An examination of avoidance extinction procedures in treatment of maladaptive higher-order repetitive behavior in autism

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Abstract

Higher-order repetitive behaviors are key elements to the definition and expression of autism spectrum disorders. Variously labeled compulsion, ritual, or sameness, these complex behaviors cause stress to the individual, interfere with adaptive activities, and generally diminish quality of life. Procedures used to address similar behaviors characteristic of other disorders, such as obsessive-compulsive disorder, frequently share a common basis in avoidance extinction. From basic flooding to cognitive-behavioral therapies utilizing graduated exposure, these methods are well established in ameliorating avoidance maintained behaviors. The present study includes two aims: 1) assess the utility of basic avoidance extinction procedures in treating maladaptive higher-order repetitive behavior among persons with autism, and 2) provide an initial examination of physiological arousal as it pertains to the performance of such behaviors. Three male participants with frequent, nonsocially maintained higher-order repetitive behaviors were selected from a pool of 18 adults with autism and intellectual disability. Results indicated that intervention achieved extinction for 2 of the 3 participants, with the third showing a decrease in target behavior. Heart rate data were available for one participant. Significant differences between epochs related to the presence or absence of the controlling stimulus were detected. Implications and limitations of experimental results are discussed.

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Introduction

Though fundamentally a complex neurological disorder, autism is behaviorally defined. Early definitions of the disorder and current diagnostic criteria alike define autism by behaviors which comprise three core areas: communication deficits, lack of reciprocal social interaction, and restricted, repetitive behaviors and interests (DSM-IV-TR; American Psychiatric Association, 2000; Kanner, 1943). Future definition of autism, which will likely subsume related autism spectrum disorders (ASDs), will streamline the definition to include two core areas: repetitive behavior and social communication, in part an acknowledgement that all communication is necessarily social (American Psychiatric Association, 2010). This forthcoming change reflects that social functioning and repetitive behaviors are fundamental to all ASDs, which currently include autistic disorder, Asperger's syndrome, and atypical autism/pervasive developmental disorder not-otherwise-specified (American Psychiatric Association, 2000).

As key features of autism spectrum disorders and their clinical diagnosis, restricted, repetitive, and stereotyped patterns of behavior, interests and activities manifest themselves in broadly different ways. Extant research addressing these behaviors utilize an equally broad variety of terms to describe such behaviors, with descriptive and operational definitions of terms such as "perseverative", "compulsive", and "stereotypic" inconsistent across studies (Bodfish et al., 2000; Militerni et al., 2002). Even a single term, such as "restricted interests," may vary in definition from person to person and be further mediated by developmental level and overall range of

alternative adaptive behavior, limiting the current usefulness of repetitive behavior labels (Militerni et al.). The category of repetitive behavior is broad and multifarious, providing ample challenges to reliable delineation.

Consistency, however, is found in the acknowledgement of the numerous challenges associated with repetitive behaviors characteristic of autism. All variety of repetitive behaviors may interfere with adaptive activities, such as activities of daily living, education and socialization, cause physical harm and distress to the individual and those around them, and, as a result, generally diminish quality of life (Bodfish, 2004; Gabriels, Cuccaro, Hill, Ivers, & Goldson, 2005; Kennedy, Meyer, Knowles, & Shukia, 2000). To be certain, not all repetitive behaviors are maladaptive (Charlop, Kurtz, & Casey, 1990). Arguably, issues of intensity, frequency, as well as function, should be considered when determining whether any given repetitive behavior requires intervention or not. Indeed, while repetition of behavior can become pathological, many forms of repetitive behavior may be seen as either neutral, adaptive, or developmentally appropriate (Evans et al., 1997). To some degree, all manner of repetitive behaviors are common to typically developing persons across the life-span and are based in evolutionary biology. However, deeper understanding of repetitive behaviors in general would better allow for the development and application of adaptations and treatments to alleviate the negative repercussions associated with maladaptive forms of repetitive behavior, particularly among persons with autism spectrum disorders.

Presently, much remains unknown about repetitive behaviors in autism and

other developmental disabilities. Of the core features of autism, repetitive behavior has received comparatively less attention by way of both descriptive and intervention research. A number of reviews of autism research have noted that repetitive behavior is generally underrepresented in etiological, descriptive, and intervention studies involving the disorder (Bodfish, 2004; Turner, 1999). This dearth of research around repetitive behavior is particularly true of elaborate forms of repetition. Existing descriptive and intervention work in the realm of repetitive behavior largely concerns lower-order motor repetition, such as stereotypy and self-injury, with little attention given to complex repetitive behavior related to restricted patterns of behavior, routines, and rigidity (Bodfish, 2004).

Though complex forms of repetitive behaviors typify autism, they are expressed as part of both normal development and other psychological disorders, such as OCD and Tourette's syndrome (Boyer & Lienard, 2007). The research presented herein conceived of certain forms of complex repetitive behavior in persons with autism as based in avoidance. Through this frame-work, such behavior (often denoted as ritual or compulsive) is established through association with the termination of some real or perceived aversive outcome and maintained through feedback associated with the termination of some conditioned stimulus. Assuming an avoidance model of higher-order repetitive behavior, this study examined the effectiveness of avoidance extinction procedures, such as exposure and response blocking, in remediation of ritual or compulsive-type behaviors among persons with autism. To further examine this conceptualization of ritual or compulsive-type behavior, this study also provides a

preliminary examination of physiological arousal as it pertains to such behaviors.

Literature Review

Owing to a clear need for research specific to the realm of complex repetitive behaviors in autism, this chapter first seeks to describe and differentiate lower and higher order repetitive behavior. Second, prominent elements of higher-order repetitive behavior, namely those variously considered compulsive, ritual, or routine behavior are examined. This entails a discussion of physiological arousal as it pertains to such repetitive behaviors and the measurement thereof. Lastly, relevant intervention options from both human and non-human animal research as they relate to maladaptive higher-order repetitive behaviors will be considered, with a particular focus on avoidance behavior and the extinction thereof.

Categories of Repetitive Behavior

Because of the variety among those behaviors considered repetitive, it is useful to employ categorization according to form and presumed function. The various repetitive behaviors outlined in diagnostic criteria, as well as in numerous studies concerning autism, differ greatly not only in their manifestations but in their neurological operations (Lewis & Bodfish, 1998; Militerni, 2002). To facilitate clear consideration, repetitive behaviors are divided into two classes in the fashion employed by recent studies (Turner, 1999; Lewis, Tanimura, Lee, & Bodfish, 2007). That is, although they do co-occur in persons with autism and related neurodevelopmental disabilities, *lower order* and *higher order* varieties of repetitive behavior will be considered separately. Factor analyses using standard diagnostic tools for autism have provided support for dual dimensions of the overall class of repetitive

behavior, finding distinct subclasses of repetitive motor-sensory movement and rigidity/insistence on sameness (Cuccaro et al., 2003; Richler, Bishop, Kleinke, & Lord, 2006). Though the categorizations of lower- and higher-order are not pro forma, they are helpful in differentiating repetitive behaviors which are phenomenologically different.

Lower-order Repetitive Behavior

Loosely defined, lower-order repetitive behavior consists of dyskinesia and akythesia, perseverative behavior, tics, stereotypy, and self-injury (Lewis & Bodfish, 1998; Turner, 1999). These behaviors may be conceived of as *primarily* consisting of simple repetitive motor behavior, whereas with higher-order repetitive behaviors, more complex cognition is tied to the motivation and expression of the behaviors, and those behaviors themselves are generally more complex in their expression (Lewis, Tanimura, Lee, & Bodfish, 2007). Instances where the distinction between lower- and higher- order are blurred, such as with certain forms of tics and self-injury, will be addressed later in this section. Though the focus of this work falls on higher-order repetitive behavior, the following will briefly review each of those repetitive behaviors considered lower-order so as to provide a contrast with the higher-order realm.

Involuntary repetitive behavior. The broad class of lower-order repetitive behavior is by no means homogenous. One common manner of subdividing these behaviors is to distinguish between those which are voluntary and involuntary. This section will review the involuntary repetitive behaviors dyskinesia, akythesia, and tics.

Dyskinesia and akythisia. Both dyskinesia and akythisia are both considered

neuroleptic-induced involuntary behaviors (Lewis & Bodfish, 1998). That is, these behaviors are believed to result from the use of medications affecting dopamine production, such as first generation and atypical antipsychotics, as well as neuroleptics in general. Dyskinesia is a chronic condition most often associated with prolonged neuroleptic use, while akythisia is typically conceived of as a psychomotor side-effect of such drugs. It is notable that this variety of repetitive behavior is not particular of autism (or of particular prevalence therein) (Turner, 1999). Dyskinesia and akythisia may consist of a variety of behaviors that include, but are not limited to, atypical, repetitive mouth and face movements, twitching, jerking, tongue thrusting, and restless movement.

Tics. While not the result of neuroleptic use, tics are likewise considered involuntary and are typically defined in their relation to psychiatric disorders (e.g., tic disorder or Tourette's syndrome) and may vary from simple to complex. In some cases, tics may resemble complicated repetitive behaviors found in other disorders (e.g. compulsive behavior) but are generally simple in their manifestation (Singer & Walkup, 1991). Lewis and Bodfish (1998) note that tics often manifest as "normal" behavior repeatedly executed. Growing controversy exists regarding the nature of tic related disorders, such as Tourette's, and their relationship to either lower- or higher-order behavior. Although frequently described as involuntary, some have suggested that tics are more akin to higher-order behaviors due to cognitions involved in the performance of these behaviors, making tic disorders more closely related to obsessive-compulsive disorder (OCD) (Leonard et al., 1992).

Voluntary repetitive behavior. The following represent two varieties of consciously produced repetitive behavior, stereotypy and self-injury. As with involuntary repetitive behaviors, self-injury and stereotypy are found in a variety of disorders.

Stereotypy. Though the previously described behaviors may resemble those in the category of stereotypy, it is important to note that stereotypical behaviors are considered voluntary in nature. This variety of repetitive behavior is generally conceptualized as an "excessive production of one type of motor act" (Ridley, 1994, p. 222). Other definitions add an environmental component, as with Berkson (1983, p. 240) who describes stereotypy as unvaried behavior patterns "in response to environmental change". Unlike other repeated patterns of behavior relatively common to humans, stereotypy tends toward constraint of movement, demonstrating fewer "degrees of freedom" in its expression (Newell, Incledon, Bodfish, & Sprague, 1999). However, factors of severity, frequency, and relative constraint affect conceptualizations of typical versus atypical in regard to these matters of degree, making any single definition of stereotypy difficult (Symons, Sperry, Dropik, & Bodfish, 2005). Despite some variance across studies, most definitions do share common elements of frequency and restraint of motor movement.

Stereotypical behavior is common to both human and non-human animals. It is seen frequently among infants, caged zoo animals, and persons with developmental and similar disabilities (Berkson, 1983; Mason, 1991; Ridley, 1994; Evans et al., 1997). The behavior is likewise found in typically developing children, among whom the

behaviors are generally not considered maladaptive or clinically significant (Muthugovindan & Singer, 2009). For our purposes, we will look only at stereotypy among persons with neurodevelopmental disabilities, such as autism, as it is most relevant to our topic.

Stereotypy is often seen among persons with developmental disorders, occurring at rates as high as 100% among samples of persons with autism (Campbell et al., 1990). One common example of stereotypy among persons with autism is hand flapping, although stereotypic behavior may take nearly any form (Bodfish, 2004). Often, stereotypic behavior is described as non-adaptive and even purposeless (American Psychiatric Association, 2000; Lewis & Bodfish, 1998; Powell et al. 1999). This view is in competition with other conceptualizations of stereotypy which identify a distinct functional component to such behavior (Berkson, Gutermuth, & Baranek, 1995). Such a view distinguishes *functional* (which concerns relationships between behavior and controlling stimuli) from *adaptive* (a qualitative judgment about the "normalcy" of a behavior), highlighting that a behavior may be functional without being adaptive.

In keeping with a functional view of stereotypy, numerous studies have demonstrated through single-subject design utilizing analogue functional analysis that stereotypy may serve a variety of functions, from fulfilling sensory needs (automatic reinforcement) to escape from a task-demand situation (Kennedy, Meyer, Knowles, & Shukia, 2000; Lovaas, Newsom, & Hickman, 1987). Ultimately, those studies concluded that stereotypy can be quite complex and varied in its form and function, and that its

interaction with the environment or sensory input falls in line with the definition given by Berkson (1983). Studies which have demonstrated a sensory component to stereotypy are also in line with reviews of both human and animal studies which suggest that the availability of environmental stimulation impacts the development and expression of stereotypic behavior, finding that in many cases stereotypy is "sensory bound" (Lewis, Tanimura, Lee, & Bodfish, 2007; Mason, 1991; Ridley, 1994; Symons, Sperry, Dropik, & Bodfish, 2005). Though not true for all cases of stereotypic behavior, those studies did find that environmental enrichment or the provision of varied sensory experiences were associated with decreases in observed stereotypy.

***Self-injury*.** Frequently observed in autism as well as a wide variety of other disorders, self-injurious behavior, or SIB, is generally considered a lower-order repetitive behavior (Turner, 1999). However, SIB is not lacking in complexity. It may be seen as elemental to a particular disorder (e.g., Lesch-Nyhan) or other genetic expression, physiological dysregulation, biorhythmic disturbances, pain and CNS sensitivity, environmental control and communication, or some combination of these factors (Schroeder et al., 2001). Though it occurs across conditions, SIB is frequently found among persons with autism. Using a quasi-experimental design employing an age, gender, and IQ matched control group, researchers found at least one variety of self-injury in 69% of persons with autism (Bodfish, Symons, Parker, & Lewis, 2000). That number was not significantly higher than the rate for a matched control group of persons with intellectual disability, however, illustrating that self-injury, while typical to autism, occurs at relatively high levels among other populations as well.

Like stereotypy, self-injurious behavior may serve a number of functions and take on complex and varied forms. From early on, self-injury was believed to be controlled by multiple operant and sensory functions, with variation according to the nature of the disorder of concern and its unique pathophysiology (Carr, 1977). This view of self-injury generally remains true today. In their prominent experimental analysis of self-injury, Iwata et al. (1982/1994) demonstrated self-injury to be variously controlled operantly or by automatic reinforcement across time and subjects in a multiple-baseline design. In a controlled setting, researchers in that study manipulated a variety of environmental events and found clear patterns of self-injury among subjects. Notably, factors associated with self-injury differed highly by person. In a review of research concerning the various functions of self-injury across psychiatric disorders, Klonsky (2007) identified seven broad but distinct categories of function for self-injurious behavior across 18 empirical studies. That study found patterns of self-reported affective states concerning function of self-injury among persons with disorders such as borderline personality and did not include persons with developmental disorders. Overall, self-injury varies greatly in both form and function across populations, and no single cause or remediation may be identified.

One potential difficulty with the classification of “lower-order” repetitive behavior as a whole is that the previously reviewed behaviors are not homogenous (Turner, 1999). Self-injurious behavior or stereotypy may serve an identifiable function, such as the attainment of negative or positive reinforcement, whereas dyskinesia is involuntary and without function, differentiating these lower-order

behaviors by existence of a function per se, thus affecting the manner in which they are addressed therapeutically (Campbell et al., 1990; Kennedy, Meyer, Knowles, & Shukia, 2000). Moreover, differences of function and etiology confuse the category of lower-order. Arguably, a stereotypic or self-injurious behavior which serves to obtain some outcome is more closely related to higher-order repetitive behavior than to an involuntary lower order behavior owing to the presumed cognitions involved in the development and execution of the behavior. If cognitions are tied to certain self-injurious and stereotypical behaviors, might they be conceived of as higher-order? As seen in Klonsky (2007), complex cognitions are tied to self-injury in numerous cases. Additionally, even among involuntary behaviors such as tics, there is a growing body of work suggesting that these behaviors may have more in common with higher-order behaviors, such as compulsivity (Leonard et al*.,* 1992). Clearly, there are numerous demands for further research in the area of repetitive behaviors, including the development of precise and meaningful categorizations of such behavior.

As such, it is imperative to consider that even those behaviors classified as "lower order" may differ substantively from each other, with certain lower order behaviors qualitatively more complex than others. The dichotomy between lower- and higher-order repetitive behaviors is relatively new and currently lacks substantial empirical backing. These nascent categories are useful, however, in providing us with a broad scheme by which to organize the many varieties of both disparate and similar repetitive behaviors. For the purposes of the current work, this dichotomous organization will be used only to divine those behaviors which are best represented as

compulsive, ritual, or routine.

Higher-order Repetitive Behavior

Behaviors considered higher order generally include insistence on sameness (sometimes denoted “sameness behavior”), repetitive language, restricted interests, and adherence to specific behavioral patterns and routines (Turner, 1999). Unlike lower order repetitive behaviors, this class of behavior is described as having a “distinct cognitive component” (Lewis, Tanimura, Lee, & Bodfish, 2007, p. 66). In a factor analysis of items on the Autism Diagnostic Interview-Revised (ADI-R), researchers found that ritual and sameness behaviors occur as a distinct domain from repetitive sensory/motor behaviors (such as stereotypy), suggesting that though they share repetition in common, they are in fact fundamentally different (Georgiades et al., 2007). In another study examining distinctions between repetitive behavior types, all higher-order behaviors were classified together as involving cognitive rigidity, highlighting that such behaviors are alike in that they are related to fixed patterns of behavior and comparatively complex, inflexible cognitions (Carcani-Rathwell, Rabe-Hasketh, & Santosh, 2006). That study consisted of a nonexperimental comparison of repetitive behaviors among three groups culled from a large sample of persons with pervasive developmental disorders with and without intellectual disability, and intellectual disability alone. The results indicated that, unlike lower-order repetitive behaviors, the realm of cognitive rigidity was not significantly associated with intellectual disability alone and appeared to be autism specific.

Like those considered lower-order, not all higher-order behaviors are similar in

form and function. One variety of higher-order behavior for which potential treatments will not be considered for the purpose of this research is that of repetitive language. Known also as echolalia, it occurs commonly among verbal persons with autism with a prevalence of about 75% (Lewis & Bodfish, 1998). The behavior typically consists of repetitive speech that may be simple or complex in nature (e.g., a single word or a phrase) and may be immediate or delayed, and may serve a number of functions. Though the current study considered repetitive verbal behavior that was part of a cluster of higher-order behaviors (e.g., part of some routine or compulsive behavior), it did not address echolalia alone.

Those behaviors that were considered as related under the category of higher-order repetitive behavior for this study are sameness, adherence to specific behavioral patterns and routines, and compulsive behavior. Behaviors denoted as compulsions, sameness, and rigid adherence to routine may be difficult to differentiate because they manifest in such similar ways, supporting the notion that they could be considered under the same phenomenological umbrella (Lewis & Bodfish, 1998; Turner, 1999). Moreover, because of how they are defined elsewhere, sameness, compulsion, and rigidity/routine/ritual behaviors are functionally related to one another in that they all involve patterns of behavior that are performed to serve some inflexible cognition (Bodfish, 2004; Turner, 1999). Arguably, there is little substantive semantic difference among terms of sameness, adherence to routine, and compulsion. In the following section, higher-order repetitive behaviors will be considered individually, followed by a discussion of meaningful similarities and differences

between them.

Sameness behavior. No formal definition for sameness behavior exists, though it is frequently cited as part of the repetitive behavior dimension of ASDs. Early use of the term "sameness" beyond Leo Kanner's conception of autism came with Prior and MacMillan's (1973) use of their Sameness Questionnaire. Using said questionnaire, they identified numerous forms of sameness behaviors among the entirety of a small sample of children with autism. In their examination of diagnostic realms of repetitive behavior in autism, in a study similar to the previously discussed Georgiades et al., 2007 piece, Cuccaro et al. (2003) found sameness as reflective of a general resistance to change that is characteristic of autism versus other developmental disorders. They further define this category as involving the individual "imposing an order (or responding to a lack of order) in the environment" (p. 13).

Elsewhere, sameness has been defined as conceptually related to OCD, distinguishing it only in so far as sameness involves broader patterns and routines (Lewis & Bodfish, 1998). Those authors further note substantial overlap between sameness and compulsivity as defined in the Prior and MacMillan (1973) study. The actual basis of sameness behavior is difficult to pinpoint. Most conceptualizations of sameness go no further than denoting it as stereotypic or ritualistic, a distinction that seemingly attempts to explain the behavior by attaching a different, but similarly imprecise, label to it (Green et al., 2007). Sameness behavior, while at once lacking a consistent definition, has been long described as both integral to the repetitive behavior dimension of ASDs and involving cognitive rigidity.

Ritual and routine behavior. As with sameness, little attention is paid to examining ritual and routine behaviors in autism and elsewhere. Though part of diagnostic criteria for ASDs, routine and ritual behaviors are common among to human and non-human animals, and often occur for adaptive reasons that evolve over the course of an organism's life-span (Evans et al., 1997). Rigid, ritual, and routine behaviors are thought to exist in various forms, including developmentally appropriate childhood behavior, behavior characteristic of certain life stages, as pathological behavior (e.g., OCD), or as culturally determined behavior (Boyer & Lienard, 2007). As with stereotypy, the qualitative difference between typical and atypical ritual/routine behavior may have more to do with issues of frequency, intensity, and relative constriction than with the actual behavior per se. In their comprehensive overview of dimensions of ritual behavior, Boyer and Lienard describe all ritualized behavior as possessing five common dimensions. These dimensions include: 1) a compulsive drive to perform the ritual behavior; 2) rigid adherence to the behavioral pattern; 3) a lack of functionality, or "goal demotion"; 4) repetition and redundancy; and 5) a restricted range of themes. By this definition, a distinction exists between functional *routine* behaviors and nonfunctional *ritual* behaviors. Interestingly, among descriptions of autism, the terms ritual and routine are often used interchangeably. Boyer and Lienard further propose that ritual behaviors occur as a means of addressing inferred threats to fitness, and that the performance of routine and ritual behavior achieves a safety signal of sorts wherein the perceived threat is temporarily diminished. This theoretical account is in line with that of the current piece in that it conceives of certain

ritual/routine behaviors as self-reinforcing in relation to the non-occurrence of an aversive event. The very language used in the description of ritual behavior matches that used in two-factor avoidance theory as it pertains to signaled and unsignaled (or Sidman) avoidance (Dinsmoor, 2001). Taken further, we might conceptualize higher-order repetitive behaviors as well matched with interventions which address avoidance behavior, a view congruent with the crux of this research, and an issue that I will address in more detail further on.

Compulsive behavior. Different researchers take "compulsive" to embody different meanings. Some see it as de facto related to clinical psychopathology while others take a more global view of the term. As defined by the American Psychiatric Association, compulsions are ritually performed, impairment causing behaviors which are intentional, purposeful, and repetitive (2000). Other definitions are broader, describing compulsivity as "repetitive, intentional behaviors that appear to follow certain rules" (Lewis & Bodfish, 1998, p. 82). As with ritual and sameness behavior, little is known about the occurrence of compulsivity outside of its clinical definition. In a review of existing epidemiological surveys from nine international sites, Bebbington (1998) found prevalence of clinically defined compulsivity ranging from .7 to 2.1%. In that study, as in others, compulsivity is defined in relation to OCD, and thus there is little information regarding its occurrence in the general population.

In one study of compulsive-like behaviors among typically developing young children, researchers found mean rates of compulsivity to occur anywhere from 27 to 58% among children ages <12 months to 5 years old (Evans et al., 1997). That study

defined compulsivity as including “Just Right” behaviors, involving symmetry and patterns, as well as repetitive behaviors, such as preference for and performance of routine behavior. It is unclear the extent to which the behaviors in that study might be considered maladaptive or unreasonable, an element to the clinical definition of compulsivity which distinguishes such behaviors from adaptive, normalized complex repetitive behaviors. At its essence, the Evans et al. study demonstrated the commonality of nonpathological, potentially adaptive compulsive behavior. If such behaviors signal (and sometimes truly achieve) safety or fitness, it should follow that organisms frequently perform repetitive behaviors and that the key distinction for terms such as compulsivity, sameness, and ritual is their relative nonfunctionality.

Looking to the previously discussed dimensions of higher-order repetitive behavior (sameness, ritual/routine, and compulsivity), a number of prominent similarities exist. Foremost among these similarities is the interdependent manner in which they are conceptualized, posing a logical fallacy of circular reasoning. That is, definitions of these terms rely on each other to describe the behaviors which characterize them. For instance, sameness is defined by describing rigidity and routine, while ritual and sameness are described by compulsive expression of inflexible behavior (Lewis & Bodfish, 1998; Cuccaro et al., 2003; Boyer & Lienard, 2007). Indeed, the very definition of compulsion as seen elsewhere describes it as consisting of sameness behavior and rigid adherence to routine (Lewis & Bodfish, 1998). This confluence among definitions makes pragmatic differentiations among the terms something of a difficulty.

Because of the extent to which the terms used to describe higher-order repetitive behaviors are interrelated and mutually dependent, this study made use of this interdependence among definitions and attempted to address underlying commonalities between higher-order repetitive behaviors. The purpose of this research was to examine *maladaptive* higher-order repetitive behaviors and their potential remediation, and thus any maladaptive form of sameness/ritual/compulsive behavior fell under its purview. As the majority of theoretical explanations of higher order repetitive behaviors in autism involve an aversive association with behavioral flexibility, this study conceived of these behaviors as sharing a basis in avoidance for the purpose of describing potential intervention (Green et al., 2007; Turner 1999). Because it is more often addressed in treatment literature in its maladaptive form, much of this review as it pertains to intervention focuses on those behaviors described as compulsions, although maladaptive sameness behavior and adherence to ritual/routine are considered as functionally related.

Compulsive Behavior and Autism

In this section, higher-order repetitive behavior as it pertains to clinically defined compulsion in autism as well as other disorders, particularly obsessive compulsive disorder, are examined. As with autism, repetitive behavior is a defining element of OCD. Though categorically different from autism, the body of work regarding the description and treatment of obsessive-compulsive disorder should inform the treatment and understanding of compulsivity and related behaviors in autism given similar forms of cognitive rigidity and patterns of behavior associated

with both disorders.

Clinical Expression of Compulsivity

In the previous section on repetitive behavior, we looked at compulsivity as a general variety of higher-order repetitive behavior and its occurrence both in and outside of its clinical definition. Here, compulsivity is addressed only in its clinical, maladaptive expression.

Definition. Belonging to a larger family of repetitive behavior, compulsion is often identified by another label depending on the clinician, researcher, or measurement, an issue seen in a variety of other works and with a variety of other repetitive behaviors, such as stereotypy (Evans et al., 1997; Lewis & Bodfish, 1998; Bejerot, 2007). For instance, a ritualistic act could be identified as ritual behavior, or as a stereotypy, a compulsion, or as sameness behavior based on the complexity of the behavior involved and the relative incongruity among definitions (Prior & MacMillan, 1973). Phenomenologically, compulsions differ from many other repetitive behaviors, such as stereotypy, in so far as compulsions are intrinsically tied to certain cognitive rules. In obsessive-compulsive disorder, these rules are said to be the result of obsessions, which are defined as repetitive, persistent thoughts or impulses which produce anxiety (American Psychiatric Association, 2000).

Compulsions, then, are generally considered the behavior which occurs to alleviate the anxiety and stress caused by the associated obsessions. Though compulsion is a clinical term that is arguably not precise to similar behaviors in autism, it is fruitful to explore the ways in which remediation of compulsive behavior in other

disorders applies to treatment of higher-order repetitive behavior in autism regardless of whether those behaviors are technically classified as compulsion, sameness, or adherence to routine (Baron-Cohen, 1989). As discussed in the previous section, there exists much overlap in the definition of those behaviors considered higher-order. At their core, the varieties of higher-order repetitive behavior are the same: they involve ritualized, often maladaptive, behaviors that are performed in accordance with some inflexible rules.

Prevalence. Regarding the prevalence of clinically described compulsion, there is general agreement regarding the lifetime prevalence of compulsivity as manifested in adult obsessive-compulsive disorder, which is estimated to be approximately 2.5% in the United States (Karno, Golding, Sorenson, & Burnam, 1988; DSM-IV-TR; American Psychiatric Association, 2000). Subclinical occurrences of obsessions or compulsions have been estimated to be much higher, approaching 30% based on epidemiological surveys (Ruscio, Stein, Chiu, & Kessler, 2010). Though comparatively fewer studies address childhood OCD, the *Diagnostic and Statistical Manual of Mental Disorders* reports the prevalence of child and adolescent OCD at 1%-2.3% (American Psychiatric Association, 2000). Though diagnosis of OCD may not occur until adulthood, symptoms related to the disorder generally manifest themselves prior to age 18 in 80% of adults diagnosed with OCD (Pauls et al., 1995). In one study seeking to identify those behaviors comorbid with compulsivity among persons with intellectual disability, Bodfish et al. (1995) found that compulsions among 40% of a sample of 210 adults with severe or profound mental retardation. Notably, researchers in that study

identified significant comorbidity between compulsions and stereotypy/self-injury.

Do Compulsions Occur in ASDs?

Though certain higher-order repetitive behaviors in autism appear to meet a broad definition of compulsivity, especially as it relates to functionally similar ritual/sameness behavior, there are some difficulties in applying the clinical definition of compulsivity to ASDs. In this section, two of the major challenges to identifying compulsivity in autism will be examined, and studies which specifically identify compulsive behavior among persons on the autism spectrum addressed.

Existence of obsessions. As previously noted, it is difficult to determine the extent to which compulsion captures the phenomenon of higher-order repetitive behavior in persons with ASDs. Concerning this issue, Baron-Cohen (1989) suggests that the term “compulsion” be applied with caution to behaviors seen in autism, noting that compulsions are necessarily tied to obsessions, although this view is not universally held. Because many individuals with autism spectrum disorders are unable to effectively communicate their state of mind, it is difficult to assess whether or not compulsive-type behavior is tied to obsession with much of the ASD population. One suggestion for assessment of nonverbal individuals involves use of functional behavior analysis to rule out repetitive behavior as a result of low arousal, as in certain stereotypies, rather than of obsession (Baron-Cohen, 1998). Such a procedure, presumably similar to that used by Kennedy, Meyer, Knowles, and Shukia (2000), would differentiate complex stereotypy from higher-order behavior which is similar in its presentation. However, such a differentiation may be unnecessary given the distinct

qualitative differences that have been demonstrated elsewhere in measurements of lower- and higher-order repetitive behaviors both formally (such as the ADI-R) as well as informally (Cuccaro et al., 2003).

One important consideration in determining whether compulsions exist in autism is that inability to express psychological state as it pertains to obsessions does not preclude their presence, nor does that absence of measurable obsession diminish the potential for distressing compulsive behaviors. Related to this issue, compulsion-only OCD has been documented in a number of studies, suggesting that compulsions are not consistently tied to specific obsessions, a matter particularly relevant to persons with ASDs or those otherwise unable to effectively communicate their cognitions (McDougle, 2000). Notably, when assessed with standard measures of compulsive behavior, persons with autism score well beyond what would be expected in the general population, including non-autistic age, IQ, and sex matched controls (Bodfish, Symons, Parker, & Lewis, 2000; McBride & Panksepp, 1995; Militerni, Bravaccio, Falco, Fico, & Palermo, 2002).

Insight. Whether obsessions are present or not, clinical definition of OCD also requires that an individual have insight into the nonfunctional nature of their thoughts or behaviors. At some point during the course of the disorder, an individual needs recognize that their obsessive thoughts or compulsive behaviors are unreasonable or excessive (DSM-IV-TR, American Psychiatric Association, 2000). As with obsessions, inability to communicate among many with autism bars assessment of insight. Do individuals with ASD recognize the distress or irrationality of their obsessive thoughts

and compulsive behaviors? Although it has been suggested that the compulsive behaviors found in individuals with autism are not ego-dystonic (in conflict with needs and ideal behavior), research among individuals with both OCD and traits central to high-functioning autism and Asperger's syndrome suggest otherwise (Bejerot, Nylander, & Lindstrom, 2001). In that study, researchers used a non-experimental design wherein traits among persons with OCD were assessed. A significant relationship between autistic traits and OCD was detected, and the authors proposed that Asperger's and high-functioning autism may disguise features of OCD.

Moreover, it is important to note that compulsivity need not be ego-dystonic in all cases. Epidemiological studies of OCD have found that poor insight is associated with greater symptom severity among persons who otherwise meet clinical criteria (Ruscio, Stein, Chiu, & Kessler, 2010). Moreover, unlike criteria for adult OCD, the DSM-IV-TR includes exceptions for children in regard to insight. According to diagnostic criteria, children with obsessive-compulsive disorder may not recognize the unreasonable or disruptive nature of their thoughts or behaviors (American Psychiatric Association, 2000). OCD in children may present as compulsion only, and obsessions may be ego-syntonic; that is, the individual does not have insight into the unreasonable or disruptive impact of their thoughts and behavior. Such is often true of compulsive behavior in ASD as well. In a review of medical treatment of OCD traits in persons with pervasive developmental disorders, McDougle, Kresch, and Posey (2000) suggest that persons with autism may lack the cognitive capacity to perceive and communicate the nature of their obsessions and the effects thereof. The authors

further cite the typical IQ gap between those with OCD and those with autism. As such, obsessions and compulsions found in autism may more closely resemble those found in children with OCD where no or poor insight is common. However, no studies to date have specifically addressed this issue.

Compulsivity in autism. As previously noted, prevalence of compulsive behavior in autism appears quite high. In a study of repetitive behavior in autism, Bodfish et al. (2000) compared 32 adults with autism with an age, IQ, and sex matched control group of individuals with mental retardation and found a significantly higher incidence ($p < .003$) of compulsive behavior among those with autism. Using the MR-OCD scale (a variant tailored to persons with intellectual deficits) to assess compulsivity, the researchers examined and compared compulsive behavior for members of both groups. That study ensured that other repetitive behavior scales did not overlap with measurement of compulsive behavior, that compulsion only was measured rather than similar repetitive behaviors. Overall, 94% of individuals with autism in the study exhibited at least one compulsive behavior (Bodfish et al., 2000). This finding supports similar work which found that 100% of 50 subjects with autism displayed compulsive behavior in a matched-pairs design using standard measures of OCD behaviors (McDougle et al., 1995).

Comparing Autism and OCD

As higher-order repetitive behaviors, especially those which may be categorized as compulsions, manifest in both autism spectrum disorders and obsessive-compulsive disorder, it is not surprising that comparisons between ASD and

OCD have been made. One neurobiological review of behaviors associated with autism notes similar elevations of measurable 5-HT (serotonin) and oxytocin in individuals with autism and OCD, supporting common neuropsychological elements among both disorders, which are likewise both believed to be organic in their etiology (Boulougouris, Chamberlain, & Robbins, 2009, Waterhouse, Fein, & Modhal, 1996). Waterhouse, Fein, and Modhal note that elevated serotonin and oxytocin are correlated with similar elevations found in the cerebrospinal fluid of individuals with obsessive-compulsive disorder, suggesting that similar neurological states are associated with the performance of repetitive behaviors in both OCD and ASD. Similarly, another study has identified a possible genetic link between autism and OCD, finding that children with high scores in the domain of repetitive behavior using the ADI-R were significantly more likely to have a parent with OCD or its traits (Hollander, King, Delaney, Smith, & Silverman, 2003).

Further examining similarities between the two disorders, a handful of studies have specifically sought to compare populations with autism to those with OCD using standard measure of obsessive-compulsive behaviors. The most prominent of these, McDougle et al. (1995), compared the repetitive behaviors associated with autism with those found in obsessive-compulsive disorder. In a case controlled study, researchers age and sex matched fifty individuals with autism with fifty adults with OCD. Obsessions and compulsions were assessed with the standard Yale-Brown Obsessive Compulsive Scale (Y-BOCS). Nonverbal participants with autism were included, with parents serving by-proxy in completion of the Y-BOCS when necessary. Results

indicated that compulsions were characteristic of both groups. However, significant differences existed between groups in the type of compulsions exhibited. For instance, researchers found that persons with autism were more likely to have compulsions of the ordering and touching type compared to the OCD group, who were more likely to have compulsions of the checking and cleaning type. Additionally, the autism group demonstrated fewer obsessions than did the OCD group, though it is likely that this is a function of IQ differences between the groups and the authors note that obsessions are in part determined by one's ability to recognize and communicate intrusive thoughts (MacDougle et al.).

The finding that the nature of obsessions and compulsions differ between those with autism and those with OCD has been replicated in other studies (McBride & Panksepp, 1995; Bejerot, Nylander, & Lindstrom, 2001). Using by-proxy raters to assess compulsive behavior among a population of young adults with autism, McBride and Panksepp (1995) identified compulsive behaviors which were both complex and goal focused. However, they likewise report that the constellation of behaviors differed from those typically found in OCD. In that study, qualitative assessment of these compulsions uncovered recurring themes of checking and cleaning among those with ASD. This is in part consistent with the McDougle et al. (1995) in that group differences were noted. However, those researchers found checking and cleaning to be high among persons with OCD alone. It is possible that while some elements of compulsion type differentiate persons with autism from those with OCD, there may yet be enough heterogeneity of compulsion type among those with either ASD or OCD to impede

those factors from reliably predicting group membership.

One notable exception to the finding that the nature of compulsions differ by group is that of a study by Russell et al. (2005), which compared individuals with high-functioning autism or Asperger's to a sex matched group of individuals with OCD. As in the McDougle et al. study (1995), Russell et al. (2005) employed the standard Y-BOCS, as well as its ancillary symptom checklist in measurement of compulsive behavior and obsessive thoughts. The results of their study indicate that only the somatic category of obsession and the checking and repeating categories of compulsions were higher among the OCD group. No significant differences were found between groups for the other ten categories of obsession and compulsion types.

The previously discussed McDougle et al. (1995) study sought to determine differences in repetitive behavior between autism and obsessive-compulsive disorder. Because control for IQ was not possible in that design (wherein groups were age- and sex-matched), causal conclusions are somewhat tenuous. The sample of adults with OCD used in the study was necessarily characterized by normal intelligence due to the exclusion criteria at the OCD clinic from where they were recruited. Conversely, 70% of those in the group with autism met DSM criteria for mental retardation. The authors acknowledge this, and further note that their results cannot be generalized to children, for instance, and that their findings relate only to measurable behavior and not neurobiology. It is possible that the differences in type of compulsive behavior, as well as the relative paucity of measurable obsession among those with autism, are due in part to the incongruity of cognitive functioning between the groups, a bias which was

built-in to the design used.

This gap in cognitive functioning was narrowed partially by the Russell et al. (2005) study, which excluded individuals with IQ < 70, allowing for stronger inferences. Comparing those with high functioning autism and Asperger's syndrome to a sex-matched OCD group, their study found similar frequencies of obsessive-compulsive behavior across groups. Moreover, they found a higher frequency of obsessions among those in the Asperger's and high-functioning autism groups than reported by previous studies which did not control for IQ (McDougle et al., 1995; McBride & Panksepp, 1995). Another key finding in that study was that participants in the ASD group reported their obsessions and compulsions to be both intrusive and distressing (or ego-dystonic) in, according to the researchers, the standard nomenclature (Russel et al., 2005). This finding is important for three reasons. First, it further supports the notion that obsessions and compulsions in populations with ASD may cause distress to the individual despite difficulties in detecting it. Second, it provides another feature of OCD required for diagnosis, narrowing the phenomenological gap between higher-order repetitive behavior in OCD and ASD as clinical disorders. Interestingly, the researchers found that approximately 25% of individuals in the ASD group met ICD-10 criteria for obsessive-compulsive disorder. Third, the finding that higher-order repetitive behavior caused distress among those with ASD corroborates the notion that complex repetitive behavior deserves greater attention in the realm of treatment.

Repetitive Behavior and Arousal

Ritual, routine, and compulsive behaviors in particular go beyond mere patterned behavior- they are presumed to involve avoidance of aversive outcomes, existing as overextensions of adaptive behavior involving negative reinforcement and cognitive rigidity. The performance of such behaviors should be preceded by autonomic arousal (engagement of the sympathetic nervous system) and followed by a return to a baseline or homeostatic arousal state (Fowles, 1980). While researchers have demonstrated the extinction of avoidance responding through behavioral interventions, they are unable to demonstrate changes in internal state relevant to physiological arousal by behavioral measures alone. With disorders such as OCD, anxiety is typically assessed by way of self-report. Questions of validity aside, measures relying on self-report are not often feasible for use among persons with autism due to cognitive and/or communication deficits, making physiological measures a potentially useful means of assessing stress and arousal (Groden et al., 2005).

Among anxiety disorders, most researchers have examined the role of physiological arousal by group comparisons (Slaap, Nielan, Boshuisen, van Roon, & den Boer, 2004; Zahn et al., 1995). These studies are valuable in demonstrating few underlying differences among groups (e.g., OCD versus control) on measures of heart rate and heart rate variability. Examinations of anxiety disorders which employ physiological measures are typically concerned with questions of autonomic nervous system dysfunctions. They have tended not to address in-group changes in relation to controlling stimuli and performance of ritual behavior. Though avoidance and

physiological arousal are assumed to play a role in anxiety disorders such as OCD, few studies have specifically examined this issue. One early study evaluated exposure therapy with galvanic skin response as the dependent variable (Hyman & Gale, 1973). Participants consisted of females with significant fear of snakes. The experimental procedure consisted of graduated exposure to phobic stimuli for three groups (treatments differed slightly for each group). Though the purpose of the study was to compare varieties of exposure therapy, the findings indicated that physiological arousal was attenuated by habituation to fear-inducing stimuli.

Although the role of arousal (such as over- or under-arousal) has long been discussed in regard to persons with autism (Berkson, 1967), use of physiological measures to detect its relationship with behavior is limited. Sigman, Dissanayake, Corona, and Espinosa (2003) compared heart rate variability during social exposure between a group of children with autism to a group of children with an age, IQ, and language level matched non-autistic group. That study noted that aversive stimuli are associated with elevations in heart rate and avoidance/escape behavior, but overall found low no elevation in arousal during test phases. In an assessment of the effects of stressors on heart rate in persons with autism, Groden et al. (2005) found that while heart rate was a viable measure of physiological arousal, idiosyncratic differences precluded any generalization of findings. This outcome, however, is valuable in that a number of cardiovascular findings were inconsistent with a general arousal theory. For instance, a number of participants did not respond as expected to stressful tasks. Though methodological concerns may explain such inconsistencies, it is possible that

as of yet, there is simply too little known about the effects of stress on persons with autism.

One study did, however, demonstrate fairly consistent within-group changes in arousal before and after self-stimulatory behaviors using skin conductance measures (Hirstein, Iverson, & Ramachandran, 2001). Those researchers found sympathetic nervous system changes associated with engagement of stereotypical and tactile sensory stimulation, attributing their findings to malfunctions in autonomic regulation among persons with autism. It is not clear from the data whether autonomic regulation explains changes in the data, though the match-up of behavioral and physiological changes is of interest. A clearer understanding of the relationship between physiological states and behavioral responses to stimuli would inform both theory and potential treatment.

One unpublished study specifically examined heart rate during response blocking of ritual behaviors in a teenage female with autism and OCD (Jennett, Beaulieu, and Hagopian, 2008). Those researchers found a significant association between test phases and arousal, noting that arousal was highest during treatment phases involving response prevention. This finding was in line with assumptions around compulsive behaviors involving avoidance and negative reinforcement. Of interest as well is that the aforementioned study used heart rate, rather than performance of ritual behavior, as the dependent variable.

Avoidance Extinction

The following will consider those behavioral intervention strategies specific to

issues associated with high-order repetitive behaviors. As will be described later in this work, many elements of the following behavioral strategies are frequently applied to treatment of disorders characterized by complex repetitive behavior and avoidance, such as OCD and phobias. This section begins with an exploration of early models of avoidance and its extinction.

Avoidance Behavior

Avoidance responding among animals, similar in many respects to anxiety motivated behavior among humans, has been noted in numerous early studies involving animals (see Baum, 1970, for a review). Importantly, avoidance responding was shown to be especially resistant to extinction when compared to extinction procedures involving other types of behavior. With avoidance responding, the organism makes some response which has previously led to the termination of some future aversive event. Because the response takes place even in the absence of any real outcome (i.e. the aversive event), the response continues even during extinction because the response itself is reinforcing (Baum, 1970). Thus, the organism may continue to make a given response even though that response may no longer be beneficial or adaptive. This is an important distinction between escape and avoidance motivated behaviors.

With escape, the organism contacts the aversive event prior to performing the behavior that terminates it, whereas in avoidance, the aversive event may never have actually occurred. Because of this key difference, procedures which aim to eliminate or even identify escape behavior are often ineffective when applied to avoidance. For

instance, though much applied work lumps escape and avoidance together, the measurement of avoidance apart from escape requires comparatively elaborate techniques (Jones & Friman, 1999). Almost exclusive to non-human animal research, measurement of the effects of avoidance conditioned stimuli (or fear responding, in some studies) often include some iteration of the conditioned emotional response (Estes & Skinner, 1941). Methods employing a conditioned emotional response involve recording the suppressive effects of an aversively conditioned stimulus on positively reinforced behavior. For use among humans, such a procedure would involve numerous ethical and procedural challenges.

Two-factor avoidance theory. Avoidance behavior may be maintained over the course of many trials even when the performance of the behavior is no longer necessary to avoid an aversive event, as would be expected in the application of classic extinction procedures. This quality of avoidance has long vexed behavioral theorists and inspired the promulgation of numerous explanatory models (Mineka, 1979). Perhaps the most prominent, and long standing, is two-factor avoidance theory (Mowrer, 1947). At its essence, two-factor theory predicts that avoidance behavior will maintain so long as it achieves the termination of the aversively conditioned stimulus, or conditioned negative reinforcer, and not with the termination of an actual aversive event. Control of what may have started as an escape response transfers to a conditioned stimulus for the aversive event (Overmier & Bull, 1969). It has been argued by Dinsmoor (2001) that this model is consistent with unsignaled avoidance as well, wherein he postulates that a safety signal occurs internally (i.e. the organism's

own behavior serves as feedback). Though theorists continue to pose caveats to Mowrer's original two-factor theory (a review of which is beyond the scope of the present work), it retains its primacy in the realm of avoidance behavior (Maia, 2010).

Non-human Animal Research

Because of challenges involved in decreasing avoidance behavior by way of classic extinction techniques, a procedure using response blocking was developed to promote avoidance extinction. This unique element of avoidance extinction addresses negative reinforcement associated with termination of the conditioned stimulus. Early examples of this response prevention, or "flooding", come from experimental psychological research involving extinction procedures in non-human animal behavior labs. One of the first studies to employ response prevention involved two groups of rats avoidance conditioned to a chamber by way of shocks delivered through a floor grid (Page, 1953). The learned avoidance response for both groups involved exiting the chamber by way of a door. In extinction, shocks were terminated and one group was denied access to the neighboring chamber, thus blocking the learned avoidance response. After extinction, both groups (and an unshocked control) were tested for the avoidance response. The blocked response group showed significantly more rapid extinction of the avoidance response than the unblocked group. A two-factor avoidance paradigm would suggest that for the unblocked group, the behavior of exiting to a neighboring chamber remained under a schedule of continuous reinforcement (Dinsmoor, 2001).

Experiments employing similar designs followed, with psychologist Morrie Baum prominent among researchers investigating avoidance extinction. The most popular design for flooding experiments was developed by Baum (1965) and utilized a single chamber wherein the avoidance conditioning took place by way of an electrified floor grid and the escape response occurred by jumping or climbing onto a wall-mounted shelf (flooding would occur by removal of the shelf). Several studies compared groups of rats on avoidance extinction using the aforementioned apparatus and found the same result: that avoidance responding was most efficiently extinguished by way of response blocking (Baum,1966; 1969).

Mineka and Seligman (1975) expanded avoidance extinction to less immediate aversive events. In one of a series of studies, a white box was paired with the administration of a poison whose effects may be attenuated by over-drinking. As with shock avoidance, the authors posited that responding (water drinking) maintained even when poisoning ceased because the rats fail to contact the contingency wherein the conditioned stimulus is not followed by aversive event. They further posited that the behavior occurred in anticipation of an aversive event (in-line with an S-S theory of classical conditioning). When blocking of water drinking occurred, over drinking behavior rapidly extinguished, presumably the result of exposure to the new contingency. Variations in the procedures employed for avoidance acquisition and flooding found similar results (Baum & Myran, 1971; Baum, Pereira, & Leclerc, 1985). These important early works involving flooding established response prevention as an efficacious way to rapidly extinguish avoidance responding.

Human Applications

Basic research involving response prevention posed numerous implications for human behavior therapy, especially in areas involving anxiety, phobias, and other similar issues where the client may not actually contact aversive outcomes associated with a fearful stimulus (Morganstern, 1973). Around the same time as Morrie Baum's early flooding work, others were utilizing the notion of response blocking in treatment of psychological disorders among humans. Among the earliest treatments using flooding techniques was implosive therapy, a mixed behavioral-psychodynamic therapy that largely utilized imagined flooding (Stampfl & Levis, 1967). Similar to exposure treatments, implosive therapy involves systematically imagining exposure to anxiety-inducing stimuli, typically in a clinical setting. Using an experimental design, Hogan (1966) found implosion therapy superior to traditional therapy in post-test MMPI scores among institutionalized persons with psychotic disorders. Similarly, Hogan and Kirchner (1966) found implosive therapy superior to control among college females with rat phobia in a lab-based study using random assignment.

In a review of early implosion therapy research, Morganstern (1973) found that, overall, the body of existing research regarding implosive therapy effectiveness was mixed. That review suggested that certain theoretical underpinnings of the therapy (i.e. its psychodynamic aspects) were unsupported by research. It further attributed many of the successes claimed by implosive therapy to demand characteristics, noting that the psychodynamic elements of the therapy were especially prone to this threat. As a result, assessments of implosive therapy

effectiveness lacked strength in their ability to assert causality, an issue highlighted by Morganstern. Overall, the psychodynamic elements of implosive therapy were unproven in their therapeutic role, serving to do little more than inform participants of researcher expectations. Though this therapy is no longer viewed as relevant, the exposure elements of implosive therapy, whether in-vivo or imagined, are often utilized in treatment of numerous mental disorders.

Systematic desensitization. Despite some positive results from studies examining the efficacy of implosive therapy, overall the therapy was found to be less effective than similar alternatives that were available. In his aforementioned qualitative review, Morganstern (1973) compared implosive therapy with systematic desensitization therapy, finding systematic desensitization superior overall. Though both therapies seek to extinguish avoidance responding through exposure, systematic desensitization progressed in a gradual manner and frequently involved real encounters with relevant stimuli (rather than imagined only). Additionally, systematic desensitization does not include psychodynamic elements and is more heavily based on the theoretical tenets related to avoidance extinction.

Systematic exposure without psychodynamic elements is seen as not only more effective with human participants, but also less prone to the ethical problems and potential iatrogenic effects associated with unstructured, rapid exposure to traumatic stimuli (Morganstern, 1973). Systematic desensitization is a flexible and individualized therapy that can be adjusted to the needs of a client and may be used in a wide range of circumstances. Indeed, systematic desensitization and graduated exposure

techniques are well established in treatment of avoidance behavior and can accomplish the same outcome as flooding in a variety of contexts, though they generally do require more time to achieve the same result (Chambless et al., 1998; Liebowitz & Klein, 1981).

Like response prevention, systematic desensitization and exposure techniques have long stood as empirically validated behavioral therapies (Tryon, 2005). In his comprehensive review of theory underlying the mechanisms involved in systematic desensitization, Tryon concludes that its therapeudic effectiveness is best explained by a Parallel Distributed Processing Connectionist Neural Network model (or PDP-CNN). The model involves the impact of experience on learning and memory, seeking to explain changes by way of intervening variables involving neural networks. Though there is some attempt on the part of Tryon to dispel the explanatory power of mainstream two-factor avoidance theory, most conclusions the PDP-CNN model fit with a behavioral paradigm (Dinsmoor, 2001). Though a detailed discussion of PDP-CNN models is beyond the scope of this work, it in short explains desensitization by detailing the way in which exposure to fear stimuli while engaged in a relaxed or non-avoidant behavior creates a dissonance which is ameliorated by way of "constraint satisfaction." The constraint satisfaction process involves learning which alters synaptic weights regarding networks of stimuli and behavior. Though perhaps not the most parsimonious explanation for extinction, PDP-CNN model is generally in-line with current psychological theory and has been empirically supported by neuroscience research.

Exposure with response prevention. The response prevention component of both flooding and implosive therapy has survived beyond its early association with experimental animal research and psychodynamic therapies, and is not mutually exclusive of exposure and systematic desensitization. Response prevention has become an important compliment to effective exposure therapies, particularly those which concern avoidance behavior, where response prevention plays a key role. Modern treatment of obsessive-compulsive disorder best exemplifies effective use of elements from both response prevention and systematic exposure in treatment of various psychiatric disorders and will thus be the main focus of this discussion of intervention based in avoidance procedures, though other popular treatments will also be examined.

Multiple strategies may be used in the treatment of obsessive compulsive disorder. Psychological interventions from cognitive-behavioral therapies to psychodynamic therapies have been used in both research and practice related to OCD (Abramowitz, 1997). However, of these treatments, exposure and response prevention (ERP) is generally considered the gold standard of treatment for OCD and related disorders (Abramowitz, 1997; Franklin et al., 2000; Simpson, Huppert, Petkova, Foa, & Liebowitz, 2006). In a meta-analysis of OCD interventions, exposure and response prevention was found to be the most effective treatment when compared to cognitive therapy and medication based treatments (van Balkom et al., 1994)

Exposure and response prevention (sometimes denoted exposure and ritual prevention) is seen by many as the preferred psychological treatment for relatively

permanent remediation of behaviors related to OCD (Abramowitz, Foa, & Franklin 2003; Franklin et al., 2000; Foa et al., 2005). Though ERP varies by patient needs, clinician training, and other factors, it typically consists of in-vivo or imagined exposure exercises as well as trials where the patient is progressively exposed to the situation or object of distress. This part of the procedure mirrors systematic desensitization as used in treatment of phobias. The response prevention piece of this therapy involves abstinence or blocking from compulsive or ritualistic behavior. The client is prevented from performing the response that fulfills the compulsion. Throughout, patients may discuss or self-monitor their obsessive thoughts as well as the disconfirming evidence provided by exposure exercises (Foa et al., 2005; Abramowitz, 1997). This cognitive component of therapy is separate from the behaviorally based exposure and response prevention elements, the roots of which may be seen in the early flooding work of Baum (1966) and Page (1953) and systematic desensitization and exposure therapy as developed by Wolpe (Tryon, 2005).

ERP and childhood OCD. Given the potential for ego-syntonic higher-order repetitive behavior among persons with autism, it is important to consider treatment of childhood OCD, where repetitive thoughts and behaviors need not be acknowledged as dysfunctional. Though researchers have only begun to explore ERP in treatment of childhood OCD, a number of studies demonstrating its efficacy exist. One early case study found ERP to be successful where medication was not in reducing compulsive and other disruptive behaviors in a child diagnosed with OCD (Owens & Piacentini, 1998). In an open trial of exposure and response prevention among forty-

two children with OCD, researchers noted high response to treatment (78.6%) and reductions in symptom severity (Piancentini, Bergman, Jacobs, McCracken, & Kretchman, 2002). The findings of that study were similar to those of another open trial of ERP among children insofar as the treatment was found to be effective as determined by post treatment testing, though neither study made use of an experimental design, limiting causal interpretations for both (Franklin et al., 1998). One recent assessment of ERP among children utilized a randomized, controlled design among a small number (20) of children diagnosed with OCD. The researchers found statistically and clinically significant improvement among the ERP group when compared to control. Moreover, they found that improvements in behavior among the ERP group were maintained 14 weeks beyond the conclusion of treatment. This study offers promising findings, though further controlled, experimental studies of ERP among children are required to better assess the effectiveness of the procedure in that population. Certainly, existing work does suggest that the therapy is effective in treatment of OCD specific to children.

ERP compared to pharmacological treatment. Though ERP is thought to be the most effective OCD remediation, pharmacological treatments of OCD are often used as a first-line approach to treatment of behaviors associated with OCD and similar disorders. The greater resource demands of ERP may increase the appeal of more readily available medication based treatments, which are comparatively easier to provide (Abramowitz, Foa, & Franklin, 2003). Moreover, few clinicians specialize in ERP and access to this treatment may be limited or nonexistent in many communities (Foa

et al., 2005). Used alone or in tandem with psychological interventions, pharmacological treatments typically include use of tricyclic antidepressants and serotonin reuptake inhibitors (SRI), and more recently, selective serotonin reuptake inhibitors (SSRIs) (Foa et al., 2005). The most popular, and perhaps most effective, medication used in cases of OCD is the SRI clomipramine (2005). However, due clomipramine's profile of side-effects (such as drowsiness, constipation and urinary problems, mood changes, nausea, and agitation), SSRIs, such as fluoxetine, have gained in clinical popularity and the focus of recent research into pharmacological treatment of OCD (Abramowitz, 1997; Foa et al, 2005; Hollander, 1998). Quantitative reviews of clomipramine versus SSRIs (such as fluoxetine and sertraline) have demonstrated meager differences among these drugs on OCD symptoms, supporting more recent use of SSRIs in treatment of OCD (Abramowitz, 1997; Kobak, Greist, Jefferson, Katzelnick, & Henk, 1998; McDougle, Kresch, & Posey, 2000).

Because pharmaceutical treatments are often used in lieu of ERP, it is important to examine their efficacy in treatment of OCD and related behavior disorders. In a randomized, placebo controlled study of OCD treatments, Foa et al. (2005) found clomipramine superior to placebo. However, the same study found clomipramine significantly less effective than both clomipramine and ERP combined and ERP alone. Given the design used in that study, one may draw strong inferences regarding the comparative effectiveness of ERP therapy over pharmaceutical treatments. Meta-analysis of randomized, controlled studies across all types and classes of medication for OCD found clomipramine more effective than other

pharmacological options (Ackerman & Greenland, 2002). However, in another quantitative review of OCD treatment research, clomipramine was again found superior to placebo and but only marginally more effective than other SRIs and SSRIs, a promising finding given the side effects associated with clomimpramine (Abramowitz, 1997).

Overall, the existing body of research regarding treatment of obsessive-compulsive disorder indicates general agreement as to the primacy of ERP over other therapeutic options, while among pharmacological treatments research finds clomipramine at least slightly more effective than other medication options, side-effects notwithstanding. For the purposes of the present research, the finding that ERP is superior to medication suggests that behaviorally based treatments utilizing both exposure and response prevention for avoidance extinction may likewise be most effective, and long lasting, in treatment of higher-order repetitive behavior among persons with ASDs.

As this section has described, avoidance behavior and its relation to anxiety-inducing stimuli has long been addressed by way of behavioral strategies involving exposure and response prevention in a variety of forms, from rapid flooding to systematic desensitization. In the following section, we will consider the possible application of these strategies to treatment of repetitive behaviors characteristic of ASDs.

Implications for Autism

Repetitive, ritualized behavior in autism that occurs to prevent some real of

perceived outcome involving specific environmental stimuli fits not only a model which conceives of higher-order repetitive behaviors as avoidance based, but with a treatment model intended to address these behaviors. Conceptualizations of higher-order repetitive behaviors as ritual, sameness, or compulsive behavior that entails detection and amelioration of perceived threats through repetitive avoidance behavior make interventions targeted to maladaptive avoidance particularly relevant to ASDs (Evans, et al., 1997; Boyer & Lienard, 2007). As detailed in previous sections, the best examples of avoidance interventions come from the realm of treatment involved in cases of clinically defined compulsion and higher-order repetitive behaviors related to distress inducing stimuli. In sum, exposure and response prevention procedures seem most effective in reducing or eliminating avoidance behavior.

Because of the similarities in behavior patterns between autism spectrum disorders and OCD, treatment cross-over may prove efficacious (McDougle et al., 1995; McBride & Panksepp, 1995; Bodfish et al., 2000; Bejerot, Nylander, & Lindstrom, 2001; Russel et al., 2005). A handful of studies have utilized OCD pharmacological treatments in the treatment of repetitive behavior problems associated with autism. One double-blind, placebo controlled study of 24 children and young adults with autism found clomipramine more effective than placebo in reduction of obsessive-compulsive symptomology (Gordon, Stat, Nelson, Hamburger, & Rapoport, 1993). Subsequent studies, however, have shown mixed results overall and highlight the potential problem of the adverse side-effects associated with clomipramine. In a review of SRIs in treatment of problematic repetitive behavior among persons with

developmental disorders, McDougle, Kresch, & Posey (2000) noted that inconsistent results and frequent reports of side-effects were common to clomipramine studies among that population. Given the scant and conflicting body of research, the authors of that review further argued that controlled studies are needed regarding the effectiveness of SRIs on the repetitive thoughts and behaviors associated with autism. Placebo controlled studies would better assess the effectiveness of SRIs such as clomipramine as well as various SSRIs in the treatment of problematic repetitive behavior among persons with autism.

As with studies concerning pharmacological treatment of compulsivity among persons with ASDs, application of ERP among persons that population is quite limited. One recent case study examined ERP in treatment of obsessive and compulsive symptoms in a child with Asperger's disorder and found an overall decrease in those behaviors (Reaven & Hepburn, 2003). However, that study was largely descriptive in its aims, making it difficult to infer cause regarding efficacy of ERP procedures. That case study did suggest, however, that it may be appropriate to apply ERP procedures to ASDs in order to ameliorate complex repetitive behavior problems. The single subject in that study had a diagnosis of Asperger's, which differs from autism in that the former is not associated with communication deficits and may be related to the efficacy of ERP in that study. Differences in communication ability would likely impact the application of certain cognitive aspects of treatment, but would arguably not affect the primary behavioral components of exposure and response prevention.

Another recent study examined ERP in treatment of OCD in a child with autism,

finding ERP successful in decreasing target behaviors (Lehmkuhl, Storch, Bodfish, & Geffken, 2008). This study likewise employed a case study design around a single subject, limiting its internal and external validity. However, it likewise suggests that ERP procedures may be appropriate for at least certain persons with autism who demonstrate compulsive-type symptoms. The study did note that the subject's repetitive behaviors were classic of OCD (e.g., fears of contamination) and were not necessarily typical of higher-order repetitive behaviors seen in ASDs (McDougle et al. 1995). It is unclear whether to what extent true differences (other than one that is clinically defined by OCD) exist between behaviors typical of OCD versus those typical of autism. As previously discussed, compulsions may differ in their content and form between OCD and autism samples but occur at similarly significant levels in both groups (Russell et al., 2005).

Aside from the two aforementioned studies, no assessments of systematic exposure and response prevention treatment of higher-order repetitive behavior in autism currently exist. Searches of major databases, as well as backward chaining from relevant material, have yet to yield any study specifically assessing the effectiveness of exposure and response prevention therapy in treatment of higher-order repetitive behaviors among those diagnosed with autistic disorder. One possible explanation may involve the previously discussed cognitive and communication barriers to treatment among many of those with autism. The cognitive therapy elements of ERP would likely fail to translate to intellectually impaired individuals with autism. However, the behavioral components of exposure and response prevention are well-

established as effective in altering behavior and need not necessarily be combined with cognitive therapy (Morganstern, 1973; Thyer, Baum, & Reid, 1988). Another explanation for the lack of work examining treatment of higher-order repetitive behavior is that much of autism research has focused on social and communication deficits, with attention to restricted and repetitive elements of autism commonly focused on lower-order repetitive behaviors such as stereotypy or self-injury (Bodfish, 2004).

Although full cross-over application of ERP therapy from OCD to autism is lacking, certain components of ERP are used in applied behavior analysis interventions common to treatment of other problems found in autism, such as systematic desensitization for phobias and response blocking. Previous research has found exposure interventions successful in remediation of escape and avoidance behavior related to phobic stimuli in persons with and without developmental disabilities (Efranian & Miltenberger, 1990; Hagopian, Crockett, & Keeney, 2001; Jones & Friman, 1999). Furthermore, a number of studies have demonstrated the effectiveness of exposure and related procedures in remediation of a variety of problem behaviors associated specifically with autism. One study utilized systematic desensitization (in the form of graduated stimulus change) to address compulsive object attachment in 2 children with autism, finding that systematic exposure to changes in stimuli resulted in greater behavioral flexibility (Marchant, Howlin, Yule, & Rutter, 1974). Two recent studies have utilized variants of systematic exposure to remediate maladaptive escape behavior associated with phobic stimuli among children with autism (Ricciardi, Luiselli,

& Camare, 2006; Shabani & Fisher, 2006).

A number of studies have utilized behavioral procedures similar to those in ERP to address problems of maladaptive repetitive behavior, demonstrating through single-subject design the efficacy of behavioral procedures in altering or eliminating problems of stereotypy (Lerman, Kelley, Vorndran, & Van Camp, 2003). In a review of treatments for stereotypy among persons with IDD, response prevention (or response blocking) was identified as generally successful in remediation of such behaviors (Lancioni, Singh, O'Reilly, & Sigafoos, 2009). However, those authors do note that treatment literature involving response prevention generally utilizes it as part of a more complicated array of techniques, making it difficult to generalize results.

One recent study specifically addressed compulsive-like straightening behavior in an adolescent with autism using avoidance extinction and functional communication training (Kuhn, Hardesty, & Sweeny, 2009). That study demonstrated a sharp decrease in the straightening behavior using response blocking paired with skills training. In total, these studies relate to ERP in their use of exposure with and without response prevention to eliminate avoidance or escape responding. Moreover, they represent ways in which therapies might establish new contingencies between behavior and controlling elements of the environment. Representative of a larger body of behaviorally based interventions for autism, these studies suggest that the behavioral strategies typical of avoidance extinction and ERP may likewise prove successful among persons with ASD.

Research Question

Given the exigency for treatment research specific to higher-order repetitive behaviors in autism, this study examined the effectiveness of exposure with response prevention in treatment of higher-order repetitive behavior. The intervention utilized elements found in treatment of similar behaviors characteristic of other disorders as well as lower-order repetitive behaviors, such as stereotypy. Using an avoidance conceptualization of higher-order repetitive behavior, two research questions were addressed. First, do avoidance extinction procedures decrease higher-order repetitive behavior in persons with autism? Avoidance extinction procedures were utilized to determine whether exposure to controlling stimuli coupled with response prevention lead to decreases in ritualized behavior. Ancillary to this goal, the study also examined the relationship between physiological arousal and various phases of the behavioral protocol (i.e. baseline, exposure to controlling stimuli). This element of the study represents a preliminary step in answering the following: Is the presence of controlling stimuli associated with increased physiological arousal?

General Method

Overview

To address the research questions, two separate but related experiments were conducted. For Experiment 1, participants with frequent, nonsocially maintained higher-order repetitive behavior took part in a study of intervention based on avoidance extinction procedures using an ABAB single subject experimental design. For Experiment 2, heart rate data were collected for one participant during experimentally manipulated conditions to assess physiological arousal in relation to the performance of ritual type behavior under a variety of circumstances.

Participants and Setting

Recruitment. Study participants were recruited from a population of 18 adults with autism and ID living in a suburban intermediate care facility for persons with mental retardation (ICF/MR) group home specializing in autism services. Legal guardians were contacted by mail for the purpose of consent through an intermediary at the group home (the facility director). Contact information for the study author was given along with consent (Appendix A) and HIPPA forms. Consent was obtained for 15 (83%) of the potential participants. Study procedures were approved by the University of Minnesota's Committee for the Protection of Human Subjects as well as the Board President and Director of the above described group home.

Inclusion/exclusion criteria. Inclusion criteria included: (a) either children or adults diagnosed with autism, (b) diagnosis of intellectual disability, (c) presence of nonsocially reinforced compulsive or ritual type behavior, (d) participation in a single

agency or school (to control for factors related to setting). Presence of autism was based on an existing diagnosis of autistic disorder using the Diagnostic and Statistical Manual of Mental Disorders criteria (American Psychiatric Association, 2000). Presence of intellectual disability was determined by existing diagnosis based on standard IQ measures. The presence of significant higher-order repetitive behavior was determined through use of the compulsive and ritualistic behavior subscales of the Repetitive Behavior Scale-Revised (RBS-R) and follow-up interview (Bodfish, Parker, Lewis, & Symons, 2000, see Appendix C). The RBS-R is an independently validated measure of repetitive behaviors specific to persons with developmental disorders such as autism (Lam & Aman, 2007). Those participants whose screening indicated the presence of at least one compulsive or ritual behavior of daily occurrence were considered for the study. Functional analyses (FA) were conducted for those participants with frequent higher-order repetitive behavior. Participants for whom the FA indicated automatic or undifferentiated reinforcement were included.

Exclusion criteria consisted of: (a) infrequent higher-order repetitive behavior, (b) lower-order repetitive behavior alone, (c) socially maintained higher-order repetitive behavior, (d) current or recent treatment of higher-order repetitive behavior. Participants for whom compulsive or ritual behaviors do not occur consistently in the presence of controlling stimuli or whose repetitive behavior is low-frequency (as indicated by the RBS-R) were excluded. Persons for whom the RBS-R indicated only stereotypy or self-injury were not included. Participants whose repetitive behavior was maintained by socially reinforcers (e.g., attention or escape)

were excluded as such behavior would not fit within the theoretical framework of this study. Persons currently or recently (previous 6 months) receiving treatment specifically for problem repetitive behavior were also excluded to protect internal validity.

Selection. All consented participants were screened for specific repetitive behaviors of interest (e.g., ritual or compulsive type behavior) using the RBS-R. The RBS-R was completed by the group home supervisory staff person identified as having the most experience working directly with each potential participant. In all, four different group home staff completed the RBS-R for each of the 15 consented participants. Five potential subjects were identified from this pool based on the following criteria: presence of one or more compulsive or ritual type behaviors scoring as either a 'moderate' or 'severe' problem occurring frequently. Though frequency is measured qualitatively by the RBS-R, follow-up discussion with raters identified those behaviors that occurred at least daily. Based on severity as defined by the RBS-R and frequency as defined as "at least daily", five participants were selected as eligible for the study protocol. Follow-up discussions were conducted with group home staff to facilitate a clear understanding of the details related to each participant's behavior. Of the five eligible participants, three individuals with the most frequent and severe higher-order repetitive behavior were enrolled in the study.

Participants. Participants were three adult males diagnosed with autism (DSM-III-R or later). Their autism diagnosis had been confirmed by the group home's consulting clinical psychologist. The same psychologist administered the most recent

cognitive assessments for each participant and placed each of the three in the severe range of intellectual disability. The first participant, Shawn, was a 54-year-old nonverbal man who had been functionally deaf since adolescence. The second participant, Kyle, was a 46 year old man with limited verbal skills consisting of echolalia and two- or three- word novel utterances. The third participant, Jacob, was a 42 year old man with limited verbal skill consisting of three- to four- word utterances. All three participants were ambulatory and attended separate day training and habilitation programs on weekdays for approximately 6 hours per day.

Setting. The group home consisted of three separate apartment suites and one adjacent house. The participants in this study lived in the larger building, one in each of the three suites. These living areas comprised five single bedrooms off of a large common room, two large, shared bathrooms, and a kitchen. The three large suites shared the same basic layout with some minor aesthetic and furniture differences. All FA, baseline, and treatment sessions took place in these suites with the exception of generalization trials for one participant (Kyle). For Kyle, generalization baseline and treatment trials were conducted outside of the apartment suite in a variety of settings (non-residential administrative areas of the group home, a store, and parking lots).

Experiment 1

For Experiment 1, targeted higher-order repetitive behaviors were addressed by exposure to controlling stimuli with response prevention (avoidance extinction) for the three participants.

Measurement

Target behaviors. RBS-R staff interviews yielded descriptions of specific repetitive behaviors for each of the three participants. All three participants exhibited behaviors that staff reported to be nonfunctional and "compulsive" (using varying terminology, they described the behaviors as reliably produced under a variety of circumstances). None of the three behaviors were new to staff and no staff person reported knowing when or how the behaviors started, though a number of staff speculated as to cause for some participants.

Shawn. For Shawn, the most frequently reported ritual-type behavior involved checking and closing the door to the kitchen in his suite. Staff reported that Shawn would stand near the kitchen area for prolonged periods of time, presumably waiting for others to exit so that he might fix the door into a "just so" closed position. When closed, Shawn would repeatedly open and slam closed the door until it was aligned in some certain manner that was unclear to staff persons. At other times, staff reported that Shawn would position himself on a couch or chair in the living area so that he might watch the kitchen door. As when he stood adjacent to the kitchen door, Shawn would fix the door into a specific closed position anytime it was left open. He rarely

closed the door when the kitchen was occupied by another resident or staff person. Staff provided no speculation regarding the cause of the behavior but did report that it was one of a number of such "just so" behaviors performed by Shawn. Probes conducted prior to functional analysis indicated that the behavior reliably occurred regardless of how ajar the door was positioned (ranging from fully open to 2 inches ajar). These compulsive-like just-so behaviors (particularly in regard to the kitchen door) occurred throughout the day and interfered with both leisure and skill acquisition programs. This interference manifested through Shawn's leaving adaptive activities to close the door or waiting near the kitchen for prolonged periods of time for the opportunity to do so.

Kyle. Kyle's target behavior involved the placement of his head upon the sleeves of dress shirts worn by others. Staff reports indicated that upon seeing a person in a dress shirt, Kyle would walk rapidly toward the person and firmly press his head against the person's upper or lower arm. This behavior was reported to occur regardless of the person wearing the shirt, but was particular to dress shirts. Interestingly, staff reported that Kyle exhibited the behavior only with dress shirts worn by a person. Dress shirts alone or dress shirts worn by stuffed animals did not evoke the behavior (a failed previous intervention attempted by Kyle's day program involved the provision of large stuffed animals wearing dress shirts). Staff further reported that employees of the agency, particularly those who worked in the suite in which Kyle resides, refrained from wearing long sleeved dress shirts. When in the community, staff reported avoiding areas where persons wearing dress shirts were

likely encountered as Kyle did not seem to discriminate between familiar and unfamiliar persons in regard to the target behavior. Staff reported numerous occasions upon which Kyle attempted or completed placing his head on the arm of a stranger in the community. Concerning this issue, staff reported another failed intervention from 2003 that exposed Kyle to dress shirts with removable sleeves (contingent on the head-to-sleeve behavior) which had been implemented due to the risk of victimization associated with the act. No current staff persons were aware of the justification for intervention involving removable shirt sleeves. The behavior in general interfered with Kyle's opportunities for community participation and limited his involvement in adaptive activities in any locales where persons wearing dress shirts were likely to be present. Additionally, it restricted through accommodation the type of clothing those around him were able to wear.

Probes indicated that the behavior occurred with long sleeved dress shirts of a variety of colors, patterns, and traditional dress shirt fabrics (both broadcloth and Oxford). The behavior occurred regardless of the person wearing the shirt during probes (male/female; familiar/unfamiliar). Textured shirts, however, did not elicit the behavior. On a couple of occasions outside of this study, the behavior occurred with a short sleeved dress shirt. However, this result was not reproduced during baseline and treatment sessions. During probe sessions, a corduroy shirt and flannel shirt occasioned none of the head-on-sleeve behavior. Another probe was conducted wherein a blue broadcloth men's dress shirt was placed upon the back of a couch situated near Kyle's room. At no time during this probe did Kyle physically interact with

the dress shirt while it was placed near him.

Jacob. The third participant, Jacob, performed a number of repetitive behaviors involving a fire alarm key panel and speaker in the main living area of his suite. The alarm speaker was situated on an outside wall approximately eight feet from the floor, with the key panel three feet below that. The alarm speaker and panel (henceforth referred to as "alarm") were situated near the threshold of the adjacent kitchen and dining areas. Unlike the stimuli involved with the other two participants, the alarm stimuli were clearly related to noxious events (i.e. a loud fire alarm). However, staff persons played no role in activating the alarm, nor were drills initiated from this area (this was done from a nonresidential area of the group home). Staff reported that Jacob was highly distressed during fire drills and other occasions when the siren sounded, which occurred approximately four times yearly, and that this distress was exhibited daily during times when other persons stood in close proximity to the alarm. Staff reports further indicated that Jacob would check the alarm area multiple times daily for the presence of others. When other people were near to the alarm, Jacob would exhibit one of a number of behaviors including yelling at that person, physically dragging that person from the area, and repeatedly checking the area until the person had moved.

Initial probes found some amount of variability concerning "how close was too close". Standing within two feet of the alarm area would reliably elicit any of the above described behaviors. Probes indicated that the yelling, pulling, and checking behaviors occurred regardless of whether the person standing near the alarm was familiar staff,

an unfamiliar stranger, or a fellow suite resident, though staff reported that it was more likely to occur with less familiar persons. On one occasion, dragging and yelling occurred with a staff person standing approximately six feet from the alarm, though this event was not reproduced. Jacob's behavior in regard to the alarm frequently interrupted adaptive activity for himself and others and limited use of the physical environment for other residents and staff. Moreover, the close proximity of others to the alarm clearly caused distress for Jacob.

Response measurement. In the following section, operational definitions of target behaviors, used for the purpose of measurement across initial analyses, baseline, and treatment, are described for each participant.

Shawn. For Shawn, the target behavior involved closing of the kitchen door. Across FA and treatment conditions (described below), this behavior was defined as any instance wherein Shawn's hand held the door and moved it in any amount to its point of terminal closure. Occasions where Shawn shut the door from its fully open position to terminal closure were counted in the same manner as when Shawn moved the door to its terminal closure from slightly ajar (in line with probes that indicated that the behavior was independent of how open the door was). Occasions where Shawn held the door and shut it repeatedly were counted as multiple closures (each time the door contacted the terminus). Occasions where Shawn held the door in the closed position were counted as a single closure. Touching or holding the door without causing it to move was not counted.

Across conditions in the functional analysis, the door was opened every 30s for

a duration of 15s (or until Shawn closed the door). This was done eight times for each session (15s open, 15s closed for a total of 4 minutes). To obtain baseline, door closing was unblocked and ignored. However, the door was reopened 15s after it was closed by Shawn for each occasion this occurred to mirror treatment phases where the door would be continuously open. During all treatment phases, all attempts at door closure (described above) were recorded. Rate of door closing per hour was calculated for all phases.

Kyle. For Kyle, the target behavior involved placing his head upon dress shirt sleeves worn by others. Across FA and treatment conditions, two behaviors were measured, completed behaviors and attempts. First, completed head-on-shirt behavior was defined as contact between either side of Kyle's head (independent of pressure) against any part of the dress shirt sleeve worn by the interventionist. This included upper and lower parts of either arm. Contact between Kyle's head or any other part of his body to another area of a dress shirt was not counted, and such occurrences were quite rare. Head to arm contact was measured using a 10s partial interval recording procedure resulting in a percent of intervals metric.

Attempts were defined as any instances wherein Kyle's head came within a foot of the interventionist's shirt sleeve clad arm during treatment sessions, necessitating the interventionist to block the behavior. Blocks involved the interventionist placing their hand between Kyle's head and the shirt and neutrally pulling the targeted arm back from his head. Each of these blocked attempts were counted and measured by frequency count (frequency of blocked attempts per 3

minute session). Attempts that occurred outside of intervention and generalization sessions were blocked but not counted.

Jacob. For Jacob, target behaviors involved yelling at or physically moving persons near the alarm. Though alarm checking occurred more often, there were a number of measurement challenges to properly capturing occurrences of checking. Because the most common consequences of checking when another person was near to the alarm were either yelling or moving the other person away, these behaviors were selected as targets for measurement. Moving others and yelling were measured by frequency per 30s of exposure to a person standing near the alarm during baseline and treatment conditions. For baseline conditions, staff moved away from the alarm contingent on Jacob's yelling or physical moving them, allowing for a 30s break from exposure before returning to the alarm area. This pattern was repeated until a full 30s of exposure occurred for each baseline session. For the extinction conditions, yelling and physical movement did not achieve a break from exposure. These sessions ended when a full 30s passed without either target behavior occurring. During functional analysis, target behaviors were measured as percent of opportunities in which behavior occurred across four opportunities per session. Session and exposure length were based on initial probes and staff interview. FA sessions were kept relatively short to minimize distress for Jacob.

Yelling was defined as a verbal directive made by Jacob toward any individual standing within 2 feet of the alarm that concerned moving (moving or going away). These directives were almost exclusively yelled at the person near the alarm. Probes

and discussion with staff persons revealed that these directives were simple and generally clear in nature, most often taking the form of one of the following: “Man, move!”, “(name), move!”, “Go away, man!”, “(Name), go away!”. Jacob would use the first name of familiar staff and fellow residents, and man/woman for unfamiliar persons. Yelling directed toward others not standing near the alarm or verbalizations unrelated to moving were not counted.

Physically moving persons standing near the alarm was defined as grabbing another by any part of the body and pulling them in any direction away from the alarm area. Touching a person near the alarm, but not forcing movement, was not counted. Staff reports indicated that the moving behavior only took place in instances where another person stood or moved near to the alarm; aggressive or physically forceful behavior was uncommon for Jacob except for alarm related instances. Because of Jacob’s size and strength, it was determined that it would be infeasible to resist, or adequately prevent, his attempts to physically move another during intervention phases, thus no movement attempts were defined. Specific procedures to put the moving others behavior on extinction will be discussed in a later section.

Functional Analysis

For each of the three participants, analogue functional analysis procedures were utilized to screen for socially maintained repetitive behavior. These functional analyses were based in part on those described by Iwata et al. (1982/1994). Procedures and analogue conditions were tailored to each of the three participants based upon staff interviews and initial probes/observation.

Shawn. Three conditions were used for Shawn's functional analysis (alone, task demand, and leisure) to examine the influence of these contingencies on rate of target behavior. The alone condition was used as a control condition to assess the rate of target behavior in the absence of social consequences of any kind. The task demand condition allowed for the provision of escape contingent upon target behavior, while the leisure condition assessed the rate of target behavior during free access to preferred activities. The leisure condition was used across participants in lieu of a play condition, though its content and form remained the same. Based upon staff interview, attention was not assessed for Shawn as a possible function based on the following rationale: Staff reported that Shawn, who was functionally deaf with limited nonverbal communicative ability, had little interest in social interaction with others and responded with general ambivalence to attempts at positive social attention.

Functional analyses for Shawn were conducted on two consecutive days during the late afternoon. In all four minute sessions, the kitchen door was opened by a therapist every 30s and remained open for 15s, at which point it would be closed for a period of 15s, thus the door was open for 15s and closed for 15s throughout each session. Each time the door was opened, if Shawn closed the door before 15s had elapsed, it would remain closed until the next scheduled door opening. A second therapist recorded whether Shawn closed the door at any time during each 15s opportunity. Across conditions, Shawn was positioned so that the kitchen door was fully visible to him.

During the alone condition, Shawn was seated in the main living area of the

suite but not engaged in any leisure or task activity. During these times, staff persons remained physically distant from him (in other areas of the suite). For the task demand condition, a 10s escape from a task was provided for each instance of door closing. After 10s, Shawn was redirected to the task. For these conditions, the tasks consisted of housekeeping duties performed in the main living area (e.g., cleaning tables). For the leisure condition, Shawn was engaged in a preferred activity of his choosing (e.g., putting together puzzles) in the main living area. A therapist stood near Shawn (as in the escape condition), but no social consequences were provided.

Kyle. Functional analysis sessions took place over three nonconsecutive days during early to mid-afternoon in the main living area of the suite where Kyle resides. To test the influence of various contingencies on the occurrence of the targeted head-on-shirt behavior, four conditions were arranged for the analogue functional analysis. The four conditions were ignore (dress shirt), ignore (no dress shirt), escape, and attention.

Across all conditions, sessions began in the main living area with the therapist standing 2 to 3 meters from Kyle and within his line of sight. For both ignore conditions, Kyle was free to engage in preferred activities while in the main living area of his suite. For the ignore (non-dress shirt) condition, the therapist wore a textured long sleeve shirt. In both ignore conditions, Kyle received no social consequence for placing his head on the shirt and was free to perform the behavior throughout these sessions. For the escape condition, Kyle engaged in a housekeeping task with a second therapist. Fifteen seconds of escape from the task demand was provided contingent

on Kyle placing his head on the first therapist's dress shirt. After 15s of escape, Kyle was prompted to return to the task. Task demands were initiated and followed through by a second therapist. These task demands consisted of housekeeping programs and all took place within the main living area of the suite. For the attention condition, Kyle was given a mild reprimand contingent upon placing his head on the shirt sleeve by the therapist wearing the shirt. These reprimands varied between "Don't do that, Kyle" and "No Kyle, that's bad". It was determined through staff interview that reprimands of this type best reflected the natural consequences delivered outside of experimental conditions.

Jacob. Five conditions were conducted for Jacob across nineteen sessions to test their influence on the occurrence of yelling at and physically moving staff persons in close proximity to the alarm. For the purpose of functional analysis, data on physical movement of the therapist were not analyzed due to comparatively low incidence. This behavior occurred a total of four times across sessions in three different conditions [alone (1), preferred (2), and escape (1)]. Sessions took place of the period of two days in the mid- to late afternoon in the main living area of the suite in which Jacob resided.

For the behavior of yelling, the five conditions were alone, attention, escape, preferred, and control. For the alone condition, Jacob was not engaged by the therapist or in any activity, and no social consequences for the occurrence of any target behaviors were delivered beyond moving away from the alarm. For the attention condition, Jacob was free to engage in any activity of his choosing, during

which a nearby therapist offered verbal reassurance contingent on yelling or physically moving the second therapist near to the alarm ("It's OK Jacob"). For escape, Jacob was engaged in a housekeeping duty in the main living area of the suite by one therapist while another stood near the alarm. Fifteen seconds of escape from the task were provided contingent on the occurrence of yelling or physical movement. For the leisure condition, Jacob was engaged by the first therapist in a leisure activity of his choosing in the main living area (e.g., looking at magazines) and noncontingent neutral social interaction was provided while a second therapist stood near the alarm. The control condition mirrored the leisure condition with the exception that the second therapist stood in a neutral location approximately 5 meters across the room from the alarm.

Results. Data from Shawn's functional analysis are presented in Figure 1. Shawn's FA data were undifferentiated consistent (although not confirmatory) with an automatic reinforcement function. Percent of opportunities in which door closing occurred varied widely within and across conditions. Rates were somewhat lower during task demand conditions. It is possible that this is due to the nature of the task (table cleaning) which required that Shawn's gaze be directed away from the door.

Results of Kyle's functional analysis are presented in Figure 2. Visual inspection of functional analysis data indicated a clear elevation of the head-on-shirt target behavior during ignore conditions where a dress shirt was available. The target behavior occurred at a comparatively lower rate during the escape and attention conditions. Notably, there were no occurrences of the behavior during the same condition with a nondress shirt. These results are consistent with a nonsocial

reinforcement interpretation.

Results of Jacob's functional analysis are presented in Figure 3. Functional analysis data for Jacob were largely undifferentiated and low rate. It is notable that during a number of sessions, Jacob would seem to avert his eyes from the alarm area. This behavior is supportive of staff reports that Jacob may be attempting to avoid some aversive relationship between the other persons and the alarm. Overall, the FA data for Jacob are consistent with an automatic reinforcement interpretation.

Interobserver agreement. For all three participants, inter-observer agreement (IOA) data were conducted with the primary investigator and four group home program supervisors participating in data collection. Data were collected for a total of 26% of all sessions, with the criterion of obtaining IOA data for no less than 20% of sessions for any single participant. There were 8 IOA trials for Shawn (35%), 12 IOA trials for Kyle (24%), and 13 IOA trials for Jacob (23%). Because of the nature of the treatment used for Shawn, IOA was not collected for his second treatment phase. In lieu of IOA, during Shawn's second treatment phase, fidelity checks were conducted (described below).

IOA was calculated for each participant by summing the total number of agreements divided by the sum of total observations (agreements plus disagreements). Percent IOA was generated by multiplying this figure by 100 [A/(A+D)*100]. Agreement was defined as both observers coding the same result for each given trial (straight frequency count, frequency within 10s interval, or occurrence, depending on phase and participant). Disagreement was counted as any of the above

wherein observers coded a different result. For Shawn, mean IOA for door closing was 96% (ranging from 87-100%). For Kyle, IOA was calculated for both contact with the shirt and attempts. Mean IOA for frequency within 10s intervals was 94% (ranging from 88-100%). Mean IOA for attempts was 89% (ranging from 76%-100%). For Jacob, mean IOA for the target behavior of yelling at staff was 91% (ranging from 72%-100%).

Experimental design. For all three participants, an ABAB single subject reversal design was employed to assess the effects of treatment on baseline rates of target behaviors. For one participant, Kyle, a separate AB design was added for generalization trials.

Intervention

Shawn. For Shawn's door closing target behavior, baseline data were collected continuously and calculated as rate per hour wherein an ajar door was made continually available on three separate occasions over two days. During the baseline phase, door closing was left uninterrupted. For the first treatment phase, the door was mechanically altered to prevent full closure. Two 3" door hinges were unpinned and attached to the door frame just below each of the existing hinges. The hinge shafts prevented full closure of the kitchen door (the door could be closed to within 4 inches of full closure). During this time, staff persons at the group home ignored the behavior (which was in-line with their typical practice for the target behavior). Each instance of attempted door closure on the part of Shawn was recorded throughout the day over a period of 14 days. For the reversal phase, the door was unblocked with door closing recorded in the same manner as in baseline after the seventh treatment day.

For Phase 2 of treatment, the door was blocked in the same manner as in Phase 1, but staff working with Shawn would redirect him to an adaptive activity each time he attempted to close the kitchen door. This change to treatment added to the quality of response blocking already in place with the mechanically altered door. This change to treatment was implemented in response to the persistence of door closing behavior with response blocking alone.

Kyle. For Kyle's head-on-shirt target behavior, baseline data were collected in a manner similar to the ignore condition of the functional analysis. Head-on-shirt behavior was recorded using 10s partial intervals over a 3 minute period. The behavior was neither blocked nor socially attended to. For treatment phases, head-on-shirt behavior was neutrally blocked using the procedure described in the Response Measurement section above. As with FA and baseline trials, each treatment session lasted 3 minutes. Primary treatment and baseline sessions occurred in the main living area of Kyle's residential suite at various times throughout the day and during a variety of activities. A variety of staff persons trained in the intervention procedure served as therapists for treatment sessions.

Generalization. Because of concerns related to the occurrence of this behavior in community settings, training for generalization to various nonresidential settings was implemented for Kyle. Generalization baseline measurement began at approximately the same time reversal data were collected for the primary treatment. Baseline data for generalization were collected on two occasions in both the administrative building of the group home and at a local commercial store (Target).

Treatment sessions were likewise conducted at these locations, both inside and in parking lots. For all generalization trials, Kyle was accompanied by a known staff person during routinely scheduled community access programming. A person unknown to Kyle, wearing a dress shirt, would stand in areas of the above locales where Kyle was known to pass by. As needed, this person would implement the same blocking procedure used in the primary treatment setting. These data were recorded as percent of opportunity for attempts and successful completions of head on shirt. A reversal of treatment procedures was not used for the generalization component of Kyle's data collection.

Jacob. For Jacob's behaviors related to persons near the alarm (yelling and physically moving people away), baseline data were collected for both behaviors over the period of two days. Yelling at staff to move (described above under response measurement) was measured by frequency count during each trial of 30s exposure. Physically moving the staff person from the alarm area was recorded as percent of opportunities. During baseline and treatment sessions, the staff person stood approximately 1 foot from the alarm. For baseline sessions, yelling at or physically moving this staff person achieved a 30s period wherein the staff person moved away from the alarm (> 10 feet). During treatment, all vocal directives were neutrally ignored by the person standing near the alarm. Because of Jacob's size, it was not possible to physically prevent him from moving staff away from the alarm area. As such, when moving occurred during treatment, staff allowed the behavior but would immediately return to the alarm area after being moved. So as not to end a treatment

trial after a vocal directive or movement, sessions ended contingent on one full 30s interval without either vocal directive or movement. All treatment and baseline sessions were completed by a variety of persons (10) trained in the procedure so as to prevent any one person from becoming associated with the alarm.

Results

Baseline and treatment phase data for Shawn, Kyle, and Jacob are presented in Figures 4, 5, and 7, respectively. Figure 6 displays generalization results for Kyle.

Figure 4 displays baseline and intervention data for Shawn. During baseline, the target behavior of door closing occurred at a rate of approximately 4.2 times per hour when the door was continuously re-opened after each closure by Shawn. During the first treatment condition of response blocking alone, the level of door closing decreased from baseline but was not trending downward prior to reversal. For the single day of reversal, Shawn's baseline rate of door closing returned to its original level with just under 5 door closures per hour.

After reversal, the door was again mechanically blocked for a period of 7 days. During this time, the rate of door closing returned to level approximating those in the first treatment phase. Again, variability and the lack of a clear downward trend characterize data for this phase. On day nineteen, redirection was added to response blocking. This change was associated with a decrease in overall level from response blocking alone, though by the end of Shawn's participation in this study, door closing had not reached zero with an average rate of 1.4 attempts per hour.

Figure 5 displays baseline and intervention data for Kyle. During baseline, the

target head-on-shirt behavior occurred for approximately 69% of 10s intervals during 3 minute sessions. During the first treatment phase, attempts at the target behavior reduce to zero after the first treatment session. Completed attempts were at zero for all treatment sessions (because of response blocking). During the reversal phase, the head-on-shirt behavior returned to near baseline levels. For the second treatment phase, data indicate wide variability in attempts between sessions 12 to 29. The peak rate occurred at session 29 before dropping to zero thereafter. The behavior remained at or near zero for the remainder of this treatment phase. At two-week follow-up, the behavior remained at zero for 3 of 4 sessions (two attempts were made in the second-to-last follow-up session).

Figure 6 displays generalization baseline and intervention outcomes for Kyle. Baseline data indicate a moderate rate of head-on-shirt behavior across community settings. For the intervention phase, a rapid effect treatment effect occurred. Occurrence of the target behavior remained at zero for most sessions of Kyle's generalization training.

Figure 7 displays baseline and intervention data for Jacob. During initial baseline, the target behavior of yelling at staff to move occurred at a relatively low-rate for each 30s of total exposure (staff moved away contingent on yelling). During the first extinction phase (yelling is ignored), the target behavior decreased but remained at 1 occurrence per exposure trial for half of sessions. For the return to baseline, rate of yelling was variable but generally higher than during extinction. At the return to extinction, rate of yelling mirrored the second baseline phase initially before

dropping to zero for five sessions. The behavior returned to baseline rates over the course of about 6 sessions before once again dropping to zero. At two-week follow-up, the rate of yelling remained at zero per 30s exposure.

Discussion

The complexity, topography, and frequency of higher-order repetitive behaviors differed greatly across the three participants. None of the three target behaviors constituted a discrete response class and all were without exception part of a larger repertoire of repetitive behaviors and responses in general. These complexities posed a number of challenges to the development of objective and useful measures. It was likewise difficult to determine the extent to which any of these behaviors were maintained by avoidance despite the effect avoidance extinction had on each of the behaviors, particularly Kyle and Jacob, whose target behaviors decreased to zero.

The idiosyncratic nature of these behaviors is not surprising given their broad expression across the lifespan among diverse populations and persons with autism specifically (Bodfish, Parker, Symons, & Lewis, 2000; Evans et al., 1997). In the case of Shawn, repetitive door closing appeared to be but one form of a variety of “just-so” behaviors. Staff reported a number of other instances of checking and fixing on the part of Shawn. What effect, if any, intervention for kitchen door closing had on similar checking and fixing behaviors is unknown. For Kyle, the behavior of placing his head on dress shirt sleeves occurred in relation to specific stimuli and its topography was largely unvaried (insofar as he pressed his head to shirts in the same way each time).

This behavior was reliably produced and easily tracked. For Jacob, however, the repetitive checking of the alarm area took many forms and occurred at varying levels of intensity. From a measurement standpoint, Kyle's behavior was more discrete and predictable than Jacob's, though both fit within the compulsive level of the RBS-R. As with Kyle, Shawn's repetitive door closing was a straightforward measurement target, while his related door checking was not. The complex qualities of these higher-order repetitive behaviors created challenges for behavioral measurement and intervention.

For Kyle, attempts at the target head-on-shirt behavior rapidly dropped to zero for the first treatment phase but appeared more resistant post-reversal. Two explanations are possible for this result. First, it may be that a return to baseline conditions undermined the avoidance extinction procedures established in the first treatment phase. Second, the second treatment phase was characterized by greater variability of therapists. Because Kyle appeared to associate the presence of the primary investigator with study procedures by the first baseline phase, it was necessary to systematically vary the person wearing the shirt and ensure that the primary researcher was not present for all sessions. Trials with a novel therapist are marked by an asterisk in Figure 5. A number of spikes in the head-on-shirt behavior occurred in trials with a new therapist, though this phenomenon appears to lessen after trial 27. This may be the result of generalization of extinction to any person wearing a dress shirt. However, the behavior remained, albeit at a low rate, upon one trial during two-week follow-up.

To a lesser extent, this same phenomenon was observed with Jacob. Like Kyle,

Jacob's target behaviors involved others (in his case, anyone near the alarm). Staff reported that Jacob would quickly associate a single person with the alarm if they were to stand near it too often. As with Kyle, the aim of the intervention concerned extinction of an avoidance behavior in regard to a range of controlling stimuli rather than an insular example thereof. To ensure this for Jacob, therapists were varied to avoid associating any one person with the alarm starting with early probes. Given that two of the three participants in the current study appeared to readily form associations between a single therapist and controlling stimuli, possibly associated some aversive outcome, it is important to program for generalization from to the outset (Stokes & Baer, 1977).

It would appear that generalization programming is especially important in the case of avoidance extinction to prevent second order conditioning to potentially aversive stimuli. In the current study, a pattern of behavior resembling second-order conditioning was seen with Kyle. Though this phenomenon was not systematically examined here, probes conducted post-treatment indicated that while Kyle's head-on-shirt behavior had dropped to near zero with various dress shirt clad persons, it continued to occur with me. More importantly, it occurred during probes where I wore a short sleeved shirt. Having run much of the initial functional assessment myself (and availing myself freely to Kyle across conditions while wearing a dress shirt), it is possible that my presence (i.e., Stimulus 2), had become conditioned to Stimulus 1, the dress shirt. That Kyle's head on shirt behavior would occur with me absent a dress shirt after the behavior had otherwise dropped to zero in extinction with other therapists is

consistent with second order respondent conditioning. Non-human animal studies on this phenomenon indicate that a variety of factors impact the transfer of stimulus control in regard to aversive events (Rescorla, 1979, 1982). This is particularly true of the persistence of the second order association in the face of first order extinction. Though studies on this issue among humans are limited, there is some evidence that second order conditioning persists after first order extinction (Jara, Vila, & Maldonado, 2006). Given the scope and level of experimental control involved in the present study, it is difficult to do anything but speculate on the occurrence of second order conditioning from the controlling stimulus to a single therapist. It is possible that operant stimulus control transferred from the dress shirt to a particular person. However, future studies may wish to explore the occurrence of higher order conditioning as it pertains to maladaptive behavior from the outset in a manner adapted from non-human animal research.

It is notable that the behaviors exhibited by Jacob were unrelated to the sounding of the alarm. Fire drills at the group home were initiated from a control panel well outside of Jacob's suite. Moreover, those living and working with Jacob played no role in the initiation of fire drills. Though Jacob appeared to have correctly identified the source of sound for fire alarms in his suite, his behavior indicated an incorrect causal association regarding the proximity of others to the alarm and its activation. Staff reported that Jacob exhibited clear signs of anxiety pertaining to the close proximity of others to these environmental elements (such as fearful expressions, attempts to look away from the area, escape to his bedroom). Jacob's case provides a

useful example of how avoidance behaviors may be established, as well as how such behaviors may serve no actual function in regard to the avoidance of aversive stimuli. In the case of Jacob, it is easy to speculate as to the association between staff proximity to the alarm panel and an aversive event. In the case of other ritual and compulsive-type behaviors among nonverbal persons, a similar association may exist but lack a clear connection for outside observers. This highlights the importance of careful consideration in regard to function of higher-order repetitive behaviors

In the case of Shawn, the target behavior of door closing did not decrease to zero by the completion of the study. This is particularly interesting given the high number of training opportunities for this behavior. Because the environment was mechanically altered to prevent repetitive door closing, the treatment, as it were, was in-place whenever Shawn was awake and in his home. As his data indicate, Shawn attempted the door closing behavior at a relatively frequent rate throughout treatment phases. It has long been acknowledged that avoidance behaviors may be particularly resistant to extinction, and a much longer treatment phase may have been needed to fully bring Shawn's door closing to extinction (Baum, 1970). By the end of his participation in the current study, Shawn's door closing had decreased but extinction was not achieved.

It is possible that for Shawn, the controlling stimulus was not properly identified. The treatment in his case assumed that an ajar door served as the S^D for the door closing behavior (or alternatively, as a CS for some unknown event), and that full closure of the door served as feedback, or a safety signal. For Shawn, the distinction of

the door fully closing versus blocking may not have been salient to the S-R-S relationship in this case. Whether a misidentification of relevant stimuli on the part of the investigator or overselectivity on the part of Shawn, actual completion of door closing seemed only partially relevant to the performance of the target behavior (Lovaas, Koegel, & Schreibman, 1979). It is notable that when staff redirected Shawn away from closing the door (rather than relying on mechanical means of response blocking alone), the behavior decreased. This may indicate that performing the door closing behavior (rather than actually having the door closed) served as feedback for Shawn (Dinsmoor, 1999). Because the present research relied on observation and by-proxy interview, it is possible that some key relationship was not given proper consideration. Deeper understanding of the occurrence and assessment of avoidance behavior among humans would improve our ability to identify those factors key to complex repetitive behaviors.

Experiment 2

For Experiment 2, one participant, Shawn, wore a heart rate monitor prior to the start of treatment to determine what, if any, effect the presence of controlling stimuli for target behavior had on physiological arousal. Heart rate variability was collected and analyzed for this purpose.

Methods

Prior to data collection for this experiment, Shawn wore a heart rate monitor (described below) on two separate occasions to acclimate him to its use. Staff interviews were conducted to determine the time of day when the fewest distractions would occur to ensure stability across recording phases. A time period where Shawn would not be engaged by staff and when other group home residents were not present was selected. During recording, environmental and social factors were kept stable across both baseline and exposure phases.

Dependent variable. Heart rate was measured continuously for a period of 17 minutes and 45 seconds in the mid-afternoon just prior to the commencement of treatment (Experiment 1). Heart rate (HR) and heart rate variability (HRV) were recorded using a chest strap heart monitor (Polar Wearlink) and wireless watch receiver. Heart rate was measured and recorded as beats per minute every .5s. Polar receivers show good reliability with other methods of heart rate measurement, with correlations upwards of .98 (Leger & Thivierge, 1988). The receiver was synched to the monitor and connected to a belt loop on Shawn's pants.

Baseline phase. Eleven minutes and 30 seconds of baseline were recorded

wherein the controlling stimulus (open kitchen door) was not presented. Shawn was in no way prevented from adjusting or otherwise manipulating the kitchen door. Shawn was standing near the kitchen at the onset of baseline recording. Throughout heart rate recording, Shawn was unengaged by staff and continually present in the main living area of his living suite.

Response prevention phase. After baseline recording, the kitchen door was opened and mechanically altered to prevent full closure. The continuous presentation of the controlling stimulus occurred for 6 minutes and 15 seconds. No other environmental change was made during this time. Shawn attempted to close the door multiple times throughout this period. He remained present in area near to the kitchen door throughout this phase.

Analysis

Heart rate data were transferred to a computer from the wrist recorder for analysis using SPSS and Kubios software (Biosignal Analysis and Medical Imaging Group, 2008). Outliers and missing data were corrected using Kubios software by replacing them with the mean value of surrounding beats (Bernston et al., 1997). Data were visually examined for aberrant results and a medium level of artifact correction applied using the Kubios software. One spurious value was removed using this method. Heart rate data were broken into two samples based on the time at which the controlling stimulus (open and mechanically altered door) was presented. Kubios software was used to generate heart rate and HRV descriptive statistics for each of these samples.

All HRV values for each sample were transferred to an SPSS database for further analysis. Distributions were tested for normality and homogeneity of variance. Both of these assumptions were well met. Regarding independence, heart rate values tend toward autocorrelation, though this factor was not addressed for the purposes of analysis in the present study. As both samples were interdependent, a paired samples t-test was used for analysis. To fit this analysis, the first sample was matched to the second by SPSS in number of values (513) used for comparison.

Results

Descriptive data for the baseline and exposure phases are presented in Table 1. Mean HRV for baseline and exposure phases was .604 and .57, respectively. Histograms for the distribution of values for the baseline and exposure epochs are presented in Figures 8 and 9. Paired sample t-test of HRV means between phases indicated a significant difference at $t(512) = 12.96$, $p < .000$ (Table 2).

Discussion

Heart rate variability provides a strong indication of central nervous system response to a given stressor, particularly sympathetic activation (Camm, et al., 1996). A relationship between physiological response, subjective anxiety, and behavior has been noted elsewhere and is theoretically in line with the behavioral expression of anxiety disorders (Fowles, 1980). The data presented here lend support to an avoidance view of compulsive-type behavior in autism in that the presence of controlling stimuli for the higher-order repetitive behavior occasions activation of the sympathetic nervous system. It is plausible that the presentation of controlling stimuli,

conditioned directly or indirectly to some real or perceived aversive event, activate a fight-or-flight response, as evidenced by a change in HRV between conditions. More generally, these data support the utility of cardiac measures in identifying the relationship between environmental events and stress reactions (Groden et al., 2005; Sigman, Dissanayake, Cornona, & Espinosa, 2003).

Both epochs were sufficiently long and stable so as to mitigate the effects of autocorrelation, allowing for this preliminary examination of the effects of stimuli related to higher-order repetitive behavior on physiological arousal. Future examinations of HRV as it relates to repetitive behavior might employ time series models to better capture patterns in the data as per 'gold standard' recommendations regarding varieties of cardiac data (Camm et al., 1996). Such methods have been used in larger between-subjects studies of HRV among persons with autism (Groden et al., 2005). Similarly, future designs might employ both epochs of equal length (greater than 5 minutes), as well as a reversal phase regarding presentation of the controlling stimulus.

Another weakness of the present data is that it consists of an AB design. As such, it is possible that some factor aside from the target stimulus explains change in HRV from baseline to exposure. An ABAB design around target stimuli would provide for a stronger demonstration of effect. Such a design would be particularly powerful if a given exposure phase ended with the performance of the higher-order repetitive behavior. Such a design would potentially demonstrate whether the successful performance of the behavior itself is associated with a decrease in HRV and HR. This

too would provide support for theory pertaining to the amelioration of aversive stimuli as safety signal among non-human animals (Dinsmoor, 2001).

General Discussion

Taken as a whole, data from the two experiments presented here provide support for an avoidance conceptualization of compulsive-like repetitive behavior among persons with autism. Long utilized for treatment of OCD, phobias, and similar psychological disorders, exposure and response blocking procedures achieved reductions in target behaviors for each of the three participants. For two of the three, target behavior reached zero-occurrences by the end of the study. In the case of Shawn, for whom heart rate data was available, it would seem that the presence of controlling stimuli for compulsive-type behavior is associated with physiological arousal. This finding is consistent with higher-order repetitive behavior as avoidance in that it suggests that such behaviors are performed to address some aversive environmental event.

Role of staff behavior

For staff working with all three participants, the target behaviors were generally viewed as inherent to each individual. The behaviors had occurred for as long as anyone could remember and, as such, were seen as reflective of personality rather than of some problematic behavioral pattern that might be attenuated. While on one hand this strategy of accommodation may embody quality care, it becomes with the passage of time de rigueur and thus often unexamined and unquestioned by successive staff persons, among whom turnover is quite high. The well-intentioned rules and structured care provided by staff come to maintain and support rigid, sometimes maladaptive, repetitive behaviors.

Though functional analysis data for each of the three participants in this study indicate that target behaviors did not primarily serve a social function, it is likely that rules and structures imposed by staff inadvertently maintained said behaviors. The higher-order repetitive behaviors exhibited by each of the participants may have shaped staff behaviors in a manner put them in the position of supporting avoidance contingencies. Such reciprocal effects have been demonstrated elsewhere and are not uncommon to a variety of problem behaviors found among persons with IDD and those who work with them (Carr, Taylor, & Robinson, 1991; Lambrechts, Van Den Noorgate, Eeman, & Maes, 2009).

The targets of this study exemplify not only the diversity of higher-order repetitive behaviors, but the manner in which they are maintained by others. For all three participants, staff behavior was such that it supported maintaining contingencies for each three target behaviors. In the case of Shawn, staff had long allowed repetitive fixing to take place and made no attempt to interrupt or reduce this behavior. Arguably, such an accommodation is sensible depending on the frequency and intensity of such behavior. In the case of Shawn, the primary issue of concern with closing the kitchen door involved the amount of time spent waiting to close it and the interruption the behavior caused during adaptive activities. Closing the door per se was not itself a problem. Rather, it was the allocation of time spent doing so that had become maladaptive.

In the case of Kyle, staff made every attempt to avoid situations where shirt sleeves might be encountered. On community outings, staff watched for persons

wearing dress shirts and avoided drawing near to them. At the group home, staff as a rule did not wear long sleeved shirts. At one point during the study, a group home staff person (unaware of Kyle's participation in this study) observed that I was wearing a dress shirt and advised that I should "not let Kyle see you wearing that". Though dress shirts are not necessary to the performance of direct care duties in a group home setting, it is interesting that staff had long accommodated Kyle's head-on-shirt behavior by themselves avoiding the possibility of it occurring by effectively implementing an informal dress code.

Shawn clearly found others near to the alarm an aversive event. Staff working with him did what they could to avoid agitating him in anyway, especially as it related to his physically moving persons from the alarm area. They understandably sought to avoid having Shawn physically move fellow residents as well as themselves. As with Kyle, informal rules were established to prevent eliciting any maladaptive behaviors from Shawn. During training, new staff persons were informed that they should not go near the alarm and that they should redirect other residents away from it if such a situation should arise. Because the alarm was situated in the main living area between the kitchen and a seating area, it was not uncommon for people to be in the alarm area and yet every effort was made to explicitly stay away from the alarm in the presence of Jacob. From an avoidance perspective, staff behavior likely served to confirm whatever belief Jacob held concerning others and the alarm.

Effects of response blocking

A related issue concerns the use of response blocking procedures and the potential for iatrogenic effects. Among individuals with ID and autism, these effects might take the form of collateral self-injury, aggression, property destruction, or transference of the blocked behavior to an existing or new topography effects (Lerman, Kelley, Vorndran, & Van Camp, 2003). Conversely, other researchers have found that response blocking procedures can occasion adaptive behavior. Fisher, Lindauer, Alterson, and Thompson (1998) applied response blocking to problem behavior among two participants with IDD and found decreases in destructive and stereotypical behavior (both part of a response chain) and an increase in adaptive behavior. Though that study hypothesized a sensory function to target behaviors, that they were automatically reinforced is an important analogue to the present study. In any case, attention to collateral effects of response blocking procedures may be a key to achieving socially valid outcomes.

As with response blocking, the accompanying extinction may also produce unwanted side-effects. Undesired outcomes of extinction can include extinction induced aggression, collateral self-injury, as well as general distress and anxiety (Lerman, Iwata, & Wallace, 1999). However, it is important to distinguish between social and nonsocial operant behavior as well as and operant and respondent extinction. With avoidance extinction, though an important operant occurs, it is noncommunicative in nature (arguably an important factor to induced aggression or SIB). Additionally, avoidance extinction theoretically involves a key respondent

component that may only be addressed through exposure (Chambless et al., 1998). That said, avoidance extinction procedures often involve aversively conditioned stimuli and likely produce some degree of stress. Such procedures should be carefully and thoughtfully applied to eschew potential behavioral side-effects.

To partially guard against such effects in the present study (in addition to response-driven treatment), an assent procedure consisting of termination criteria (see Appendix B) was employed for each of the participants. None of the three participants in the current study met termination criteria during any condition in Experiment 1, including all phases involving exposure and response blocking. One participant met assent criteria for Experiment 2 due to self-injurious behavior related to wearing the heart-rate monitor and was withdrawn from that part of the study.

Potential global effects related to participation were also assessed using standard behavioral data collected by the group home. Staff at the group home systematically tracked data regarding a number of problem behaviors for all residents (when relevant), including self-injury for each of the three participants (this behavior took a variety of forms, at varying frequencies, for the participants, and tracking of these behaviors had been in place for years). According to that data, rate of self-injury was unaffected by study procedures (base rates did not change significantly before, during, or after study participation). However, it is important to note that collection of SIB data was unrelated to the present research and interobserver agreement is unknown.

Though no obvious iatrogenic effects resulted from exposure and response blocking procedures, two of the three participants (Kyle and Jacob) exhibited behavior that suggested anxiety during treatment, while for Shawn, heart rate data indicated a significant change associated with stress during the exposure phase. It is important to consider these potentially negative effects associated with avoidance associated stimuli not only in the provision of treatment, but in the day to day experience of persons engaged in avoidance behavior at baseline levels. In the following section, stress reactivity as it related to exposure for each participant will be explored.

Throughout his participation in the study, Kyle occasionally engaged in short bouts of perseverative speech concerning shirt sleeves (e.g., “Lay on the sleeves,” “Shirt sleeves”). Though this repetitive speech did not appear to interfere with either treatment procedures or daily activities, it did indicate that Kyle may have been “stuck on” the topic of shirts even when not directly interacting with them. Staff reported that such repetitive speech is not uncommon for Kyle and would occur in reference to a variety of topics.

For Jacob, a number of safeguards were established to protect his well being due to any distress caused by participation. Despite these safeguards, there were some indications that study procedures produced anxiety for him. Starting with FA sessions, Jacob would occasionally appear to purposefully look away from the alarm area. This behavior occurred more often during the start of intervention where verbal and physical attempts to move staff were ignored. During one trial where this behavior occurred, Jacob was working on a table task near the alarm area. While the therapist

stood near to the alarm, Jacob continued to participate in the task but turned his head in such a way, presumably, so as to move the alarm out of his line of sight. This behavior was observed during a number of sessions but did not appear to interfere with either the procedure or other adaptive activities. To some degree, it appeared that Jacob adapted his avoidant behavior in regard to the alarm, though it is difficult to provide exact detail on how frequent or how effective Jacob's visual avoidance was. As with Jacob's checking behavior, this visual avoidance provides a number of challenges related to objective definition and measurement. Nonetheless, it is important to consider these more subtle topographies of avoidant behavior.

Limitations.

A number of limitations are relevant to the present study. First, because it was not possible to decisively identify avoidance behavior, it is possible that some, or even all, of the target behaviors in the present study were not actually based on avoidance. Assessment using the RBS-R classified the target behaviors as compulsive or ritual (rather than stereotypy, for instance), but confirmation of an avoidance basis in humans relies largely on verbal report, an approach not feasible for the participants in this study. Functional analysis suggested that the target behaviors were automatically reinforced, which is in-line with avoidance. However, an automatic function is likewise indicative of behaviors serving some sensory function unrelated to avoidance (Kennedy, Meyer, Knowles, & Shukia 2000). Though avoidance extinction procedures appeared effective for each of the three participants, such post-hoc arguments for an avoidance basis are not particularly useful for applied purposes related to assessment

or for causal claims specifically related to avoidance theory. While avoidance extinction may be relevant as treatment of higher-order repetitive behaviors, the question remains whether the target behaviors addressed in this study represent the same class or construct of behavior.

Another limitation involves the systematic tracking of other higher-order repetitive behaviors and collateral behaviors during treatment. Each of the participants, Shawn and Jacob in particular, performed other higher-order repetitive behaviors not targeted by intervention in this study (generally due to relative frequency). The current results cannot speak to the effect of avoidance extinction for a targeted repetitive behavior on the occurrence of another, related behavior. Such data would provide information regarding the global behavioral effects of intervention. As seen with other studies, response blocking may produce elevations in other problem behaviors. Although this study took into account staff collected data on SIB before, during, and after intervention, this collateral behavior data collection was not developed or verified as part of the current investigation. Future studies should consider employing systematic tracking of possible behavioral side effects.

Extinction is typically paired with differential reinforcement and not often used alone, though these treatment strategies are usually not specific to avoidance behavior. The thrust of the current study was to test the stand alone effects of avoidance extinction procedures on higher-order repetitive behavior, but clinical use of such procedures may benefit from the inclusion of differential reinforcement, competing activities, or communication training akin to procedures used elsewhere

(Kuhn, Hardesty, & Sweeny, 2009). Extinction of responding in the case of avoidance procedures through flooding and habituation to controlling stimuli is qualitatively different from extinction of appetitive and escape behaviors. With those behaviors, potential for contact with reinforcement remains. With avoidance extinction, learning involves a new association between stimuli and the nonoccurrence of an aversive event.

Future directions

Future studies might employ an assessment of response blocking procedures similar to those used by Lerman and Iwata (1996), where intermittent blocking was compared to continuous blocking. As posited by Lerman and Iwata, such a procedure may serve to differentiate between punishment versus extinction of automatically maintained behavior. In the case of avoidance, we might expect intermittent blocking to produce decreases in target responding. Unlike sensory maintained behavior, however, decreases in responding during intermittent blocking of avoidance responding would likely not be due not be due to punishment. More likely, we might attribute effects to exposure to the nonaversive contingency. Once again, however, the problem of identifying avoidance behavior and differentiating it from sensory behavior remains.

In the field of autism, further understanding of avoidance behavior in regard to environmental events may allow for the development of effective intervention for certain varieties of maladaptive higher-order repetitive behaviors. These data suggest that avoidance based intervention is effective in reducing target behaviors, and further

exploration of such treatment is warranted. More broadly, the role of avoidance in behavioral inflexibility might be considered by educational strategies and early intervention for persons with ASDs in that exposure to and contact with a range of non-aversive contingencies and events early on may inoculate against the development of inflexible behavior (Sidman, 1989). Exposure-based strategies could ultimately be employed to teach tolerance to variability, ameliorating the anxiety-inducing quality of those stimuli which are tied to complex repetitive behaviors, such as insistence on sameness and compulsivity. It is through the use of such methods that inflexible avoidance responding may be reduced, allowing for the acquisition of a broader, more adaptive repertoire of behavior.

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Appendix A: Tables

Table 1

Descriptive statistics for baseline and exposure heart rate data

Statistic	Baseline HRV	Response Prevention HRV
n	1142	513
Mean	.604	.570
Median	.601	.575
SD	.443	.301
RMSSD	12.2	17.4
HRV triangular index	8.733	8.959
Skewness	.958	-.125
Kurtosis	1.373	-.812
Minimum	.513	.510
Maximum	.762	.641
Mean HR	99.96	106.68
SD HR	7.03	7.16

Note: All statistics given are for R-R metric save for those denoted “HR”.

Table 2

Dependent samples t-test for baseline and exposure heart rate data

Variable	Baseline	Exposure	df	t-score	p-value
R-R			512	12.96	.000
n	513	513			
M(SD)	.600(.045)	.571 (.03)			

Appendix B: Figures

Figure 1. Functional analysis data for Shawn. Vertical axis represents percent of eight opportunities in which Shawn closed the kitchen door. Opportunities were presented every 15 seconds.

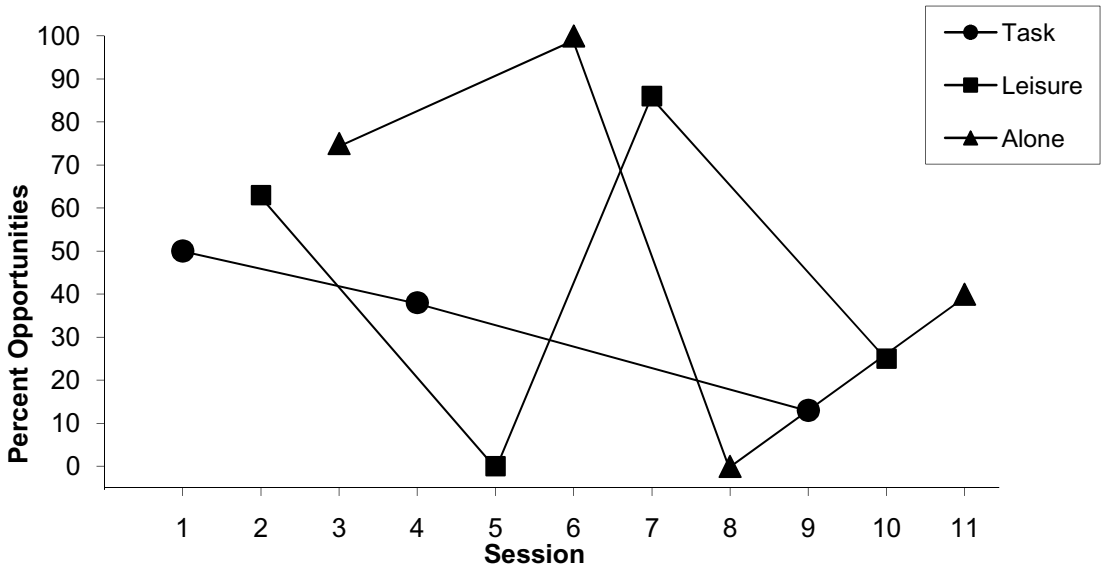


Figure 2. Functional analysis data for Kyle. Vertical axis represents percent of 10s partial intervals wherein Kyle's head made contact with the arm of the therapist wearing a dress shirt.

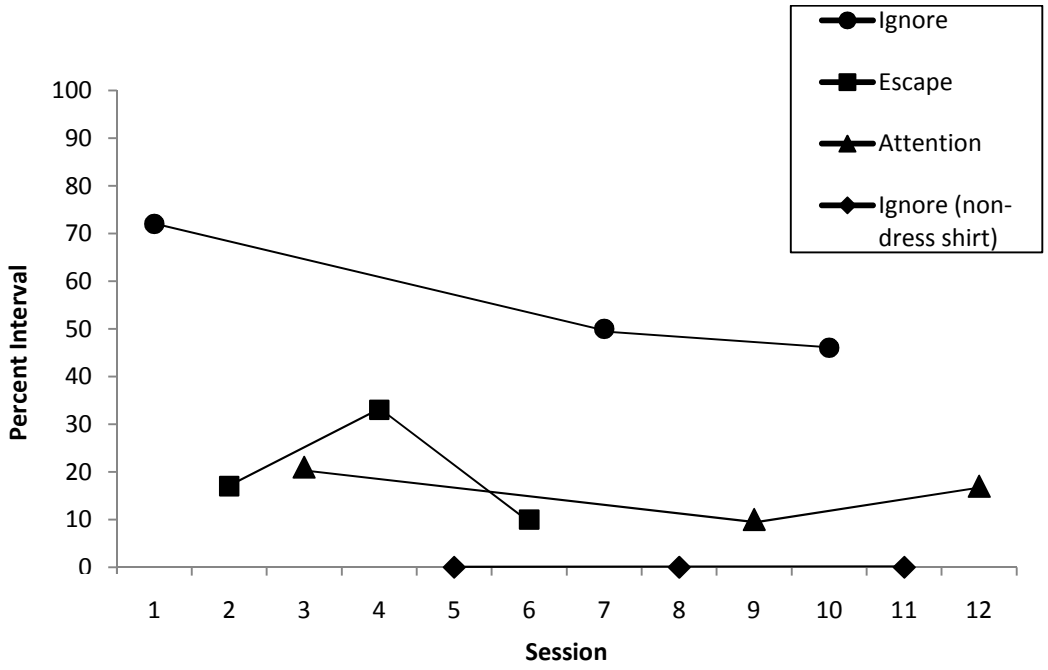


Figure 3. Functional analysis data for Jacob. Vertical axis represents percent of opportunities where Jacob yelled at the person near the alarm to move during each four minute session.

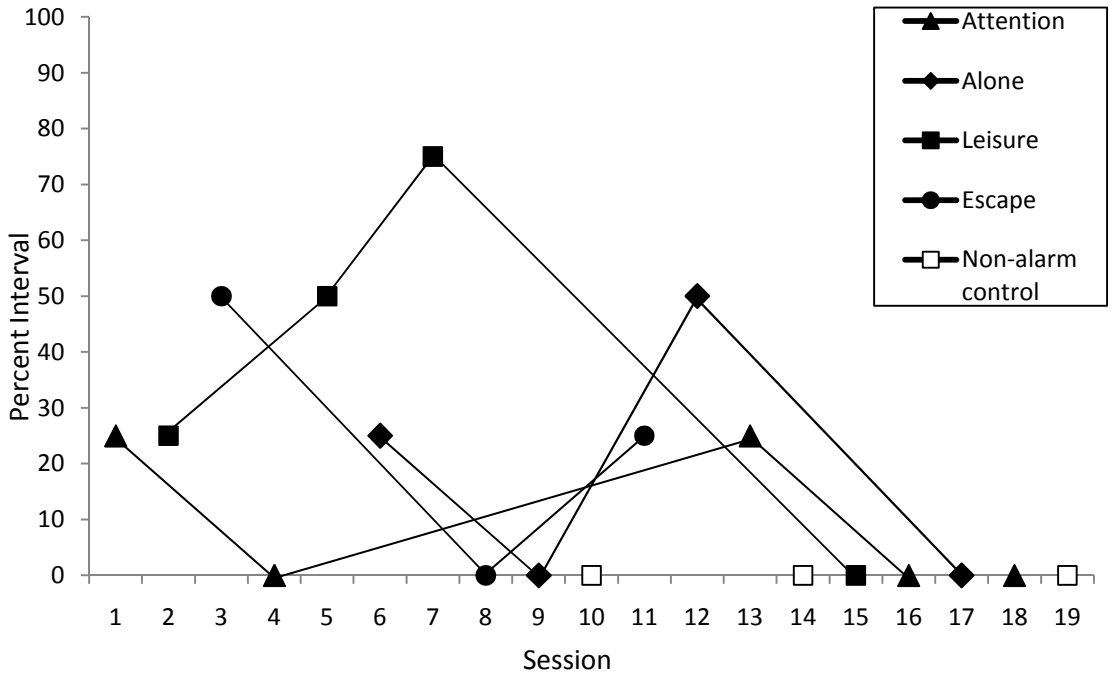


Figure 4. Baseline and treatment phases for Shawn. Vertical axis represents rate per hour of door closing/door closing attempts. Horizontal axis represents consecutive days.

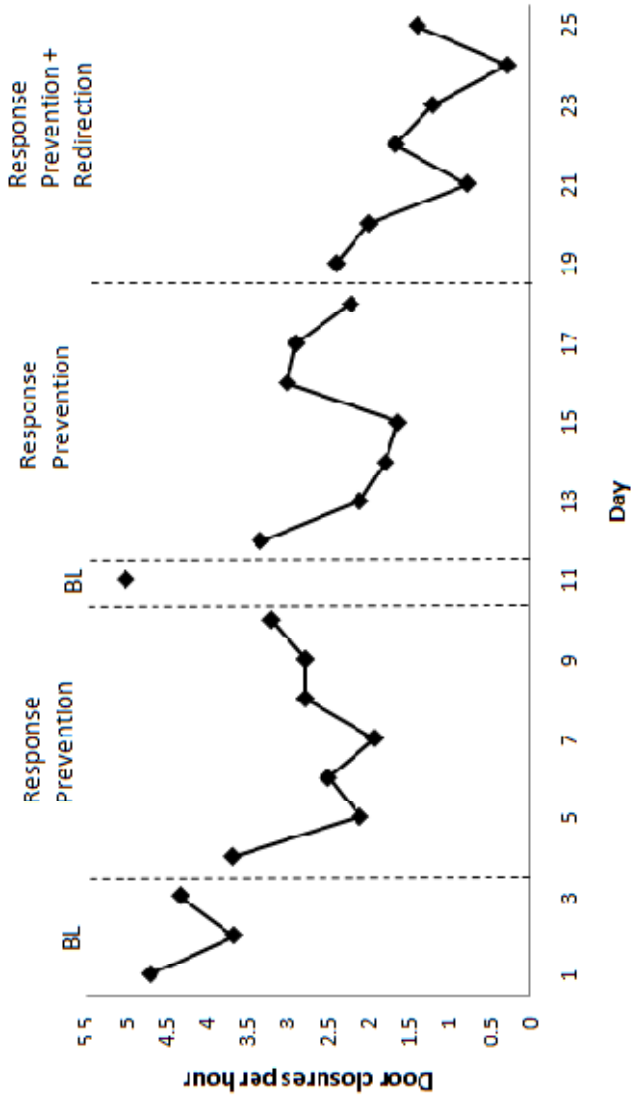


Figure 5. Baseline and treatment for Kyle. Vertical axis 1 represents percent of 10s intervals of contact between Kyle's head and the dress shirt for each 3 minute session. Vertical axis 2 represents the frequency of attempts to perform the behavior for each session.

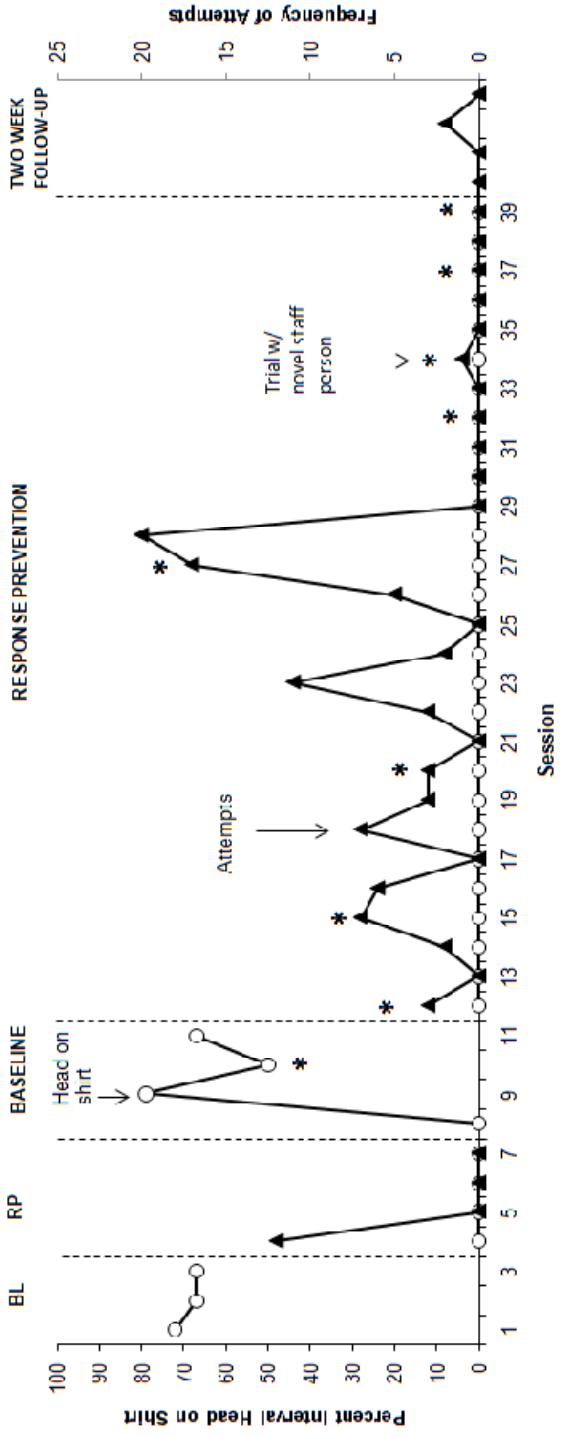


Figure 6. Generalization sessions for Kyle. Vertical axis represents percent of 10s interval wherein either an attempt or completed head-on-shirt behavior occurred.

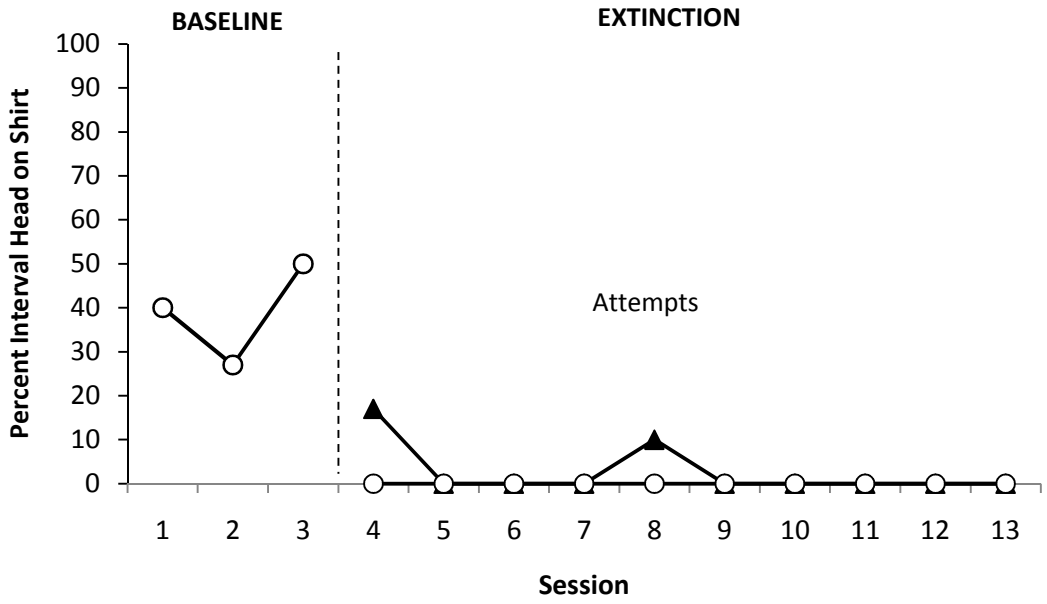


Figure 7. Baseline and treatment for Jacob. Vertical axis represents frequency of vocalizations made to staff person by Jacob regarding moving away from the alarm per exposure session.

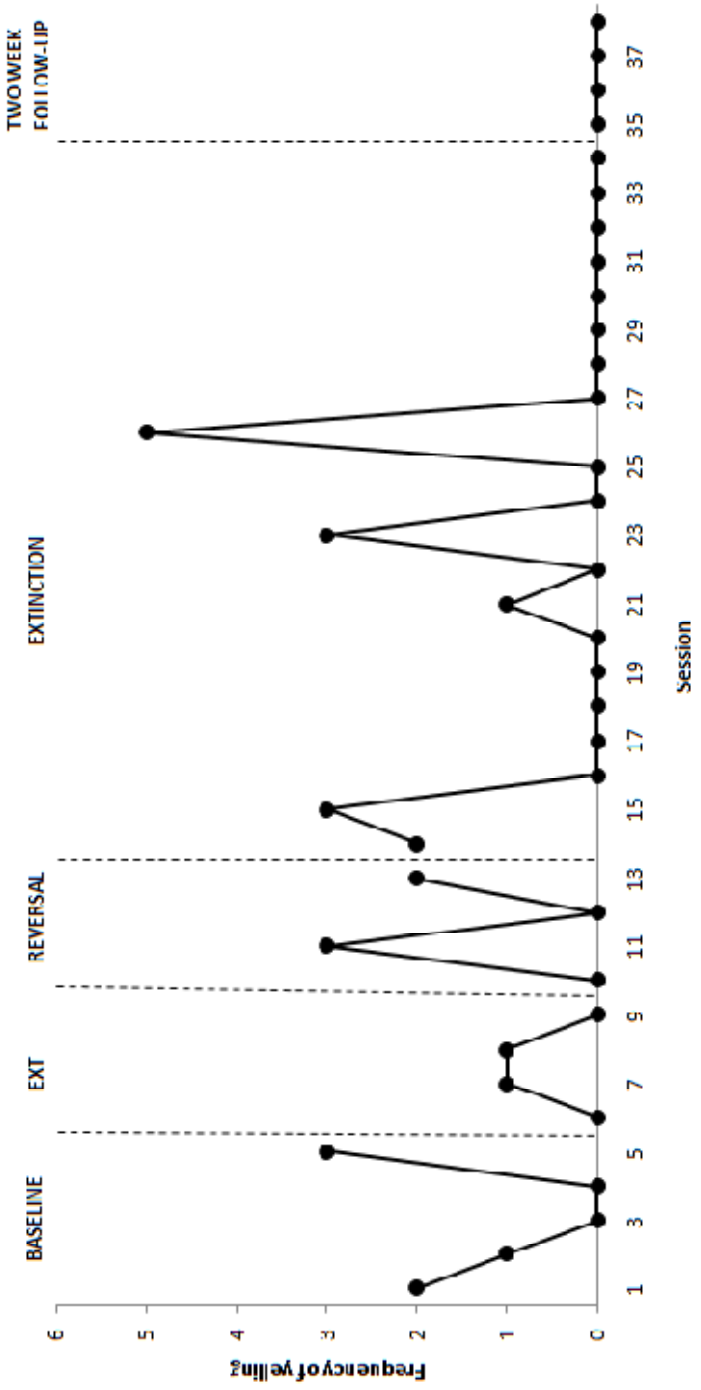


Figure 8. Distribution of R-R values for baseline heart rate epoch.

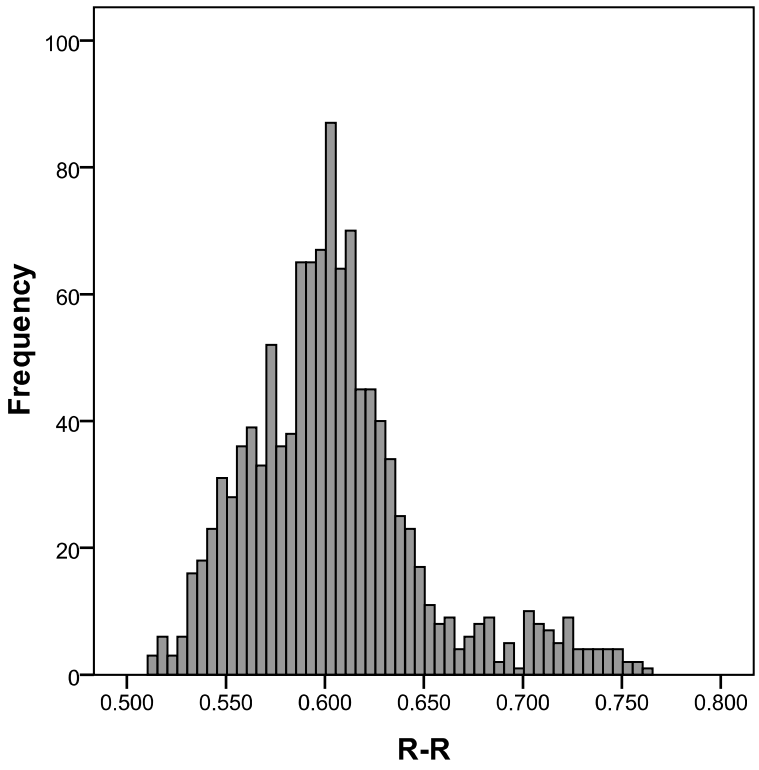


Figure 9. Distribution of R-R values for exposure heart rate epoch.

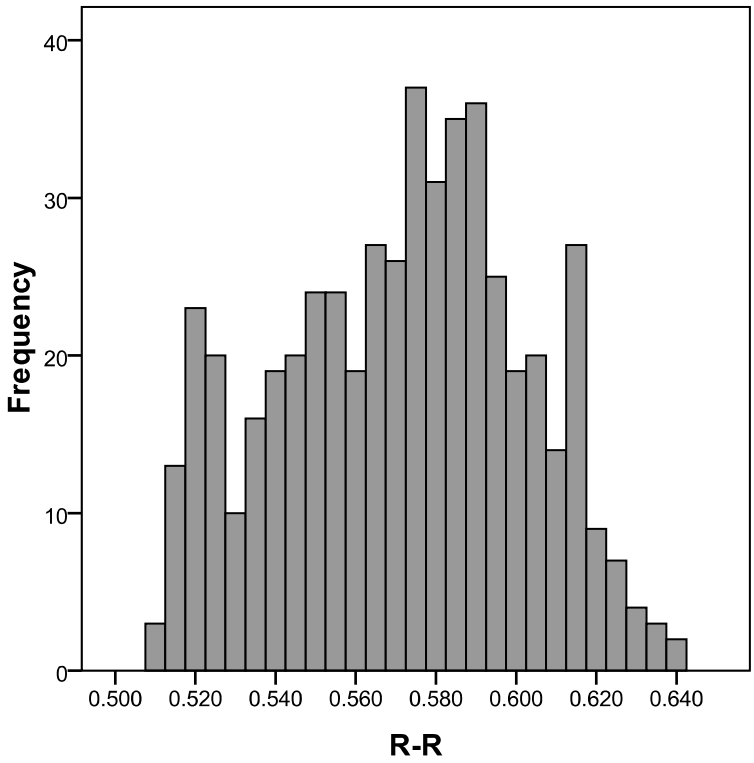
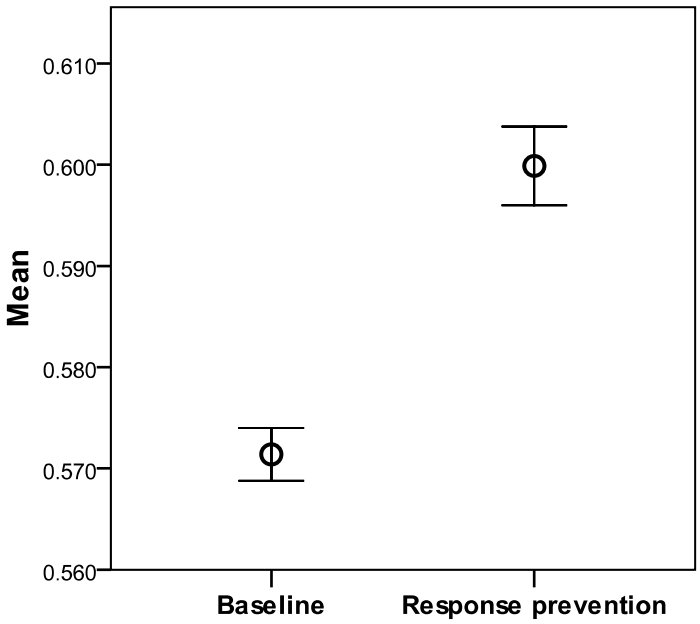


Figure 10. Mean heart rate variability with 95% confidence intervals for baseline and response prevention phases for Shawn.



Appendix C: Parent/Guardian Consent Form

CONSENT FORM

Identification and Treatment of Avoidance Based Repetitive Behavior in Autism

(Name) is invited to participate in a research study of ritual and compulsive behaviors in autism. (Name) was selected as a possible participant because he resides in a group home for adults with autism. We ask that you read this form and ask any questions you may have before agreeing to consent for (Name) to participate in the study.

This study will be conducted by Jason Wolff, a doctoral candidate under Drs. Frank Symons and Susan Hupp in the Department of Educational Psychology at the University of Minnesota.

Background Information

The purpose of this study is two-fold. First, we will test the effectiveness of a behavioral treatment for ritual/compulsive behavior in persons with autism. Second, we will test how heart rate changes before, during, and after a ritual/compulsive behavior takes place.

Procedures:

If you consent to this study, (Name) would participate in the following: There would first be a brief assessment of repetitive behaviors (a paper and pencil measure completed by group home staff). If selected for the study based on the presence of frequent compulsive behaviors, (Name) would begin the behavioral intervention. This intervention first involves identifying why the behavior takes place by recording the behavior. This would be followed by exposure to objects and/or situations that cause the compulsive behavior to occur. This is intended to eliminate the connection between the compulsive behavior and the elements of the environment that cause it. The behavioral intervention will be tailored to the needs of each individual who participates.

(Name)'s participation would also involve wearing a heart rate monitor to assess whether stress plays a role in these behaviors. This would be done for only a portion of the study. We would measure heart rate using the same type of monitor a runner might wear: it is a non-invasive chest strap that sends a signal to a separate recorder. The total time (Name) would be involved in the study would be about 8 hours over a period of about 2 weeks.

Risks and Benefits of being in the Study

Risks involved in this study include: (Name) may experience some stress during intervention when performing repetitive behaviors. However, this stress would be no more than (Name) normally experiences (we are analyzing everyday situations) and the risks involved are minimal. We would be working only with behaviors (Name) frequently engages in. Behavior interventions such as the one used in this study are tailored to the individual. Thus, we make adjustments as we go based on (Name)'s needs to ensure that we successfully decrease compulsive behavior. If (Name) becomes agitated or indicates that he does not wish to continue with intervention, all research procedures will cease.

The benefits of participation are: If selected for the study, it is believed that the intervention may help decrease (Name)'s compulsive behavior and reduce anxiety.

Confidentiality:

The records of this study will be kept private. In any publications or presentations, we will not include any information that will make it possible to identify (Name) as a subject. More importantly, all records will be "de-identified", meaning that (Name)'s name, location, and other identifying information will not appear in any of our records.

Voluntary Nature of the Study:

This research is completely voluntary and the decision to participate will not affect you or (Name)'s relationship with Alternatives for People with Autism or the University of Minnesota. If (Name) participates in the study, you may withdraw consent at any time without affecting any of those relationships**.**

Contact and Questions:

You are encouraged to contact the principal investigator, Jason Wolff, at any time with questions regarding this study at (952) 486-1740 or wolf0354@umn.edu.

You may also contact the dissertation advisor, Dr. Frank Symons, with questions you may have at (612) 626-8697 or symon007@umn.edu.

If you have any questions or concerns regarding the study and would like to talk to someone other than the researcher(s), **you are encouraged** to contact the Research Subjects' Advocate Line, D-528 Mayo, 420 Delaware St. S.E., Minneapolis, MN, 55455; telephone (612) 625-1650.

You will be given a copy of this form to keep for your records.

Statement of Consent

I have read the above information. I have asked questions and have received answers. I give my

consent for _____ to participate in the above research study.

Signature of parent/guardian: _____

Date: _____

Appendix D: Assent Procedure

Assent procedure

For participants, consent will be given by their parent or guardian. All potential subjects are diagnosed with both autism and moderate to profound mental retardation. However, each individual has the right to refuse to participate in this research project. Because none of the potential participants are able to understand issues of assent/consent, we will determine assent case-by-case based on the participants' behavior. Research procedures will stop if, at anytime, the participant:

1) Physically removes themselves from the area where research is taking place after 1 attempt at redirection.
2) If able, verbalizes or signs "no" or "stop" during procedures.
3) Engages non-targeted vocalizations that signal discomfort or distress (a single vocalization of short duration, <5 seconds, may be ignored).
4) Engages in physical behavior indicating a desire to cease procedures (e.g., pushing away the investigator, pushing away materials related to the research). One attempt at reengagement may be made.
5) Engages in self-injurious or aggressive behavior after one attempt at redirection.
6) Removes/refuses heart monitor after 2 attempts to place it about their chest (proper use of the heart monitor should first be demonstrated to the participant).

If any of the above occur, research procedures will stop. At the PIs discretion, a second attempt may be made to engage the participant in research procedures *on a different day*. If the participant again exhibits any of the above behaviors indicating lack of assent, their participation in the research project will cease.

Appendix E: RBS-R

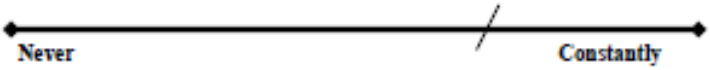
REPETITIVE BEHAVIOR SCALE – Revised (RBS-R)

Instructions:

Please rate this person's behavior by reading each of the items listed and then choosing the score that best describes how much of a problem the item is for the person. Be sure to read and score all items listed. Make your ratings based on your observations and interactions with the person over the last month. Use the definitions in the box given below to score each item.

0 = behavior does not occur
1 = behavior occurs and is a mild problem
2 = behavior occurs and is a moderate problem
3 = behavior occurs and is a severe problem

At the end of each section, there will be three questions asking you to rate that section's behaviors in terms of (a) how frequently they occur, (b) how upset the person becomes when repetitive behaviors are interrupted, and (c) how much the behaviors interfere with ongoing events. You will indicate the score by marking along each line, which represents a range of frequencies and severities. For example, if this person does those behaviors many times a day you may put the mark quite close to the right side:



I. Stereotyped Behavior Subscale

(DEFINITION: apparently purposeless movements or actions that are repeated in a similar manner)

1	WHOLE BODY (Body rocking, Body swaying)	0	1	2	3
2	HEAD (Rolls head, Nods head, Turns head)	0	1	2	3
3	HAND/FINGER (Flaps hands, Wiggles or flicks fingers, Claps hands, Waves or shakes hand or arm)	0	1	2	3
4	LOCOMOTION (Turns in circles, Whirls, Jumps, Bounces)	0	1	2	3
5	OBJECT USAGE (Spins or twirls objects, Twiddles or slaps or throws objects, Lets objects fall out of hands)	0	1	2	3
6	SENSORY (Covers eyes, Looks closely or gazes at hands or objects, Covers ears, Smells or sniffs items, Rubs surfaces)	0	1	2	3

Please answer the following questions about the behaviors described above (put a vertical mark (|) on the line to show your answer):

How **often** do they happen?
(If Never, skip to Section II) **Never** — **Constantly**

How **upset** does this person get when interrupted?
Not at all — **Extremely**

How much do these behaviors **get in the way of ongoing events?**
Not at all — **Severe interference**

0 = behavior does not occur 1 = behavior occurs and is a mild problem 2 = behavior occurs and is a moderate problem 3 = behavior occurs and is a severe problem

II. Self-Injurious Behavior Subscale

(DEFINITION: movement or actions that have the potential to cause redness, bruising, or other injury to the body, and that are repeated in a similar manner)

7	HITS SELF WITH BODY PART (Hits or slaps head, face, or other body area)	0	1	2	3
8	HITS SELF AGAINST SURFACE OR OBJECT (Hits or bangs head or other body part on table, floor or other surface)	0	1	2	3
9	HITS SELF WITH OBJECT (Hits or bangs head or other body area with objects)	0	1	2	3
10	BITES SELF (Bites hand, wrist, arm, lips or tongue)	0	1	2	3
11	PULLS (Pulls hair or skin)	0	1	2	3
12	RUBS OR SCRATCHES SELF (Rubs or scratches marks on arms, leg, face or torso)	0	1	2	3
13	INSERTS FINGER OR OBJECT (Eye-poking, Ear-poking)	0	1	2	3
14	SKIN PICKING (Picks at skin on face, hands, arms, legs or torso)	0	1	2	3

Please answer the following questions about the behaviors described above (put a vertical mark (/) on the line to show your answer):

How **often** do they happen?
(If Never, skip to Section II)

Never ——————————— **Constantly**

How **upset** does this person get when interrupted?

Not at all ——————————— **Extremely**

How much do these behaviors **get in the way of ongoing events?**

Not at all ——————————— **Severe interference**

0 = behavior does not occur 1 = behavior occurs and is a mild problem 2 = behavior occurs and is a moderate problem 3 = behavior occurs and is a severe problem

III. Compulsive Behavior Subscale

(DEFINITION: behavior that is repeated and is performed according to a rule, or involves things being done "just so")

15	ARRANGING / ORDERING (Arranges certain objects in a particular pattern or place; Need for things to be even or symmetrical)	0	1	2	3
16	COMPLETENESS (Must have doors opened or closed; Takes all items out of a container or area)	0	1	2	3
17	WASHING / CLEANING (Excessively cleans certain body parts; Picks at lint or loose threads)	0	1	2	3
18	CHECKING (Repeatedly checks doors, windows, drawers, appliances, clocks, locks, etc.)	0	1	2	3
19	COUNTING (Counts items or objects; Counts to a certain number or in a certain way)	0	1	2	3
20	HOARDING/SAVING (Collects, hoards or hides specific items)	0	1	2	3
21	REPEATING (Need to repeat routine events; In / out door, up / down from chair, clothing on/off)	0	1	2	3
22	TOUCH / TAP (Need to touch, tap, or rub items, surfaces, or people)	0	1	2	3

Please answer the following questions about the behaviors described above (put a vertical mark (/) on the line to show your answer):

How **often** do they happen?
(If Never, skip to Section II)

Never ——— **Constantly**

How **upset** does this person get when interrupted?

Not at all ——— **Extremely**

How much do these behaviors **get in the way of ongoing events?**

Not at all ——— **Severe interference**

0 = behavior does not occur 1 = behavior occurs and is a mild problem 2 = behavior occurs and is a moderate problem 3 = behavior occurs and is a severe problem

IV. Ritualistic Behavior Subscale

(DEFINITION: performing activities of daily living in a similar manner)

23	EATING / MEALTIME (Strongly prefers/insists on eating/drinking only certain things; Eats or drinks items in a set order; Insists that meal related items are arranged in a certain way)	0	1	2	3
24	SLEEPING / BEDTIME (Insists on certain pre-bedtime routines; Arranges items in room "just so" prior to bedtime; Insists that certain items be present with him/her during sleep; Insists that another person be present prior to or during sleep)	0	1	2	3
25	SELF-CARE – BATHROOM AND DRESSING (Insists on specific order of activities or tasks related to using the bathroom, to washing, showering, bathing or dressing; Arranges items in a certain way in the bathroom or insists that bathroom items not be moved; Insists on wearing certain clothing items)	0	1	2	3
26	TRAVEL / TRANSPORTATION (Insists on taking certain routes/paths; Must sit in specific location in vehicles; Insists that certain items be present during travel, e.g., toy or material; Insists on seeing or touching certain things or places during travel such as a sign or store)	0	1	2	3
27	PLAY / LEISURE (Insists on certain play activities; Follows a rigid routine during play / leisure; Insists that certain items be present/available during play/leisure; Insists that other persons do certain things during play)	0	1	2	3
28	COMMUNICATION / SOCIAL INTERACTIONS (Repeats same topic(s) during social interactions; Repetitive questioning; Insists on certain topics of conversation; Insists that others say certain things or respond in certain ways during interactions)	0	1	2	3

Please answer the following questions about the behaviors described above (put a vertical mark (/) on the line to show your answer):

How **often** do they happen?
(If Never, skip to Section II) **Never** — **Constantly**

How **upset** does this person get when interrupted?
Not at all — **Extremely**

How much do these behaviors **get in the way of ongoing events?**
Not at all — **Severe interference**

0 = behavior does not occur
1 = behavior occurs and is a mild problem
2 = behavior occurs and is a moderate problem
3 = behavior occurs and is a severe problem

V. Sameness Behavior Subscale

(DEFINITION: (resistance to change, insisting that things stay the same)

29	Insists that things remain in the same place(s) (e.g. toys, supplies, furniture, pictures, etc.)	0	1	2	3
30	Objects to visiting new places	0	1	2	3
31	Becomes upset if interrupted in what he/she is doing	0	1	2	3
32	Insists on walking in a particular pattern (e.g., straight line)	0	1	2	3
33	Insists on sitting at the same place	0	1	2	3
34	Dislikes changes in appearance or behavior of the people around him/her	0	1	2	3
35	Insists on using a particular door	0	1	2	3
36	Likes the same CD, tape, record or piece of music played continually; Likes same movie / video or part of movie / video	0	1	2	3
37	Resists changing activities; Difficulty with transitions	0	1	2	3
38	Insists on same routine, household, school or work schedule everyday	0	1	2	3
39	Insists that specific things take place at specific times	0	1	2	3

Please answer the following questions about the behaviors described above (put a vertical mark (/) on the line to show your answer):

How **often** do they happen?
(If Never, skip to Section II) **Never** — **Constantly**

How **upset** does this person get when interrupted?
Not at all — **Extremely**

How much do these behaviors **get in the way of ongoing events?**
Not at all — **Severe interference**

0 = behavior does not occur
1 = behavior occurs and is a mild problem
2 = behavior occurs and is a moderate problem
3 = behavior occurs and is a severe problem

VI. Restricted Behavior Subscale

(DEFINITION: Limited range of focus, interest or activity)

40	Fascination, preoccupation with one subject or activity (e.g., trains, computers, weather, dinosaurs)	0	1	2	3
41	Strongly attached to one specific object	0	1	2	3
42	Preoccupation with part(s) of object rather than the whole object (e.g., buttons on clothes, wheels on toy cars)	0	1	2	3
43	Fascination, preoccupation with movement / things that move (e.g., fans, clocks)	0	1	2	3

Please answer the following questions about the behaviors described above (put a vertical mark (/) on the line to show your answer):

How **often** do they happen?
(If Never, skip to Section II)
Never — **Constantly**

How **upset** does this person get when interrupted?
Not at all — **Extremely**

How much do these behaviors **get in the way** of ongoing events?
Not at all — **Severe interference**

FINAL QUESTION: Overall, if you "lump together" all of the behaviors described in this questionnaire, how much of a problem are these repetitive behaviors (both for the person with autism, as well as how they affect the people around them)? Please rate on a scale from 1 to 100, where 1 = not a problem at all, and 100 = as bad as you can imagine:

Score from 1-100: _____