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Stereotypy in Autism: The Importance of Function

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Abstract

We argue for the utility of a functional definition of stereotypy based on evidence of both sensory automatic and socially mediated reinforcement contingencies in the occurrence of stereotypy in children with autism. A predetermined sensory function of stereotypy is often invoked in the behavioral literature and the term "self-stimulatory behavior" is commonly misused as interchangeable with "stereotypy." We discuss evidence for a variety of potential functional properties of stereotypy. Diagnostic definitions are reviewed and support for both sensory and social functions is outlined. We argue that stereotypies should be described and categorized according to their function, rather than form. Furthermore, treatment decisions should be based on a functional interpretation of stereotypy, which acknowledges its operant and heterogeneous quality in autism.

Introduction

Restricted, repetitive, and stereotyped patterns of behavior are one of three core diagnostic features of autistic disorder (American Psychiatric Association, 2000) and are a frequent target of behavioral interventions for children with autism. Although the underlying causes of stereotypy are unknown, most scientists in the field believe it comprises a class of operant behaviors maintained by reinforcement contingencies (Koegel & Covert, 1972; Lovaas, Newsom, & Hickman, 1987; Rapp & Vollmer, 2005; Rogers & Ozonoff, 2005). A substantial body of research provides evidence for a sensory function of stereotypy, whereby behavior is maintained by automatic reinforcement (Lovaas, et al., 1987; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Rapp, 2006; Rincover, 1978; Rincover, Cook, Peoples, & Packard, 1979). This literature contends that social consequences are not operative, and this has encouraged a cascade of behavioral interventions presuming a predetermined sensory or self-stimulatory function of stereotypy. However, the term stereotypy is not synonymous with self-stimulatory behavior. A growing body of literature suggests that stereotypy is multiply determined and often enters into contingencies of social positive and negative reinforcement (Ahearn, Clark, Gardener, Chung, & Dube, 2003; Durand & Carr, 1987; Kennedy, Meyer, Knowles, & Shukla, 2000; Repp, Felce, & Barton, 1988). Consistent with the general literature regarding the need for treatment individualization in autism (National Research Council, 2001; Schreibman, 2000, 2005; Sherer & Schreibman, 2005; Yoder & Compton, 2004), it is important to design behavioral interventions that target stereotypy according to the functional response class to which behaviors belong rather than the topographical form alone and the assumption of automatic reinforcement as the maintaining contingency.

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This paper begins with a review of the diagnostic definition of stereotypy and its relevance to learning for children with autism. This is followed by an argument for the clinical utility of a functional definition of stereotypy, as well as a discussion of evidence supporting both the role of sensory automatic and socially mediated reinforcement contingencies in the occurrence of stereotypy in children with autism. This paper then outlines several behavioral interventions that address this challenging behavior and argues for a functional approach to designing individualized interventions for reducing stereotypy in autism.

Stereotypy as a Diagnostic Feature

According to the Diagnostic and Statistical Manual of Mental Disorders, one essential diagnostic feature of autistic disorder is the presence of restricted, repetitive, and stereotyped patterns of behaviors, activities, and interests (American Psychiatric Association, 2000). Stereotypy and stereotypic behavior are umbrella terms that refer to this broad class of topographically similar behaviors. A behavior is defined as stereotypy when it fits the requisite form, which involves repetition, rigidity, and invariance, as well as a tendency to be inappropriate in nature (Turner, 1999). Insight into the function (e.g., sensory, social, tangible) of the behavior is neither diagnostic nor invoked. In other words, membership into the group of behaviors is based on meeting criteria for the physical and observable form alone.

Stereotypic behaviors are highly heterogeneous in presentation. Behaviors may be verbal or nonverbal, fine or gross motor-oriented, as well as simple or complex. Additionally, they may occur with or without objects. Some forms involve stereotyped and repetitive motor mannerisms or use of language. Common examples of stereotypy are hand flapping, body rocking, toe walking, spinning objects, sniffing, immediate and delayed echolalia, and running objects across one's peripheral vision (Schreibman, Heyser, & Stahmer, 1999). Other forms involve more complex behaviors, such as restricted and stereotyped patterns of interest or the demand for sameness. These forms may involve a persistent fixation on parts of objects or an inflexible adherence to specific, nonfunctional routines or rituals. For example, a child engaging in stereotypic behavior may attend only to specific parts of objects (e.g., car wheels, doll eyes). Alternatively, a child may insist on playing with his or her toys in a very specific fashion (e.g., lining blocks up in identical rows repetitively).

Stereotypic behaviors are not isolated to autism. They are common to individuals with other sensory, intellectual, or developmental disabilities. For example, research indicates that a large majority of individuals with mental retardation exhibit stereotypies. However, in comparison to individuals with mental retardation, those with autism tend to display more varied topographies, along with increased severity and overall occurrence (Bodfish, Symons, Parker, & Lewis, 2000). Stereotypies also occur in typical individuals from infancy through adulthood. Some examples of stereotypic behavior in typical adults include tapping feet, nail biting, smoking, organizing, playing sports, and watching TV. Alternatively, stereotypies in typical infants and toddlers often resemble behaviors seen in individuals with autism across the lifespan (Smith & Van Houten, 1996). Stereotypies in autism are distinguished by their lack of developmental and social appropriateness. In one study, stereotypic behaviors in children with developmental delays (DD) were compared to stereotypies in two control groups of children, matched on chronological age (CA) and mental age (MA) respectively. Although no systematic differences were found between groups in percentage of occurrence or variety of displayed behaviors, the stereotypic behaviors observed in children with DD were rated as more bizarre overall compared to their CA matches. Children with DD exhibited higher levels of obvious gross motor mannerisms, as well as behaviors with higher visual intensity and focus. Behaviors exhibited by children with DD were perceived as similar in comparison to those displayed by children matched on MA (Smith & Van Houten, 1996). This study underscores

the importance of interpreting behaviors that appear repetitive, restricted, or stereotypic within the context of developmental and social norms.

Stereotypy and Learning

Stereotypy occupies a large proportion of the behavioral repertoires of children with autism (Rapp & Vollmer, 2005). As such, many researchers and clinicians consider it an important aberrant behavior to target in behavioral intervention. First, stereotypy is socially stigmatizing. Stereotypies exhibited by children with autism are often perceived as age-inappropriate in form, focus, context, duration, or intensity. The stigma attached to children who frequently engage in such behavior has obvious undesirable consequences from a parent's point of view. It may be difficult and uncomfortable for parents to bring their child to public places. However, there are also direct undesirable consequences for the child's development. The child's involvement in the community, peer and adult interactions, or typical education settings may become severely restricted.

In addition to decreasing the availability of learning opportunities in the community, stereotypy has also been shown to directly interfere with learning. Koegel and Covert (1972) found that children exhibiting high levels of stereotypy failed to learn simple discrimination tasks while engaging in stereotypy. However, suppression of stereotypic behavior, accomplished through punishment procedures, was associated with increased correct responding and acquisition of the discrimination. Follow-up studies showed a similar inverse relationship between stereotypy and spontaneous play behavior (Koegel, Firestone, Kramme, & Dunlap, 1974). Other research indicates that children with autism may demonstrate longer response latencies to sensory stimuli when engaged in stereotypic behaviors (Lovaas, Litrownik, & Mann, 1971). This collective body of research indicates that stereotypy may interfere not only with initial learning acquisition, but also with the extent to which children engage in the learned and more appropriate alternative behaviors during free time.

Recent research on predictors of differential treatment responsivity replicates some of these findings, but also introduces a greater specificity to the learning interference phenomenon. Sherer and Schreibman (2005) identified a behavioral profile for a naturalistic behavioral intervention, Pivotal Response Training (PRT) that prospectively discriminated between children who would respond or fail to respond positively to PRT. Lower frequencies of non-verbal stereotypy and higher levels of verbal stereotypy predicted positive responsiveness to treatment. Thus, although patterns of non-verbal stereotypies appeared consistent with the interference theory, these data suggest that verbal stereotypy may instead have a facilitative effect on learning. This effect has also been demonstrated in echolalic children with autism (Charlop, 1983) and across treatment (Epstein, Taubman, & Lovaas, 1985).

It is unclear why this dichotomy occurs, whereby verbal stereotypy may not compete with learning. One hypothesis is that vocal stereotypy may be a prerequisite skill for language. This theory is supported by literature on typical infants who babble prior to talking (Stoel-Gammon, 1992; Vihman, Ferguson, & Elbert, 1987). Alternatively, the lack of verbal stereotypy may be confounded with the inability to produce speech. The lack of verbal output may be a predictor for developmental readiness to speak or apraxia. Further research is needed to examine how non-verbal stereotypies interfere with learning, whereas verbal stereotypies may not.

Literature on stimulus overselectivity in autism provides some insight into why learning interferences may occur in non-verbal behavior (Lovaas, et al., 1971; Lovaas, Koegel, & Schreibman, 1979; Lovaas, Schreibman, Koegel, & Rehm, 1971). Although the everyday environment is full of multiple and simultaneous cues that are discriminative for responding or not responding, children with autism show a marked deficit in the ability to attend to simultaneous multiple cues. Furthermore, children with autism are often unable to discriminate

the relevant environmental cues from the nonessential ones. When multiple stimulus cues are present in the learning environment, these children's behaviors tend to come under the control of a narrow set of stimuli. Unable to attend at once to several environmental cues, it would be difficult for a child attending to his own stereotypy to simultaneously attend to the salient learning stimuli (Lovaas, et al., 1971).

Stereotypy as an Operant Behavior

An interpretation of stereotypy in terms of response form alone, such as the diagnostic definition described earlier, has minimal clinical utility for behavior modification. Alternatively, operant conceptualizations that consider stereotypic behaviors to be functional and lawful have resulted in many successful intervention models. As is the case with all operant behavior, form does not imply function. In fact, in many cases, it seems the response form is largely irrelevant to treatment.

Although stereotypies comprise a group of behaviors that have a similar response topography, a large body of literature indicates that these behaviors do not belong to a predetermined response class. Instead, they vary widely not only in form, but in environmental determination—across individuals, context, setting, and time. The most prominently cited maintaining reinforcement contingency is self-stimulation or automatic reinforcement (Lovaas, et al., 1987; Rapp & Vollmer, 2005; Rincover, 1978; Rogers & Ozonoff, 2005). However, another growing body of literature specifies that stereotypic behavior may be determined by other reinforcement contingencies (Kennedy, et al., 2000; Repp, et al., 1988). For example, stereotypy has been shown to operate under the control of social reinforcement (Durand & Carr, 1987) and tangible reinforcement contingencies (Ahearn et al., 2003). Interpretations of stereotypic behaviors should not presume that sharing a specific topography necessarily involves also belonging to the same response class.

The functional properties of stereotypy are often derived from functional analysis methodologies (Rapp & Vollmer, 2005), which aim to identify variables that influence the occurrence of specific behaviors through the systematic manipulation of possible controlling environmental antecedents and consequences (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). The most commonly environmental contingencies manipulated in functional analyses of stereotypies include social positive reinforcement (e.g., praise, attention), social negative reinforcement (e.g., escape or avoidance), non-social positive reinforcement (e.g., self-stimulation, automatic reinforcement, or a tangible), non-social negative reinforcement (e.g., removal of or escape from an aversive physical stimulus), or some combination of social and non-social reinforcement. This body of literature indicates the heterogeneity of the reinforcement contingencies under which stereotypic behaviors may be controlled and a similarly broad range of interventions available to address stereotypy (Kennedy, et al., 2000; Repp, et al., 1988).

Stereotypy as Self-Stimulatory Behavior

Traditionally, the literature has explained stereotypic behaviors in terms of a sensory origin and function (Lovaas, et al., 1987; Rogers & Ozonoff, 2005). Although theories about the underlying sensory origin of stereotypy have not been empirically validated, the role of sensory self-stimulation in the maintenance of stereotypic behaviors is strongly supported. This subcategory of stereotypy, commonly referred to as self-stimulatory behavior (SSB), is defined as an operant behavior, which is maintained automatically by the reinforcing sensory stimuli that it produces (Lovaas, et al., 1987). Automatic reinforcement infers that the reinforcer and the behavior are one and the same. Self-stimulatory behavior, arguably a primary reinforcer, is resistant to social consequences. Thus, it is particularly challenging to manipulate the environment, such that reinforcement is no longer available contingent upon engaging in the

aberrant behavior. Because of these characteristics, self-stimulatory behavior is difficult to change.

Several areas of research provide evidence for a subcategory of stereotypy that is maintained by sensory feedback. Although the particular sensory function being stimulated may not always be visually apparent to an observer, stereotypies often provide an obvious source of sensory input (e.g., visual, auditory, tactile vestibular, taste, or smell). Additionally, single-subject research has shown that interventions that either remove the sensory component of stereotypy (e.g., sensory extinction), or provide alternative but age-appropriate forms of sensory input (e.g., functional matching procedures), lead to a reduction in stereotypic behaviors for many children (Piazza, et al., 2000; Rapp, 2006; Rapp, 2007; Rincover, 1978; Rincover, et al., 1979). Lastly, several studies have demonstrated that allowing children with autism to engage in stereotypic behaviors contingent upon other target behaviors is reinforcing and without negative side effects (Charlop, Kurtz, & Casey, 1990; Hanley, Iwata, Thompson, & Lindberg, 2000; Kennedy, et al., 2000; Wolery, Kirk, & Gast, 1985). This argues for the automatically reinforcing quality of SSB, because the behavior itself—which presumably also functions as reinforcement—operates on the target behavior in the absence of any additional consequences. Indeed, these data empirically support the hypothesis that stereotyped behaviors are maintained by the sensory function.

Several behavioral interventions have been developed out of this conceptualization of stereotypy. Sensory extinction began as a creative experimental procedure designed to determine whether stereotypy was an operant behavior maintained by automatic sensory reinforcement. However, it also has been used as an effective intervention for reducing behaviors maintained by sensory stimulation. Sensory extinction involves systematically masking hypothesized sensory consequences for a stereotypic behavior, in order to determine if it is maintained by a particular sensory consequence (Rincover, 1978; Rincover, et al., 1979). In the first study using sensory extinction, Rincover and Cook (1978) identified hypothesized sensory reinforcers for the stereotypic behaviors of three children with developmental delays. A single-subject ABAB reversal design was used, whereby baseline sessions were alternated with sensory extinction sessions. Under baseline, participants had free access to the preferred form of stereotypy. During sensory extinction phases, an additional stimulus was introduced that removed a particular sensory consequence of the stereotypy. For example, one child's stereotypy involved spinning plates on hard surfaces while leaning his head towards the plate. Based on the hypothesis that his behavior was maintained by auditory feedback, the hard surface was covered in carpet to remove the sound produced by spinning. Across all participants, the target behaviors decreased significantly or were completely extinguished during sensory extinction phases and returned during baseline phases. These results indicated that the stereotypy of all participants was maintained by sensory reinforcement. Follow-up studies have highlighted the utility of sensory extinction as a treatment strategy and served as a foundation for an additional treatment approach, functional matching (Rincover, et al., 1979).

Upon extinguishing the sensory stimulation component of the preferred self-stimulatory behavior, Rincover et al. (1979) identified novel toy play objects that could serve as alternative and more appropriate methods of receiving the same stimulation. The identified sensory reinforcers effectively served as potent reinforcers for post-treatment appropriate toy play. This research gave way to another effective treatment method, whereby alternative sources of matched reinforcement are provided, often in conjunction with sensory extinction of stereotypy.

Researchers suggest that noncontingent access to stimuli matched in sensory function to the preferred sensory reinforcer may reduce the establishing operation (EO) for stereotypy and its

frequency of occurrence (Piazza, et al., 2000; Rapp, 2006). For example, a child who engages in repetitive spinning of objects for the visual sensory feedback might be provided with noncontingent access to spin tops. Alternatively, a child who engages in verbal stereotypy for the auditory sensory function, might be provided with noncontingent access to a musical toy. This method shares many similarities with functional communication training (Carr & Durand, 1985). Blocking the sensory reinforcement of stereotypy may lead to a state of deprivation, or establishing operation (EO), for the particular reinforcement. The body of research on matched stimulation indicates that noncontingent availability of matched stimuli competes with the automatically reinforced behavior as long as the required response efforts are comparable (Britton, Carr, Landaburu, & Romick, 2002; Rapp, 2006; Rapp, 2007).

To specify the essential feature of noncontingent reinforcement with matched stimuli, some studies have examined whether the matched function or simple stimulus preference controls the effect. Some data suggest that providing access to toys matched with stereotypy on their sensory consequences is more effective than providing access to arbitrarily selected stimuli or preferred toys inconsistent with sensory function (Piazza, et al., 2000). However, other research indicates that relative preference of an object, regardless of matched reinforcement, may decrease stereotypy equally well (Ahearn, Clark, DeBar, & Florentino, 2005). Further research is needed to determine the essential features involved in providing noncontingent access to alternative preferred and/or matched stimuli.

More traditional behavioral techniques for reducing problem behavior have also been applied to self-stimulatory behavior, but with less success. Time-out procedures and differential reinforcement of other behavior, although commonly utilized, have not been shown to be highly effective (Harris & Wolchik, 1979). Alternatively, overcorrection was validated early on as an effective intervention for self-stimulatory behaviors (Foxx & Azrin, 1973; Harris & Wolchik, 1979). Overcorrection involves both physically preventing the target behavior from occurring and also prompting the individual to engage in some alternative and more appropriate form of the same behavior. Foxx and Azrin (1973) implemented overcorrection procedures with four children with mental or developmental disabilities who engaged in high levels of self-stimulatory behaviors. It should be noted that three of the four children were not autistic. A single subject reversal design indicated that overcorrection rapidly reduced the frequency of self-stimulatory behaviors to almost no occurrence, whereas returns to baseline resulted in a return to original frequency. Although behavior change was not maintained without continued overcorrection procedures, a verbal reprimand and thinned schedule of overcorrection application was adequate to maintain low frequencies of self-stimulatory behavior.

The immediacy of behavior change makes punishment a desirable intervention (Maag, Rutherford, Wolchik, & Parks, 1986). However, overcorrection suffers from the same limitations of other punishment procedures, such as its aversive nature, social undesirability, and poor likelihood of maintenance in the absence of continued intervention. Thus, when such overcorrection procedures are implemented, they should be supplemented with functional replacement interventions, such as matched noncontingent reinforcement. For many children, however, the positive behavior support methods discussed earlier may be more socially desirable, and thus preferred, despite experimental evidence for the effectiveness of punishment procedures.

As has been demonstrated above, there is considerable support for a self-stimulatory function of stereotypy. Moreover, many effective interventions have been developed and empirically validated, such that they can be individualized to specific children and behaviors. However, these discoveries also have their limitations. The predominance of data suggesting that stereotyped behaviors serve a self-stimulatory and sensory function has led many to categorize all stereotypic behaviors as solely sensory in nature. The tendency to use the terminology, “self-

stimulatory behavior,” to describe a specific behavioral topography prior to analyzing its function has become widespread. Indeed, a predetermined and universal sensory function of stereotyped behaviors is often invoked in the literature and in practice. The term ‘self-stimulatory behavior’ has historically been misused, as if it is used interchangeably with ‘stereotypy.’

Stereotypy as a Socially Mediated Behavior

Other research has emerged demonstrating the role of social and external reinforcement contingencies in the maintenance of stereotypic behaviors. Although it is unclear whether stereotypic behaviors were once controlled only by their sensory consequences, research indicates that some children’s stereotypies also enter into social reinforcement contingencies. The social environment may serve to negatively or positively reinforce stereotyped behaviors by removing aversive stimuli or providing desirable stimuli contingent upon stereotypy.

Durand and Carr published a seminal paper in 1987 describing the social functions of self-stimulatory behavior. In fact, the title of the paper placed quotation marks around the term, “self-stimulatory,” to emphasize the unwarranted assumption of universal sensory function in stereotypy. In this study, a single subject design was utilized to analyze the influence of various environmental contingencies on stereotypic behaviors in four children with pervasive developmental disorders. Three experimental conditions, baseline, decreased attention, and increased task difficulty, were compared. During the baseline phase, children were required to complete match-to-sample and receptive labeling tasks. Reinforcement was provided on a variable ratio schedule and stereotypic behaviors were ignored. During the decreased attention condition, participants were presented with the maintenance level match-to-sample stimuli. The adult provided decreased attention. During the increased task demand phase, the receptive labeling task was presented again. However, the stimuli were selected to produce increased task difficulty. Stereotypic behaviors increased during the increased task demand condition compared to the baseline or decreased attention conditions. Follow-up studies compared rates of stereotypy during an increased task demand conditions with and without contingent time out upon engaging in stereotypic behavior. Stereotypic behaviors increased during the time out condition, indicating that these children’s behaviors were maintained by escape from task demands. Next, functional communication training, whereby children were trained to say, “Help me,” during difficult tasks, resulted in a decrease in stereotypic behaviors. In short, Durand and Carr (1987) found that stereotyped behaviors increased as a function of difficult task demands and contingent removal of aversive stimuli. Stereotyped behaviors decreased as a function of light demand and upon acquisition of an alternative and more appropriate method of communicating frustration. Negative reinforcement was the maintaining contingency.

Additional research has also validated that other socially mediated contingencies can exert substantial effects on rates of stereotypy. One study examining the effects of demand, attention, and automatic reinforcement on hand mouthing found that some children’s hand mouthing behaviors increased in frequency contingent upon social positive reinforcement (e.g., when an adult says, “Don’t do that!”) (Goh, Iwata, Shore, DeLeon, Lerman, Ulrich, et al., 1995). Another study found that children engaged in higher rates of repetitive behaviors while in the presence of an unfamiliar person as compared to a familiar person (Runco, Charlop, & Schreibman, 1986). Additionally, other research has provided evidence for the effect of tangible reinforcement on the frequency and duration of stereotypic behaviors (Ahearn, et al., 2003). These data collectively suggest that external stimuli, rather than only intrinsic automatic reinforcers, may also operate on stereotypy.

This literature should not be interpreted as an opposing argument to the sensory function of stereotypy. Instead, this review is intended to argue for an operant definition of stereotypy,

whereby function is not fixed, but rather controlled by alterable environmental contingencies. Evidence exists for both sensory and social reinforcement properties. Two studies, in particular, provide strong evidence for the argument that stereotypy may be multiply determined. Repp and colleagues (1988) demonstrated that treatment designs based on a derived (from functional analysis) function of individual behaviors were more effective than those based upon a predetermined hypothesis of the behavior's function. A more recent study found that similar forms of stereotypy occurred across various reinforcement contingency conditions for the same child, and that they often occurred at higher rates during attention and demand conditions (Kennedy, et al., 2000). In short, these data suggest that functional analyses of stereotypies should be conducted prior to presuming a likely function, and more importantly, upon deciding on an intervention. Indeed, as Durand and Carr (1987, p.130) suggest, "In considering how to label such motor behavior in developmentally disabled persons, a more useful approach might be to adopt functional labels...This terminology might eliminate some confusion, and may contribute to the design of more effective treatments."

Conclusions

It is undeniable that stereotypic behavior is a pervasive and problematic feature of autism. Furthermore, a substantial body of literature supports the need to modify these behaviors. Fortunately, a variety of effective interventions have been developed to address these problem behaviors. Although traditionally considered to operate under sensory and automatic reinforcement contingencies, research has clarified that repetitive and stereotyped behaviors may also be maintained by social or non-social positive and negative reinforcement. It is important that interventions be applied in line with this evidence. Indeed, it seems most appropriate to describe and categorize stereotypies in terms of their function, rather than their form. In so doing, applied research and clinical applications will not only involve more accurate use of terminology, but also be more likely to influence positive behavior change through effective environmental manipulations. As is the case with many applications of behavioral principles to children with autism, there is no one single effective approach to addressing stereotypy for all children or all stereotypic behaviors. However, a large research base exists to offer practitioners a variety of evidence-based behavioral interventions for stereotypy based on operant function. Although all behavior is lawful, the functional relations are not predetermined. Behavioral treatment and future research should proceed with a functional interpretation of stereotypy in autism that acknowledges its multiple, heterogeneous, and most importantly, modifiable determination.

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