategy in response to these sensory deficits. However, the current evidence suggests these behaviors are only moderately correlated (Boyd et al. 2009, 2010). Further, Boyd et al. (2010) found that primarily only one type (out of three) of sensory feature (i.e., hyperresponsiveness) was associated with the occurrence of repetitive behaviors, which suggests that sensory and repetitive behaviors are mostly distinct phenomena that would require differential treatment approaches. In addition, a variety of non-autism, psychiatric features are commonly observed in persons with autism such as anxiety (Sukhodolsky et al. 2008) and hyperactivity (Ronald et al. 2010), and these comorbid psychiatric disorders may be conceived to act as “drivers” that lead to the manifestation of repetitive behaviors. However, to date there is no clear evidence of a link between these comorbid psychiatric features and RRBs in ASD, and also the few studies that have targeted comorbid psychiatric features for treatment in ASD have failed to find robust collateral effects on repetitive behaviors (Wood et al. 2009; White et al. 2009; Drahota et al. 2010; Posey et al. 2007). Thus, while comorbid psychiatric features are important clinically, and may warrant intervention in their own right, there still appears to be a need to develop intervention strategies specifically focusing on RRBs in ASD.

A Framework for Behavioral and Psychosocial Interventions for RRBs in ASD

An important distinction that can be made in the autism intervention literature is the differentiation of comprehensive treatment models (CTMs) from focused intervention practices (FIPs) (Odom et al. 2009). CTMs (e.g., Denver Model, Lovaas Institute, TEACCH) are conceptually organized treatment packages used to address a broad array of developmental outcomes and skills for children with ASD. FIPs (e.g., prompting, reinforcement, visual supports) are individual instructional strategies that are used to address specific targeted skills or presenting symptoms. Seminal work by Odom, Rogers and colleagues has involved the examination of both CTMs (Odom et al. 2009; Rogers and Vismara 2008) and FIPs (Odom et al. 2010) in relation to accepted evidentiary criteria. As a result of this work, subsets of both CTMs and FIPs can be designated as “evidenced-based practices” for autism intervention. Although definitive evidence (e.g., multiple, independent, methodologically sound RCTs) for the efficacy of both CTMs and FIPs in autism is lacking, it is now clear that (a) specific evidenced-based practices for autism intervention can be identified, and (b) the development of young children with autism can be significantly improved by the delivery of these evidenced-based CTMs and FIPs. While the bulk of the evidence for specific CTMs and FIPs address the areas of communication, social skills, play, cognition, and independence, there is evidence that specific FIPs (e.g., behavioral teaching strategies such as differential reinforcement, response interruption/redirection) can

effectively reduce the occurrence of some types of repetitive behaviors as well as problem behaviors that can be associated with repetitive behaviors in autism, such as aggression and noncompliance (Odom et al. 2010; Horner et al. 2002). We address the evidence base for FIPs targeting the repetitive behaviors of individuals with ASD (see Odom et al. 2009 for a review of CTMs).

Conceptual and Empirical Basis of Applied Behavior Analysis Interventions

One of the most prominent theoretical/conceptual bases for behavioral intervention research is the science of behavior (Skinner 1975), specifically, applied behavior analysis (ABA) (Baer et al. 1968). One of the central tenets of ABA that has rapidly evolved over the last 30 years is functional analysis (Iwata et al. 1982, 1994). The basis of functional analysis is to conduct descriptive and preferably experimental assessments of the individual's problem behavior to identify the reason(s) why (i.e., the function or maintaining consequence) the individual engages in the behavior. Prototypically, the function of challenging behavior can be subdivided into two overarching categories, either the individual engages in the behavior for social purposes (i.e., to obtain attention or tangible objects, or to escape environmental demands) or non-social purposes (e.g., to obtain or escape internal sensory consequences). These categories have heavily informed intervention research because developed treatments often involve the concept of functional equivalence (Carr and Durand 1985), or teaching the individual a more appropriate response to obtain the same desired outcome provided by engaging in the problem behavior. This complicates the development of interventions to target repetitive behaviors as researchers have found that these behaviors may provide non-social reinforcement (Lovaas et al. 1987; Reese et al. 2005), thus it can be difficult to determine what the individual actually gains or escapes, intrinsically, by engaging in the behavior. Lewis et al. (1987) have commented on the potential circular reasoning involved in this conceptualization of non-social or automatic reinforcement as it relates to repetitive behaviors. Still functional analysis methodology has proven largely effective for the purposes of assessment and treatment planning to address repetitive and other problematic forms of behavior (Asmus et al. 2004). In fact, in recent years functional analysis methodology has been extended to better identify other forms of sensory stimulation (e.g., sound producing toys) that may provide similar reinforcement for the individual as engaging in repetitive behaviors (see Rapp 2006, 2007).

Another area of behavioral and developmental psychology that has informed RRB intervention research is the early work on environmental deprivation. This area of research showed that animals (Lewis et al. 2007; Davenport et al. 1966; Mason and Berkson 1975) and humans (Berkson and Tupa 2000) engage in more stereotypic behavior in the absence of a stimulating environment. These combined bodies of research have led to at least three types of interventions used to treat RRBs in ASD (a) consequence-based interventions that involve disrupting the repetitive behavior—reinforcer relationship, (b) antecedent-based interventions that involve modifying the environment or the individual's routine to prevent or reduce the likelihood of repetitive behavior occurring, and (c) antecedent-based interventions that have directly targeted enrichment of the child's environment or skill enrichment by teaching the child adaptive skills to examine any collateral effects on reductions in repetitive behavior. In the following section, we address consequence- and antecedent-based behavioral interventions used to treat lower order and higher order forms of repetitive behaviors found in ASD, with each section organized by the types of repetitive behaviors belonging to that particular category. However, it should be noted that we do not provide an exhaustive review of the behavioral intervention literature (see Patterson et al. 2010 for a systematic review).

Treatment of Lower Order Repetitive Behaviors

Given the extant research and research syntheses on treatment strategies for lower order behaviors, we only pay cursory attention to these behaviors but refer readers seeking additional information on this topic to other sources (see Bodfish 2010; Rapp and Vollmer 2005). Rather, we will focus on promising treatment strategies for higher order repetitive behaviors; yet, we begin with a brief overview of the lower order intervention research (see Table 1).

Stereotypies and Self-Injury—Stereotypic behavior is prototypically defined as repetitive behavior that serves no clear extrinsic purpose or goal, that is, the individual does not appear to be engaging in goal-directed behavior. Self-injurious behavior (SIB) or self-harming behavior refers to a complex set of behaviors that can vary by such characteristics as function, site of injury, underlying mechanism, and whether or not it is repetitive in nature (Schroeder et al. 2001; Symons and Thompson 1997). Again, behavioral intervention research can be subdivided into two overarching categories—consequence-based and antecedent-based interventions. Some of the consequence-based intervention strategies that have been used to treat stereotypies (e.g., repetitive vocalizations) and/or SIB in ASD and other developmental disabilities, include physically or verbally (e.g., saying, “no”) blocking the individual from engaging in the behavior (i.e., response interruption and redirection/response blocking) (Ahearn et al. 2007; Koegel et al. 1974; Liu-Gitz and Banda 2010), removal of a positive consequence when the stereotypic behavior occurs (i.e., response cost procedures) (Athens et al. 2008; Sidener et al. 2005), reinforcing other behaviors the individual displays instead of the problematic behavior (i.e., differential reinforcement) (Azrin et al. 1988) and functional communication training (FCT; Kennedy et al. 2000). FCT is a multi-component intervention that involves teaching the individual an appropriate communication response that can be used to obtain the same reinforcer as the inappropriate behavior, while simultaneously withdrawing reinforcement of the inappropriate behavior (i.e., extinction) (Carr and Durand 1985).

Antecedent-based strategies that have been used to treat stereotypic behavior include providing the individual visual or verbal cues to forewarn him of a change in the activity, engaging in calming (e.g., taking a nap) or highly preferred activities prior to a difficult or less preferred activity (Horner et al. 1997), and engaging in physical exercise. In a somewhat novel study, Conroy et al. (2005) demonstrated that a school-aged child’s engagement in stereotypic behavior decreased when a visual schedule was used to indicate times during the school day when he was allowed and not allowed to engage in the behavior. One of the more replicated findings in the antecedent intervention literature is the effect of physical exercise on the stereotypic responding of individuals with ASD (see Lang et al. 2010a). The intervention often involves the individual engaging in an exercise routine (e.g., jogging, roller skating) prior to participating in a subsequent task or activity that has been associated with stereotyped behavior (Kern et al. 1984); however, the evidence is unclear about maintenance effects of the intervention (Prupas and Reid 2001). It also is not fully understood why engaging in physical exercise leads to subsequent, even if fleeting, reductions in repetitive behaviors. Lang and colleagues proposed two reasons—first, subsequent reductions in repetitive behavior may be an artifact of fatigue; and secondly, that engaging in physical exercise may provide the individual access to the same intrinsic reinforcer as engaging in stereotypic behavior. As Lang et al. point out it is likely the first hypothesis can be ruled out because excessive fatigue is counterintuitive to the concurrent increases in appropriate behaviors that have been found following vigorous exercise routines (Kern et al. 1982; Powers et al. 1992). Another possible explanation for the effects of physical exercise on stereotypy is arousal theory. It has long been postulated that individuals with developmental disabilities, including ASD, engage in stereotypic behavior to attenuate

or intensity their arousal levels, depending upon the environmental circumstances (Turner 1999). Perhaps engaging in physical exercise decreases the need to engage in stereotypy to modulate one's level of arousal. Still as Rogers and Ozonoff (2005) point out the evidence is mixed on the role arousal plays in the sensory or repetitive behaviors of individuals with ASD.

Finally, antecedent-based, environmental enrichment studies have been used to decrease stereotypic responding. This class of interventions involves providing the individual non-contingent access to appropriate, competing sources of reinforcement, such as preferred objects (Rapp and Vollmer 2005). In general, researchers have found positive effects for environmental enrichment (Piazza et al. 2000; Vollmer et al. 1994); however, to produce robust effects the intervention often has to be supplemented with consequence-based treatment approaches, such as social reinforcement (Vollmer et al. 1994). In comparison to environmental enrichment, skill enrichment entails teaching the individual more adaptive skills (e.g., social initiation skills); with the thought being that an increase in appropriate skills will offset the need to engage in behaviors that do not serve a clear purpose or goal. Through a series of single-case design studies, Loftin, Odom and colleagues demonstrated that the use of peer-mediated intervention strategies, direct social skill instruction for the child with ASD, the use of self-monitoring strategies, or some combination thereof, led to increases in children's social interactions with peers and concomitant decreases in stereotypic behavior (Lee et al. 2007; Loftin 2005; Loftin et al. 2008).

Treatment of Higher Order Behaviors

As with lower order repetitive behaviors, an ABA perspective has informed much of the intervention research on higher order repetitive behaviors. One exception to this is the intervention research on obsessive-compulsive behavior in individuals with ASD, which can trace some of its roots to cognitive-behavioral therapy (CBT). Therefore, it is important to understand the conceptual and empirical basis for CBT prior to discussing the larger evidence-base for higher order behaviors.

Conceptual and Empirical Basis of Cognitive-Behavioral Therapy

Evidence-based treatments have been developed and used to treat repetitive behavior in disorders other than autism such as OCD, Tic Disorders, and Impulse Control Disorders. Because OCD and ASD can be comorbid and the disorders appear to share some phenomenologic and pathogenic similarities, it is reasonable to ask if psychosocial, cognitive behavior-based treatments for repetitive behaviors in OCD also would be effective in treating the repetitive behaviors found in ASD (Rapoport and Inoff-Germain 2000). On purely phenomenologic grounds, both OCD and ASD involve both behavioral manifestations (e.g., compulsions in OCD; rituals/routines in ASD) and cognitive manifestations (e.g., obsessions in OCD; insistence on sameness and preoccupations in ASD), although the form or the content of these symptoms differs in the two disorders (McDougle et al. 1995; Zandt et al. 2007) with ASD tending to involve less complex forms of symptom content that is perhaps due to co-occurring cognitive or language impairments. There are other aspects of symptomatology that also seem to differ between ASD and OCD (Bejerot 2007). For example, in OCD repetitive actions (compulsions) are presumed to function to avoid negative mood states (e.g., anxiety) whereas some types of repetitive behavior in ASD are not obviously related to anxiety and even seem to be associated with sensory seeking or positive mood states (e.g., ritualistic/sameness behaviors) (Bodfish 2010; Boyd et al. 2010). Still the similarity between OCD and repetitive behaviors in ASD appears to extend from phenomenology to pathophysiology. There is a confluence of evidence that implicates alterations in fronto-striatal brain circuitry in the mediation of repetitive behaviors in both OCD and ASD (Rosenberg and Keshavan 1998; Shafritz et al. 2008),

which has led to the use of medication treatments (e.g., SSRI's) for repetitive behaviors in both disorders. The other effective form of treatment for OCD is cognitive-behavioral therapy (CBT). In particular, a specific form of CBT termed “exposure and response prevention” (ERP) is an evidence-based treatment for both children and adults with OCD (Abramowitz et al. 2003; Huppert and Franklin 2005; Storch and Merlo 2006). The *exposure* component of ERP typically has involved the repeated, gradual exposure of the client to environmental stimuli associated with symptoms of anxiety and the subsequent expression of compulsive behaviors (Rapoport and Inoff-Germain 2000; Storch 2005). The *response prevention* component has involved the individual's self-inhibition of the compulsive act. ERP itself is based on the behavioral extinction paradigm that anxiety attenuates after repeated exposure to the distress-producing stimulus and repeated prevention of compulsive behavior associated with that stimulus (March et al. 2001). In essence, at the behavioral level the compulsion is no longer negatively reinforced, and thereby extinguished, through inhibiting the compulsive behavior that routinely accompanies the obsessive thought. It has been suggested that at a physiological level repeated exposure to the distress-producing stimulus results in autonomic habituation to that stimulus (Piacentini et al. 2002).

Obsessions and/or Compulsions—We know of only two published studies where CBT was used to treat “repetitive behavior-like” symptoms of individuals with ASD (Lehmkuhl et al. 2008; Reaven and Hepburn 2003), although there are more rigorously designed studies on the use of CBT to address social deficits and comorbid anxiety in ASD (see Lang et al. 2010b; Sofronoff et al. 2005). Also, ABA-based interventions, such as FCT, have been used to treat compulsive-like behaviors (i.e., excessive straightening) in ASD (Kuhn et al. 2009). The two CBT-based research articles were case studies and the research participant had a dual diagnosis of OCD; therefore, the CBT/ERP intervention was primarily used to treat co-occurring symptoms of OCD (e.g., excessive worrying, fear of contamination) instead of the RRBs more commonly found in ASD. Both studies involved traditional elements of CBT/ERP—(a) psychoeducation session(s) with caregivers or children to help reframe their thinking about why the individual engages in obsessive-compulsive behaviors; (b) the development of a stress hierarchy that involves listing symptoms of OCD from least to most distressing to identify the individual's “transition zone” (i.e., the area where the individual has had some success in inhibiting OCD symptoms); and (c) homework assignments that involve the individual practicing ERP techniques outside of the clinic sessions (March and Mulle 1998). Both studies also included modifications to traditional CBT techniques to accommodate symptoms of ASD; for instance, the use of written schedules to denote the sequence of activities that would occur during the therapy session, social stories to manage compulsive asking behaviors, and/or accommodation of the literal style of children's language, such as creating clear “rules” for the individual to follow. Currently, it appears that CBT/ERP could be a promising treatment for individuals with ASD who have a comorbid diagnosis of OCD. However, to date, no studies have addressed the modification of ERP for the treatment of more autism-typical subtypes of repetitive behavior (e.g. insistence on sameness, complex rituals/routines, unusual and intense interests and preoccupations). Further, given the cognitive components (e.g., cognitive reframing) involved in CBT it appears more applicable to individuals with intact cognitive abilities, thus, the application of CBT to individuals with ASD who have co-occurring intellectual or language disabilities is indeed an area for future research.

Circumscribed Interests—Circumscribed interests (CI) have been defined as interests that are unusual in their narrowness of focus, duration of time and/or intensity the individual spends pursuing the interest (e.g., fascination with certain TV shows or characters) (Nadig et al. 2010). CI are a unique category of repetitive behavior because not only may they be specific to individuals with ASD (Lam et al. 2008), but for parents and clinicians they may

reflect “islands of ability” for their children (Mercier et al. 2000); therefore, there may not be an interest in decreasing or eliminating the individuals pursuit of these interests. Yet, the category of intervention research on CI can still be subdivided into consequence- and antecedent-based approaches with the caveat that the CI, itself, is being used as the reinforcer (i.e., consequence) or stimulus that elicits appropriate behavior (i.e., antecedent). Consequence-based uses of CI include the work of Charlop-Christy and Haymes in which the CI was used as either a contingent reinforcer to improve children’s task accuracy (Charlop-Christy and Haymes 1998), or as a differential reinforcer delivered contingently on the non-occurrence of inappropriate behaviors (Charlop-Christy and Haymes 1996). Interestingly, Charlop-Christy and Haymes (1996) found engagement in stereotypic behavior or a CI to be a more powerful reinforcer than food. Antecedent-based uses of CI entail embedding the interest into the task or activity the child is to engage in to increase their motivation to display a desired behavior during that activity. Adams (1998) embedded the CI of five preschool-aged children with autism into pre-academic tasks to increase their task accuracy. There also are at least three published studies in which the CI was used as an antecedent-based intervention to increase the social behavior of children with autism during interactions with peers (Baker et al. 1998; Boyd et al. 2007) or siblings (Baker 2000). For example, Boyd et al. compared the frequency of social initiations and duration of social interactions for preschool-aged children with ASD when engaged in a game with a typical peer that included their CI (e.g., Thomas the train toys) versus a neutrally preferred toy, and found higher amounts of social engagement when the CI was included in the game. Finally, Vismara and Lyons (2007) used CI to improve the joint attention skills of three nonverbal children with ASD.

Routines and Insistence on Sameness Behaviors—This category of higher order behaviors is quite broad, and includes such behaviors as children noticing subtle changes in their environment, insisting their parents drive the same route in the car each time, and repetitiously acting out the same play scenario. Given such a range of behaviors it would be difficult to discuss all of the possible intervention strategies; therefore, we focus on a behavioral intervention technique that could perhaps be applied across a variety of behaviors that comprise this category—differential reinforcement of variability (DRV) in behavioral responding. DRV is a specific type of differential reinforcement that involves reinforcing the individual for varying his behavioral responses (Miller and Neuringer 2000; Neuringer 2004), with the reinforcement being linked to how novel the behavior is. As a practical example, if a child insists on arranging his toys in a single file line, first he may be reinforced for moving one of the toys out of line; next he may be reinforced for actually playing with one toy instead of including it in the line, and so forth. The basic premise behind this behavioral approach is that engaging in novel behavior is incompatible with engaging in perseverative responding (Neuringer 2004). Boyd et al. (in press) recently reported on the effectiveness of DRV, combined with response interruption, to decrease the repetitive behaviors and increase the appropriate behaviors of five preschool-aged children with ASD. It is also important to point out that other intervention techniques, such as visual schedules or video-based technologies have been used quite successfully to help children with ASD tolerate changes to their routine or expand their repetitive play routines (Hine and Wolery 2006; Odom et al. 2003).

Summary and Limitations of Current Behavioral Intervention Research—The field of ABA has made significant and lasting contributions to the evidence-base for the treatment of repetitive behavior in ASD. Currently, there is evidence to support both consequence- and antecedent-based treatment approaches for this symptom domain (Rapp and Vollmer 2005). In addition, the work of Loftin, Odom and colleagues on adaptive skill enrichment also provides support for the importance of teaching appropriate skills that may

counter the individual's need to engage in repetitive behavior. Yet, there is a more established body of ABA research on treatment strategies for repetitive behaviors that comprise the lower order category, although promising treatment approaches, such as DRV, have been identified for higher order behaviors. At issue is the lack of a focused program of research for the RRB symptom domain, which could lead to a more comprehensive treatment approach to target both classes of behaviors, as lower order and higher order behaviors often co-occur in individuals.

Conclusion

There is a growing body of behavioral and biological science research on the etiology, phenomenology, and developmental course of repetitive behaviors in ASD. Yet, this increasing knowledge base does not appear to have led to a commensurate increase in research focusing on behavioral treatments for RRBs in ASD. It does appear as though ABA-based, focused behavioral intervention strategies are effective at reducing some types of repetitive behaviors found in individuals with ASD. We also are learning that some of the psychopharmacological interventions thought to be effective for this symptom domain are not as promising as once hoped (King et al.2009; Volkmar 2009). Thus, there is a place for more research on behavioral intervention strategies to address the full variety of repetitive behaviors found in ASD.

Presently, two gaps exist in the literature on evidenced-based behavioral and psychosocial intervention practices for repetitive behaviors in autism. First, given that there are a variety of discrete types of repetitive behaviors, most of the behavioral/psychosocial intervention research has focused on the lower order forms of repetitive behavior and there is a need for more established evidenced-based practices to treat the quintessential "autistic" repetitive behaviors like rituals, insistence on sameness, difficulty with change, intense preoccupations, attachments and interests (Bodfish 2004). Second, existing studies and their resultant intervention practices have focused primarily on the frequency of occurrence of repetitive behaviors as outcomes, and as a result fail to address the underlying aspect of behavioral inflexibility that is so characteristic of autism. This trait is evident perhaps most clearly in the "higher order" or cognitive aspects of repetitive behaviors, such as sameness behaviors and circumscribed interests. It is reasonable to presume that a child who is more flexible in their ways of thinking and engaging with their environment will have more opportunities to explore and learn a variety of adaptive skills and behaviors (Pierce and Courchesne 2001). Thus, decreasing the child's inflexible patterns of behavior and engagement in repetitive behaviors may make the child more amenable to treatments targeting social-communication or other symptoms of autism. If so, then research on repetitive behavior interventions in ASD may need to focus less on specific topographies of RRB and more on strategies that could impact the overall level of behavioral flexibility and adaptability to promote optimal child and family outcomes.

Recommendations for Practice

The current state of the research on the phenomenology of, and behavioral interventions for, RRBs in ASD lead to at least three recommendations for clinical and educational practice. First, is the importance of functional assessment/analytic methods in the treatment of repetitive behaviors. Even though repetitive behaviors may provide the individual non-social or intrinsic forms of reinforcement, such information is still useful in the selection of treatment strategies. For example, if the actual function of the behavior cannot be identified then antecedent-based, environmental and/or adaptive skill enrichment approaches may prove beneficial. Further, it has been found that the occurrence of some forms of repetitive behavior, such as self-injury is associated with social reinforcement (i.e., a desire to escape environmental demands) (Iwata et al.1994). Thus, assessment of repetitive behavior can

inform intervention selection. Based on the phenomenological research, however, it appears that assessment of RRBs must go further than identifying topographies and functions of these behaviors but attempt to understand the degree to which these behaviors contribute to overall patterns of inflexibility and interfere with the development of other adaptive skills. Second, early intervention could be essential to the treatment of RRBs in ASD. It is known that these behaviors manifest in the early childhood years in ASD and continue into adulthood, thus, there is the potential to counteract the negative developmental sequelae associated with these behaviors through early intervention. Again, at issue, is that current evidence-based practices mainly are effective at reducing lower order and not higher order forms of repetitive behaviors. Finally, there is evidence to suggest that RRBs substantially impact the well-being and health of the family (Bishop et al. 2007; Lounds et al. 2007; Shattuck et al. 2007), and not just the child. Thus, it is important to provide parents education and training on how to effectively address these inflexible and repetitive patterns of behaviors that manifest in their everyday lives.

Recommendations for Research

In 2004, Bodfish posited a fundamental question about the depth of intervention effects: “Do these empirically established forms of behavioral and medication treatment for autism significantly impact those core features that are most characteristic and disabling for persons with autism? (p. 322).” With respect to the repetitive behavior symptom domain in ASD, it appears the answer, then and now, is most likely “no.” The fundamental issue is that there is not an evidence-based behavioral or drug treatment that targets the full variety of RRBs in ASD, or has been shown to alter a putative mechanism suspected to drive the expression of repetitive behaviors in ASD. Interventions must be developed that are effective at treating the continuum of repetitive behaviors found in ASD as well as are appropriate across the range of functioning and intellectual levels found in individuals with the disorder. Further, interventions are needed to address some of the underlying issues that may be associated with RRBs in ASD, such as generalized behavioral inflexibility, and other cognitive mechanisms, including executive dysfunction (Boyd et al. 2009; South et al. 2007) or broader attention issues (Sasson et al. 2008). There is also a need to better integrate behavioral science and neuroscience. For example, Dichter et al. (2010) used fMRI technology to track the treatment outcomes of two adults with ASD who were prescribed Citalopram to treat their repetitive behaviors. The use of brain imaging or other biologically relevant outcome measures (e.g., eye tracking, electrophysiology) in the evaluation of behavioral interventions will help determine if these treatments result in physiological changes that are likely underlying the expression of RRBs in ASD, which is one way to realize the depth of intervention effects. Finally, the integration of genetic methods and findings into intervention science and practice is a growing area of medicine (Sanders 2000) and the prospect of “personalized” interventions are being realized in some areas. Given the clear role of genetic factors in the pathogenesis of ASD, it is reasonable to assume that integration of autism genetics findings with intervention research in RRBs could be fruitful.

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Table 1

Recommended interventions by behavioral topography

Topography	Recommend practice	Brief description	*Supporting evidence
<i>Lower order repetitive behaviors</i>			
Stereotypies and self-injury	Response interruption and Redirection/ response blocking	Physically or verbally blocking the individual from engaging in the behavior	Ahearn et al. (2007); Koegel et al. (1974), Liu-Gitz and Banda (2010)
Stereotypies and Self-injury	Response Cost Procedures	Removal of a positive consequence when the problematic behavior occurs	Athens et al. (2008), Sidener et al. (2005)
Stereotypies and Self-injury	Differential Reinforcement	Reinforce other behaviors the individual displays instead of the problematic behavior	Azrin et al. (1988)
Stereotypies and Self-injury	Functional Communication Training (FCT)	Teach the individual an appropriate communication response that can be used to obtain the same reinforcer as the problematic behavior	Kennedy et al. (2000)
Stereotypies	Visual or Verbal cues	Can provide cues to forewarn individual of a change in the activity, or allow him to engage in calming or highly preferred activities prior to a difficult or less preferred activity	Conroy et al. (2005), Horner et al. (1997)
Stereotypies	Physical Exercise	Have the individual engage in an exercise routine (e.g., jogging, roller skating) prior to participating in a subsequent task or activity that has been associated with stereotyped behavior	Kern et al. (1984)
Stereotypies	Environmental Enrichment Strategies	Involves providing the individual non-contingent access to appropriate, competing sources of reinforcement, such as preferred objects	Piazza et al. (2000), Rapp and Vollmer (2005), Vollmer et al. (1994)
Stereotypies	Skill Enrichment Strategies	Entails teaching the individual more adaptive skills (e.g., social initiation skills); with the thought being that an increase in appropriate skills will offset the need to engage in behaviors that do not serve a clear purpose or goal	Lee et al. (2007), Loftin (2005), Loftin et al. (2008)
<i>Higher order repetitive behaviors</i>			
Obsessions and/or compulsions	CBT/ERP *when OCD is comorbid	Involves engaging in cognitive reframing and exposure response prevention exercises (i.e., inhibiting the compulsive act that typically accompanies the obsessive thought)	Lehmkuhl et al. (2008), Reaven and Hepburn (2003)
Circumscribed interests (CI)	Consequence-based uses of CI	CI is used as a contingent or differential reinforcer delivered contingently on the occurrence of appropriate behaviors	Charlop-Christy and Haymes (1996, 1998)
Circumscribed interests (CI)	Antecedent-based uses of CI	CI is embedded into the task or activity the individual will engage in to increase his motivation to display a desired behavior during that activity	Baker (2000), Baker et al. (1998), Boyd et al. (2007)

Topography	Recommend practice	Brief description	*Supporting evidence
Routines and insistence on sameness behaviors	Differential reinforcement of variability (DRV)	Involves reinforcing the individual for varying his behavioral responses with the reinforcement being linked to how novel the behavior is	Boyd et al. (2010), Miller and Neuringer (2000)
Routines and insistence on sameness behaviors	Use of visual schedules or video-based technologies	Used to help individuals tolerate changes to their routine, or expand their repetitive play behaviors	Hine and Wolery (2006), Odom et al. (2003)

* Articles listed as supportive evidence reflect a selected and representative body of research rather than an exhaustive review