Journal of Early Intervention

http://jei.sagepub.com

Early Development of Stereotyped and Self-Injurious Behaviors

Gershon Berkson and Megan Tupa

Journal of Early Intervention 2000; 23; 1
DOI: 10.1177/10538151000230010401

The online version of this article can be found at:
http://jei.sagepub.com/cgi/content/abstract/23/1/1

Published by:
SAGE Publications
http://www.sagepublications.com

On behalf of:
Division for Early Childhood of the Council for Exceptional Children

Journal of Early Intervention, 2000
Vol. 23, No. 1, 1–19

FEATURE ARTICLE

Early Development of Stereotyped and Self-Injurious Behaviors

GERSHON BERKSON & MEGAN TUPA
University of Illinois at Chicago

Literature on early development of typical and abnormal stereotyped and self-injurious behaviors was reviewed. Such behaviors are part of normal development, but abnormalities can be detected from birth to Age 3. Many of these behaviors reach a maximum level around Age 2 and then decline. The behaviors may be retained in some children, however, and around the time the child reaches school age, the behaviors may increase. Increase and decline of typical behaviors are delayed in children with developmental delays. The relationship between early and later behaviors has not been studied. Although many abnormal behaviors may emerge from typical behaviors in infancy, some behaviors definitely do not. Possibly, the 2nd year is a sensitive period for emergence of abnormal stereotyped and self-injurious behaviors and treatments might be most effective then. Tests of efficacy of treatments to prevent these behaviors are rare.

The study of abnormal stereotyped and self-injurious behaviors has historically focused on adults with severe mental retardation, primarily because the prevalence of such behaviors is high in this population. Stereotyped behaviors (e.g., body-rocking) are generally socially stigmatizing and may interfere with learning (e.g., Koegel & Koegel, 1989), and self-injurious behaviors (e.g., head-banging) may reach such intensity they become life-threatening. Currently, most of the research on stereotyped and self-injurious behaviors has been devoted to reducing or eliminating them in older children or adults. Although some of these attempts have been effective, others have been incomplete and even unsuccessful. The alternative to eliminating stereotyped and self-injurious behaviors is to prevent them before they become permanent and abnormal. Such an approach, however, seldom has been tried. The main concept underlying this literature review focuses on the idea that an early intervention approach is plausible, but real advances await further research on the details of early development of these abnormal behaviors.

The purpose of this paper is to provide a critical literature review of studies conducted during the past 50 years on the early development of stereotyped and self-injurious behaviors. Interest in such a review stems from the practical considerations mentioned earlier and the intrinsic interest that stereotyped and self-injurious behaviors continue to evoke. How do these behaviors emerge? Why do they emerge? Are typical and abnormal stereotyped behaviors ''the same''? Why do they become such an important part of the behavior of many typical people (Rafaeli-Mor, Foster, & Berkson, 1999) and of people with developmental disabilities?

Recent general reviews of the literature on stereotyped and self-injurious behaviors (Guess & Carr, 1991; King, 1993; Mason, 1991; Sprague and Newell, 1996; Symons & Thompson, 1997; Thompson & Gray, 1994;

Wehmeyer, 1994) have contained brief sections on the development and characteristics of these behavior classes in several populations (see especially MacLean, Stone, & Brown, 1994; Thelen, 1996). This is the first attempt, however, to provide a focused review of the literature on children during the early developmental period (i.e. birth to Age 3). Although it is unlikely that we have been successful in including all of the literature, our aim was to provide a complete picture of the current situation by including all articles done with children in the birth to 3-year period plus other useful and relevant articles.

If we knew more about the abnormal development of stereotyped and self-injurious behaviors in children with disabilities, would it be possible to prevent abnormal stereotypy and self-injury from becoming a permanent part of the child's behavioral repertoire? Unfortunately, a definitive answer to this important question is not possible. We know very little about the origin of stereotyped and self-injurious behaviors, the precursors that lead to abnormal development of these behaviors, the mechanisms that cause them to persist, or the effectiveness of existing prevention programs. Furthermore, these behaviors have been observed in a variety of contexts (Troster, Brambring, & Beelmann, 1991b) and appear to vary for different individuals (Baumeister, MacLean, Kelly, & Kasari, 1980). Thus, the answer to the general question of whether it is possible to provide effective early intervention for stereotyped and self-injurious behaviors is likely to be complex.

This review is organized into several sections. Section 1 presents some basic concepts. Section 2 discusses methodological issues pertaining to stereotyped behavior. In Section 3, the paper explores the development of stereotyped and self-injurious behaviors in isolation-reared subhuman primates and in typically developing children. Section 4 describes the emergence of abnormal stereotyped behaviors in children with disabilities. In Sections 5–7, we consider the early development of three prototypical behavior classes: body-rocking; head-banging and head-hitting; and eye-poking and eye-pressing. In an attempt for completeness, we also present a brief section (Section 8) listing various other behaviors that have been studied. Environmental correlates will then be examined, including reviews of the few related treatment studies (Section 9). Finally, Section 10 will provide some overall conclusions and will attempt to look forward to future needs in the field.

Basic Concepts

It has been 50 years since R.S. Lourie published his seminal paper on the development of rhythmic behaviors in very young children (Lourie, 1949). There had been earlier papers on movement restraint (Levy, 1944) and others from the psychoanalytic tradition (see Brody, 1960), however, Lourie's paper incorporated the early work, and thus heralded two themes that have become the main conceptual basis for much subsequent work. Lourie believed rhythmic behaviors, such as body-rocking and head-banging, were first of all ''an attempt to experience movement for the kinesthetic sensations that play an important role in the infant's development'' (p. 654). Secondly, he posed that ''in the over-all picture of their use, the most widespread function of the rhythmic motor patterns in children is to express and relieve tension . . .'' (p. 654). These two quotations underlie the self-stimulation and motor expression foci that have been the basis for much of the research that followed his paper (Lewis & Baumeister, 1982; Lovaas, Newsom, & Hickman, 1987).

In addition to self-stimulation and motor expression concepts that have been invoked to explain stereotyped and self-injurious behaviors, there is a distinction between three classes of variables that determine them. First are those factors in the organism that determine the emergence of a behavior. An example would be the presence or absence of a visual impairment as a determinant of eye stimulation. Second are factors that influence whether the behavior continues after it first appears and perhaps whether it continues into adulthood. For instance, if body-rocking is almost universal in babies in the latter part of the 1st year, what determines that it disappears in some children, but seems to persist into adult-

hood in others? Third, what factors influence the moment-to-moment fluctuations in the level of stereotyped or self-injurious behaviors? For example, head-banging tends to increase when children are ill. These three levels of analyses are generally confused in the literature on stereotyped and self-injurious behaviors, but it is almost sure that variables working to initiate, maintain, and vary the expression of these behaviors may not all be the same (Berkson, 1983).

Another important concept, especially in the birth to 3-year period, involves determining whether or not a particular behavior pattern is normal or abnormal. Many stereotyped behaviors (body-rocking) are clearly part of normal development in almost all children. Some view these behaviors as necessary for normal motor and cognitive development, but how do we know if and when they become abnormal? Wehmeyer (1994) found that it was possible to distinguish normal from abnormal behaviors by asking teachers four questions about whether a behavior interfered with adaptation. Schwartz, Gallagher, and Berkson (1986) showed differences in the duration of body-rocking bouts between typical babies and older children with severe retardation who were matched on developmental age. Because it is necessary to make a distinction between normal and abnormal stereotyped behaviors when deciding whether or not to provide treatment, a focus on the form of the behaviors as well as the context in which they occur may prove useful.

Although a discussion of the definition of self-injurious behaviors is not complex, ambiguities do exist. If a behavior results in tissue-damage, it is obviously self-injurious. Before such damage is evident, however, one might see proto-injurious behaviors, such as head-banging that occurs during a tantrum. Ordinarily, tantrum behaviors do not produce tissue damage; but in some cases, head-banging may become so intense it produces visible injury. Therefore, to achieve a clear developmental picture, one must consider not only the consequence of the behavior, but also its precursors, its form, and its function.

Summary. Several general conceptual approaches underlie the modern study of stereotyped behaviors. Perhaps the most basic approach views the behaviors as self-stimulatory, or expressions of a rudimentary motor mechanism. Three types of causes, those that contribute to the emergence of the behavior, those that maintain the behavior, and those that evoke moment-to-moment expression, determine the development of these behaviors. The causes, however, are likely to differ depending on the individual and the surrounding environment. Finally, it is important to differentiate normally occurring from abnormal stereotyped behaviors. From a practical point of view, such a distinction is critical for decisions about intervention.

Methodology

Pictures that have emerged about the early development of stereotyped and self-injurious behaviors depend heavily on research methodology. Studies covered in this review overwhelmingly employ parental report as the primary method. This method, however, contains well known threats to validity. Nevertheless, parent surveys have produced large samples, and the statistics derived from surveys have resulted in a clear, general picture of the development of stereotyped behaviors that has been replicated across studies. Thus, parent report will continue to be useful.

Fewer studies have employed formal observation methods. Thelen (1979) pioneered the observational approach in her studies of typical infants by using a refined classification system that permitted her to describe many specific behaviors that occur in an infant's 1st year of development. Thelen further classified the situations, thus permitting her to make statements about the situational correlates of many of the behaviors that were studied (Thelen, 1980).

It is unfortunate, however, that for some of her analyses, Thelen grouped specific behaviors into larger categories referring to general body parts. Although this allowed her to make some comprehensive statements about apparently related behaviors, it established a precedent that other observational researchers followed (e.g., MacLean, Ellis, Galbreath,

Halpern, & Baumeister, 1991; Wehmeyer, 1991). While the general patterns of results were not lost in those studies, specific statements about certain behaviors were thereby made unavailable. Thus, we believe further understanding is dependent upon a focus on specific stereotyped behaviors.

Another method, use of video tapes and other records for kinematic analyses, has become invaluable in movement analysis (Newell, 1996). Unfortunately, this method has hardly ever been used in studies of babies (see below for exceptions). In the future, video records may ultimately be necessary for solving some of the issues that will be raised in this review.

Aside from observational methods, there are also issues that pertain to general research design. Many studies report the prevalence of various stereotyped or self-injurious behaviors as a correlate of some measure of age. Most of these studies employ a cross-sectional design using different children to represent different ages, some however, have employed a longitudinal method (Lawrence & MacLean, 1994; MacLean et al, 1991; Troster, Hecker, & Brambring, 1994). If later behavior is related to earlier variables, longitudinal studies will probably prove most informative, but longitudinal studies must be approached with caution because they are costly and pose differential attrition problems. Furthermore, the low prevalence of stereotyped and self-injurious behaviors may increase the difficulty of studying children who have significant disabilities in the birth to 3-year period.

One alternative method of investigation, retrospective study, uses moving pictures or video records that have been collected by families. This approach has been used with some success (Adrien, et al, 1993; Baranek, 1999, Losche, 1990; Osterling & Dawson, 1994), however, the method also presents difficulties because few parents consistently collect video records of their children. Even if videos have been collected, sampling limitations may exist because many video records are of special occasions such as birthdays. Furthermore, it is possible that some parents concentrate only on behaviors they regard as normal.

Summary. Parent reports have been, and probably will continue to be the main data source in research on the development of stereotyped and self-injurious behaviors. Other more refined techniques such as video recording and kinematic analysis, however, will become increasingly important and prospective research designs will become critical as the field moves from simple description to analyses of developmental determinants. A further understanding of these determinants is necessary for early prevention and intervention to become a reality.

Typical Infants

The focus of this article is to review literature on behaviors that may ultimately become socially stigmatizing and self-injurious in children and adults with disabilities. Although the origins of these behaviors are not clear, some of them are thought to arise from patterns commonly observed in infancy (e.g., Kravitz & Boehm, 1971; Thelen, 1979; Werry, Carlielle, & Fitzpatrick, 1983; Wolff, 1968). Several studies have shown that stereotyped and self-injurious behaviors that are common in infancy tend to increase and then decrease as locomotion proceeds (Evans, et al 1997; Thelen, 1979; Wehmeyer, 1991; Werry et al, 1983). Thus, these repetitive behaviors often are observed during a child's the 1st and 2nd year of life, and a general dependable curvilinear relationship exists between age and certain behaviors. Presumably, these repetitive movements and potentially self-injurious behaviors may be age-appropriate and serve some function.

Although stereotyped and self-injurious behaviors decline in the latter part of the birth to 3-year range in typical children, they do not always disappear. Sallustro and Atwell (1978) reported that body-rocking occurred in 19%, and head-banging in 5%, of their sample of typical children who were between 3 and 6 years. Other studies have indicated lower prevalence rates, less than 5% (Foster, 1998; Werry et al, 1983) for motor stereotypies. However, in both school children and college students the prevalence of body-rocking is more similar to the level reported by Sallustro

and Atwell (Berkson, Rafaeli-Mor, & Tarnovsky, 1999; Rafaeli-Mor et al., 1999; Tan, Salgado, & Fahn, 1997; Troster, 1994).

The general basis of the association between the behaviors manifested in later life and what seem to be their counterparts in early development, is a superficial similarity in the form of the behaviors. For instance, seated body-rocking of typical infants looks similar, though not exactly the same, as body-rocking of adults. The form and function of rocking behaviors may be dependent upon individual characteristics and the context in which they occur. Seated body-rocking has been observed at about 12 months of age in normal infants (Thelen, 1979), and seated body-rocking persists most often in older individuals (e.g. Berkson, 1967; Rafaeli-Mor et al., 1999). The earliest body-rocking in infants usually accompanies the development of locomotion, but body-rocking occurs in adults whose locomotion is quite mature. Head hitting, which often occurs as part of a tantrum in normal young children is ordinarily non-injurious. On the other hand, this behavior is worrisome in adults with mental retardation because it can be seriously self-injurious as well as socially inappropriate. Thelen (1981), among others, has described stereotyped behaviors as transitional between stages of motor development. The actual relationship between behaviors in infancy and those apparently similar behaviors in adults is probably more complex and awaits detailed comparative studies of form and context across age levels.

Beyond the correlation with age, there seem to be several definable factors that contribute to the amount that certain behaviors are expressed. The first of these determinants is called arousal level, activity level, or behavioral state. Several authors (Berkson, 1967; Guess & Carr, 1991) have indicated that once a stereotyped behavior has developed, the amount and way it is expressed depends on the arousal level or behavioral state. These dimensions will be more thoroughly discussed in the section on correlated factors.

A second major factor that determines the expression of stereotyped behaviors is social history. In general, a more depriving social history predicts more stereotyped behaviors. An early study by Provence and Lipton (1962) revealed that children in institutions engage in large amounts of these behaviors. Davenport, Menzel, and Rogers (1966) showed that chimpanzees reared in social isolation engage in 33 different types of stereotyped behaviors. Mason and Berkson (1975) further demonstrated a more specific association between certain aspects of maternal deprivation and body-rocking. That is, rhesus monkeys reared on a substitute mother who moved, did not develop body-rocking, while those on identical surrogate mothers almost all developed body-rocking. More recently, Lewis (Lewis, Gluck, Bodfish, Beauchamp & Mailman, 1996; Martin, Spicer, Lewis, Gluck, & Cork, 1991) associated experiential deprivation in rhesus monkeys with a dopamine receptor deficit that may in fact be the underlying physiological mechanism underlying some stereotyped behaviors. For more information on the dopamine hypothesis see Bodfish, Powell, Golden, and Lewis (1995) and MacLean et al, (1985). Perhaps most important for this review, Thelen (1980) showed that babies who were carried and jiggled frequently, engaged in less stereotyped movement. Therefore, evidence from both animal and human research has established that specific social factors focusing on providing movement stimulation are important in the early development of stereotyped behaviors.

Summary. Stereotyped and self-injurious behaviors are very common during infancy, and they generally decline with age. Similar behaviors, however, also can occur in older, typical children and adults. Social history is one factor that determines later occurrence and possible maintenance of these behaviors.

Children with Disabilities

While various stereotypies have been observed and studied in isolation-reared animals and typically developing humans, abnormal stereotyped and self-injurious behaviors are seen more commonly in persons with disabilities. Children with autism or autistic-like characteristics are more likely to exhibit body-rocking, finger-flicking, and hand-flapping

(e.g., Abelson, 1983). Children with visual impairments are more likely to engage not only in body rocking, but also side-to-side head rolling and eye-poking or eye-pressing (Jan, Freeman, & Scott, 1977). The sparse literature about stereotypy behaviors in children with auditory handicaps gives a mixed picture. One study (Bachara & Phelan, 1980) suggests that stereotyped behavior is elevated in children with hearing impairment, however, this result is flawed because hearing impairment was confounded with residential placement. A more recent study by Murdoch (1996) found that children with hearing impairments did not have an elevated level of stereotyped behavior unless other conditions (i.e., visual impairment, emotional or behavioral difficulties, or autism) also were present. Children with Lesch-Nyhan syndrome engage in self-biting (Nyhan, 1994), and persons with Prader-Willi syndrome often engage in stereotyped skin-picking (Dykens, Hodapp, Walsh, & Nash, 1992). Finally, King (1993) pointed to a similarity between forms of compulsive behavior and self-injury and suggested that, in some individuals, self-injury is a compulsive behavior occurring in the context of brain damage. Therefore, there is reason to believe that an association exists between some specific behaviors and certain taxonomic categories of disability. Further study of the development of these specific behaviors should prove to be especially useful.

Mention also should be made of research that points to neurotransmitters in stereotypy and self-injury. In this context, dopaminergic, serotonergic, and opiate systems have been implicated (Schroeder & Tessel, 1994 for a summary). These systems all interact, so the picture will inevitably be complex, however, there seems to be enough evidence to implicate these systems as mediators.

More generally, however, there is no relation between stereotyped and self-injurious behaviors and classification of the disability (Short & Simeonsson, 1990). Instead, developmental variables and, perhaps especially, environmental variables, seem to be the most promising foci of study in an effort to understand the abnormal development of these behaviors. Although not all groups of children and adults with disabilities engage in stereotyped behaviors, abnormal repetitive movements and self-injurious behaviors are more common in children who are severely delayed in development. Among individuals with mental retardation, stereotyped behaviors are negatively correlated with IQ (Davenport & Berkson, 1962). The curvilinear relationship between age and stereotyped and self-injurious behaviors mentioned previously occurs in almost all children. As one might expect from their delayed motor development, however, the curve extends in time for children with delayed development (Wehmeyer, 1991).

The relationship between the rate (increase and decrease) of stereotyped behaviors and motor development also indicates that the origin of stereotyped behaviors is a reflection of an important developmental process, either typical or delayed. Perhaps the longer these behaviors are part of motor development, the more likely they are to become conditioned to important factors in the environment and for abnormal forms to evolve. This concept may be even more salient for children with disabilities who have fewer normal experiences as a result of sensory, cognitive, or social impairments. Although currently there is little empirical evidence demonstrating that an extended period of development provides the opportunity for a learned abnormal elaboration of movements, the idea is plausible (See Emerson & Howard, 1992 for a possible mechanism).

Summary. Certain groups of children with disabilities are more likely to manifest abnormal stereotyped behaviors. With a few exceptions, there is little relationship between specific etiology or classification and particular behavior. However, a relationship does exist between IQ and stereotypy. Perhaps delayed development, and therefore, longer maintenance of the normal infant stereotypy, may provide increased opportunity to learn about the mechanisms that maintain the behavior into adulthood.

Body-Rocking and Swaying

We turn now to a more detailed consideration of three general forms of behavior which form

the foci of most research on the early development of stereotyped behaviors. Body-rocking and swaying are clearly normal in development and are sometimes retained in the adult behavior repertoire. Head-banging and head-hitting are behaviors that many typical children exhibit during tantrums, sleep, and as part of play with objects. While these behaviors usually do not produce injury and disappear by Age 3, they may be retained under certain circumstances and may become self-injurious. Eye-poking and eye-pressing do not occur as part of typical development. They exist most commonly in children with visual impairments.

Body-rocking occurs in most children during the period in which they are beginning to crawl, achieving normal seated posture, and taking their first steps. When walking is efficient, most children give up body-rocking, although for some, the behavior may continue into adulthood. Whereas body-rocking is ordinarily regarded as a unitary behavior, there appear to be at least three major forms (Thelen, 1979). First, the child rocks or sways while the body is arched in prone position. The second form consists of a repetitive forward and back motion while the child is on hands and knees or, albeit rarely, on hands and feet (Gesell, 1954). We subsequently refer to this behavior as four-point rocking. The third major form of body rocking is forward and back (rocking) or side to side (swaying). This form of rocking is done while either kneeling in the W-position or, more commonly, in a mature sitting posture with legs in front (i.e. seated rocking). Bouncing to music may also be a type of body-rocking, but adequate comparisons with seated body-rocking have not been made.

As indicated in previous sections, four-point body-rocking is common in infancy, but it seems to disappear in all individuals by the preschool period. Seated body-rocking apparently follows a more complex course. In many children, seated body-rocking seems to arise out of four-point body-rocking. That is, some children who engage in four-point body-rocking continue to rock as they rise onto their haunches into the W-posture. Finally, as they bring their legs forward and gain a normal seated posture, they continue to rock forward and back. While very common, this progression from four-point to seated body-rocking is not universal. Seated rocking apparently may begin without being preceded by four-point posture. In other cases, four-point body-rocking is maintained as seated and standing body-rocking develop (personal observations). Furthermore, it is even possible that seated or standing rocking emerges (or reemerges) at school age (Rafaeli-Mor et al., 1999; Troster, 1994). All of this leads us to believe that comparisons are needed between four-point and seated body-rocking in infancy, and body-rocking in infancy and school-age children or adults.

The most interesting questions about body-rocking are concerned with (a) its function and (b) the factors that cause it to persist over an extended period of time. As previously stated, it seems clear that body-rocking is at least in some way associated with locomotion. A general view (Thelen, 1981) is that stereotyped behaviors are indicators of a transition in motor development. Perhaps it is possible to be more explicit. For example, Gesell (1954) regarded four-point body-rocking as important in the development of forward progression. Because these behaviors are so common in infancy, some theorists (e.g., Piaget, 1952) have viewed the repetitions of movements as having an essential role in motor and cognitive development. With body-rocking as an example, it is possible that kinesthetic feedback motivates the child to repeat actions, which in turn, results in strengthening muscle groups.

Although it appears that body-rocking plays a role in the development of locomotion, it is not clear whether the function is necessary or merely helpful. Can locomotion proceed normally without body-rocking? Or must body rocking occur? No one has examined the issue directly, however, the fact that 10% of Thelen's (1979) sample did not engage in four-point body-rocking suggests that locomotor skills can and do proceed without it. Perhaps for the two children in which four-point rocking did not occur, development was not opti-

mal. We conclude that classical statements about the importance of repetitive action on motor and cognitive development may generally be correct, but may not cover all cases. In the future, it may be appropriate to test whether repetitive movement is necessary, helpful, or only indicates development of a specific function. Studies of children with various handicaps, especially motor disabilities could be helpful in isolating the function of specific behaviors.

Other factors, not inconsistent with the view that body-rocking is related to locomotion and its development, also come to the fore in children who continue to engage in body-rocking after they walk. Children may engage in body-rocking as a form of self-stimulation. The behavior also has been observed when children are not doing other things, when they wish to withdraw from interaction with others (Davenport & Berkson, 1963), when they are ill (personal observation) or sleepy, or even asleep (Lindsay, Salkovskis & Stoll, 1982; Sallustro & Atwell, 1978), when they are excited, or when they are listening to rhythmic music (Sallustro & Atwell, 1978; Tierney, McGuire, & Walton, 1978). In all of these cases, self-regulation of arousal or behavioral state appears to be involved as a factor (Berkson, 1967; Guess & Carr, 1991). Less certain, however, is exactly what is being stimulated in these situations. Clearly, even though music activates rocking, auditory self-stimulation is not what maintains the behavior over the long run (Stewart, 1985). It cannot be visual feedback because visually impaired children, who do not see at all, engage in significant amounts of body-rocking (e.g., Jan et al., 1977). Likewise, tactual feedback appears to us to be unlikely, although it has not been studied as a possible source of self-stimulation.

As the child moves from four-point to seated body-rocking, the influence of vestibular feedback and auditory stimulation becomes more apparent. Vestibular stimulation has been studied, and is widely accepted as a source of maintenance of body-rocking (MacLean & Baumeister, 1982). Studies, however, have tended to use small samples and often are otherwise deficient as demonstrations (Lissy, 1997). Perhaps more important, when vestibular input is used postural shifts also occur. Therefore, kinesthetic feedback must be confounded with vestibular stimulation. Kinesthetic and vestibular systems are intimately connected, and it may never be possible to determine definitely whether it is one, the other, or both that maintain body-rocking. It may be feasible to make a distinction between the two parts of the system by focusing external feedback on muscles or directly to the vestibular system. From a practical point of view, such a differentiation might ultimately become important in early intervention programs that wish efficiently to prevent the permanent maintenance of socially stigmatizing body-rocking.

As indicated previously, social factors also can be important in the origin of body-rocking. Abnormal body-rocking becomes more likely when a young child lives in an unstimulating environment (Gesell & Amatruda, 1947; Provence & Lipton, 1962). Disruptive parent-child relationships and little opportunity to engage in activities that build alternative experiences may maintain body-rocking. While the importance of early social experience is well-accepted, we do not know as much about what specific processes are engaged when body-rocking becomes a stable part of the child's behavioral repertoire. Mason and Berkson (1975) attempted to analyze social deficits more explicitly and showed that externally provided movement and engaging in play activities were critical to the development of body-rocking in isolation-reared monkeys. However, analyses of specific factors in children from birth to Age 3 are rare.

Although it is important to note that several kinds of disruption in child-environment relationships may influence permanent body-rocking, no one should conclude that because a person engages in body-rocking, he or she is currently subject to a depriving environment. Furthermore, every child reacts to situational variables differently, so factors that elicit body rocking in one child, may not be the same for others. On the other hand, there is a tendency to ignore body-rocking on the

assumption that the behavior is normal and will disappear with age. As we have stated, body-rocking is a feature of normal locomotor development, however, it may not always disappear. As body-rocking persists, its amplitude and duration (Schwartz et al., 1986) may increase, collateral behaviors may increase, and both may result in a behavior that is socially stigmatizing (Berkson et al., 1999).

Summary. The two major forms of body-rocking are four-point and seated. Four-point body-rocking is probably related to the development of locomotion, but whether it is necessary, merely helpful, or a sign of locomotor development is not yet clear. Seated body-rocking may initially be related to four-point body-rocking, but it certainly has some different functions, and it is the form that most often appears in adulthood. Body rocking is probably maintained by vestibular and kinesthetic feedback, and may be mediated by a dopamine mechanism. Social factors may contribute to its maintenance, and several environmental conditions can influence body rocking's moment-to-moment expression.

Head-Banging and Head-Hitting

Self-injurious behaviors in older children and adults have been studied extensively (Thompson & Gray, 1994), although, fewer studies have looked at the birth to 3-year period covered by this review. Recent retrospective research has shown that early development is an important aspect of self-injurious behaviors in individuals who have developmental disabilities. In one study, an estimated 70% of the children began displaying self-injurious behaviors during their first 5 years (Schneider, Bijam-Schulte, Janssen, & Stolk, 1996). Behaviors such as head-banging, eye-poking, and eye-pressing have been studied programmatically in the birth to 3-year period, and we focus on these self-injurious behaviors next.

Head-banging as part of a tantrum is very common in typical children. Although this behavior is often worrisome to parents, it is generally not self-injurious. In fact, some studies have excluded children who engage in head-banging during a tantrum (de Lissovoy, 1961; Sallustro & Atwell, 1978), perhaps because the accepted definition of self-injurious behavior involves detectable tissue injury. This exclusion may be regrettable because injurious head-banging may arise out of initial non-injurious head-banging and head-hitting. For example, head-hitting may begin with non-tantrum self-stimulatory behavior such as hitting the head with an object or against an object, or hair-pulling (Sallustro & Atwell, 1978).

Additionally, there is an association between head-banging and body-rocking. Two thirds of the children who engage in head-banging also engage in body-rocking (Kravitz, Rosenthal, Teplitz, Murphy, & Lesser, 1960). Possibly, head-banging begins as incidental to four-point rocking in the crib. That is, some infants rock their body with such vigor that they repeatedly bang their head on the side of a crib. Finally, the level of head-banging may be elevated with febrile illness (personal observation) or middle ear infections (de Lissovoy, 1963). de Lissovoy's pioneering study showed a correlation between head-banging and middle ear infections. This finding has been supported recently in a single case (O'Reilly, 1997).

There are some important omissions in the few studies of children involved in head-banging. Sample limitations have prevented a thorough description of the behavior. In their study of head-banging in typical children, Kravitz et al (1960) excluded infants with outstanding orthopedic, visual, and auditory abnormalities, or those suspected of gross mental retardation or neurologic diseases. While this is consistent with their overall aim of studying typical children, it does prevent a direct comparison of typical and atypical development. On the other hand, Wehmeyer (1991) and Short and Simeonsson (1990) studied only children with developmental disabilities, again precluding a comparison.

Despite limitations such as varying definitions of head-banging and differences between studies with respect to sampling, some things in the literature are clear. The prevalence of head-banging in typical and atypical children appears to be between 3% and 15%, with most estimates being below 10% (de Lissovoy, 1961; Kravitz, et al, 1960; Sallustro & Atwell,

1978; Short & Simeonsson, 1990). Furthermore, boys engage in much more head-banging than girls do and several studies estimate the ratio to be about 3.5:1 (see Sallustro & Atwell, 1978).

Head-banging begins at 8 to 10 months of age, and like body-rocking, it increases and then decreases with age (Kravitz et al, 1960; Sallustro & Atwell, 1978). In typical children, head-banging apparently disappears, however, in children with severe developmental delays it may be retained and may become self-injurious. Verification of this picture might suggest the combination of severe disability and typical head-banging constitutes a risk factor that needs early intervention programming.

Summary. Head-banging occurs in many typical children either as a self-stimulatory behavior, that may accompany four-point body-rocking, or as part of tantrum behavior. In these forms, it ordinarily causes no tissue damage, and it normally disappears with age. In some poorly understood cases, however, head-banging does become self-injurious and is a cause for concern by therapists and other professionals.

Eye-Poking and Eye-Pressing

Eye poking and eye-pressing are different in at least two ways from previous behaviors we have reviewed. First, although body-rocking and head-banging may be seen in any child, eye-poking and eye-pressing are most commonly seen only in children with visual impairment or blindness. Second, eye-poking and eye-pressing do not appear to emerge from normal behavioral patterns, however, they generally begin during the 1st year and, as with stereotyped behaviors, they seem related to visual impairment rather than typical behavior patterns.

A limited research base exists on these ocular behaviors, probably the result of a small prevalence rate with a low incidence population. Early literature does not clearly distinguish between the two behaviors. For instance, Thurrell and Rice (1970) seemed to confuse the term eye-rubbing with other forms of eye-stimulation. Similarly, Roy (1967) discussed various oculodigital behaviors in his patients, but it is unclear whether he could differentiate the behaviors.

Until recently, eye-poking and eye-pressing have not been identified clearly as different behaviors. Jan and colleagues, and Troster and colleagues, have provided a significant advance in our understanding of these self-injurious behaviors. According to Jan, Good, Freeman and Espezel (1994), ''eye-poking is diagnosed when children chronically, episodically, and in a stereotyped manner, exert pressure with the tips of their fingers on the side of one or both globes, thereby causing self-directed pain and eventual tissue damage''(p. 321). Eye-pressing, is ''defined as steady, prolonged, non-painful pressure on one or both globes in an individual style with fingers, knuckles or fists'' (p. 321). Ultimately, the distinction between eye-poking, eye-pressing, and eye rubbing may prove to be unnecessary. For now, however, because eye-poking and eye-pressing clearly are different in form, it seems useful to differentiate them in future studies, and to separate them from non-stereotyped eye-rubbing which is typically associated with eye irritations and sleepiness.

As previously indicated, eye-poking and eye-pressing most commonly are associated with persons who are blind or visually impaired. Jan et al (1994) reported, however, that in 21 individuals with severe retardation who engaged in eye-poking, 6 apparently had no visual impairment. They concluded that frequency and severity of eye-poking may be unrelated to visual impairment. This is an issue, however, that needs further study.

Eye-poking and eye-pressing do not appear to *emerge* from typical infant behavior, however, in most cases the behavior seems to be *associated* with development. Using the Bielefeld Parents' Questionnaire for Blind and Sighted Infants and Preschoolers, researchers studied eye-poking, as well as a variety of other stereotyped behaviors in typically developing infants and preschoolers with blindness. They found that although most stereotyped behaviors come to a maximum in the 2nd year and then decline, eye-poking as well as body rocking, remain at a relatively high and particularly stable level in children with visual

impairments (Brambring & Troster, 1992; Troster, Brambring & Beelmann, 1991a).

Eye-pressing has been reported only in persons who are blind or visually impaired and this behavior seems to be connected to the onset and type of visual impairment. Jan et al. (1983) suggested that children with more severe visual impairments are more likely to engage in eye-pressing. Furthermore, they reported that children with retinal disorders most commonly exhibited this behavior, although children whose vision had been impaired as a result of optic nerve dysfunction or cortical blindness were not observed pressing their eyes. This finding supports the self-stimulation hypothesis we discuss later. Jan et al. also indicated that eye-pressing occurs only in children who are congenitally blind or lose their sight early in life implying that individuals who become visually impaired later in life do not develop eye-pressing. From a developmental perspective, this is a particularly important finding because it suggests that the time between birth and Age 3 may be a sensitive period. No specific data germane to a sensitive period hypothesis have actually been presented, but this may be important in understanding the origins of the behaviors.

As with other stereotyped and self-injurious behaviors, there is considerable interest in the factors that maintain eye-poking and eye-pressing. The idea that self-stimulation is the basis of stereotyped behaviors is widely held (Berkson, 1983; Lovaas et al., 1987), however, a self-stimulation position leads to the question: What specific stimulation is involved? Thurrell and Rice (1970) provided important information and a preliminary self-stimulation hypothesis regarding the maintenance of these behaviors. Jan et al. (1983) reported that most visually impaired children cannot explain why they press their eyes, although some can give a vague description of seeing sparks of light. Thus, as a child exerts pressure on the globe of the eye, electric currents are sent through retinal pathways producing phosphenes (sparks of light). Although this is currently the most commonly held belief, it also has the strongest evidence. As indicated, Jan et al. observed that eye-pressing is limited to children with retinal disorders. If phosphenes is what maintains eye-poking and eye-pressing, then individuals who have no vision because of bilateral optic atrophy, optic nerve hypoplasia, cortical blindness, or enucleation might not develop ocular stereotyped behaviors. If they did, perhaps other senses (e.g. tactual) might be implicated.

As with body-rocking and head-banging, it remains unclear what causes these behaviors to originate and persist in some individuals. Eye-poking and eye-pressing seem more likely to begin at a young age and continue into adulthood. Perhaps, children receive such a powerful and pleasurable sensation from ocular stimulation that few other competing behaviors can replace them. Early interventionists need to be aware of these behaviors and attempt to eliminate them before they become engrained in the behavior repertoire of young children with visual impairments. Eye-poking and eye-pressing can become socially stigmatizing, can cause damage to the eye, and can result in loss of residual vision. How to provide early intervention, however, remains a challenge for the future.

Summary. Eye-poking and eye-pressing appear to be different behaviors, but both can produce serious damage to the eyes. These behaviors emerge in the birth to 3-year period and are apparently maintained by the visual sensations they produce, although other sources of input (e.g., tactual) also may be involved. Early interventionists should be particularly sensitive to the earliest appearance of these behaviors so that prevention attempts such as providing alternatives to the stimulation, can be implemented.

Other Behaviors

There are several other stereotyped behaviors that have received less intensive study, but are worth mentioning. Among non-injurious behaviors are light-gazing (Jan, Groenveld & Sykanda, 1990), head-shaking (Jan, Groenveld, & Connolly, 1990; Wolff, 1968), and head-rolling (Sallustro & Atwell, 1978). Head-shaking and head-rolling, commonly seen in individuals with blindness and visual impairment, may in fact be the same behavior,

which is thought to be different from spasmus nutans (Jan, Groenveld, & Connolly).

From the list of self-injurious behaviors mentioned by Williams (1974), hair-pulling, self-scratching, and self-biting have received little attention in the birth to 3-year period. However, they all exist and may be important in further development of self-injurious behaviors in individual children.

Summary. Other stereotyped and self-injurious behaviors have received less study but are nevertheless important.

Correlated Factors and Treatment Approaches

Described in this section are several organismic and environmental factors that may be related to attempts at preventing abnormal development of stereotyped behaviors. These include general arousal, behavioral states, alternative activities, and social interaction. Simultaneously, we discuss issues related to the treatment of stereotyped and self-injurious behaviors.

Some stereotyped behaviors appear in association with sleep or near-sleep states, but also can occur when a child is excited, angry, or agitated. To explain this, Berkson (1967) first invoked the idea that repetitive stereotyped behaviors like body-rocking may be related to general arousal or activation. Second, to explain the U-shape of the arousal-body-rocking relationship, he suggested that, at intermediate levels of arousal, when there are other things to do, the child interacts with the environment instead of engaging in stereotyped behaviors. Thus, arousal level and engagement with the environment are conditions he believed influenced repetitive stereotyped behaviors.

Baumeister (1978) expressed concern that the arousal concept is often used in a post hoc or logically circular manner. While it is possible to avoid this circularity by altering arousal level independently, by varying organismic arousal through drugs or variations of the environment (e.g., Berkson & Mason, 1964), post hoc functional explanations are rife in the literature on stereotyped behaviors, and they may not always be helpful (Berkson, 1983).

An important, alternative concept to the simple arousal level idea has been presented by Guess and Carr (1991) who apply the concept of repetitive movements as a behavior state condition. They conceive of stereotyped behaviors as a primitive behavioral mode that regulates arousal and can be influenced by the environment. This multiple level analysis consists of three basic states. The first level involves rhythmic patterns that are internally regulated. For a second level, they suggest stereotyped and self-injurious behaviors are homeostatic responses to environmental stimulation, thus, rhythmic patterns, which may be influenced by external stimuli are adopted to ''self-regulate optimal stimulation'' (p. 307). An example of this level might be body-rocking in a noisy surrounding. The third level includes behaviors that are adapted in order to control others, either through negative or positive reinforcement. A common example might be head-banging that results in social attention.

Many other contributions, built on empirical studies of the contexts in which the behaviors occur, have helped simplify the general picture of stereotypies. Aside from developmental variables emphasized by Wehmeyer (1994), several environmental factors are probably important and subject to modification. Thelen (1980) showed that babies whose parents engage them in more social behavior tend to show less stereotyped behaviors. Sallustro and Atwell (1978) observed that body-rocking occurred most frequently when a child was listening to music; head-banging occurred most often when a child was tired, irritable, or upset; and head rolling was most commonly observed when the child was alone in a crib or playpen. Troster's study (1994) of children without handicaps in residential care institutions also suggested potentially useful information in the classification of behavioral contexts. He concluded that various normal nervous habits and stereotyped behaviors tended to occur in four general situations: concentration/demand; arousal/frus-

tration; boredom/monotony; and stimulation/distraction.

Several studies have shown that typically developing children may body-rock, head-roll, or hit their heads on pillows while apparently asleep (de Lissovoy, 1961; Lindsay et al., 1982; Sallustro & Atwell, 1978). Typical infants as well as infants with developmental disabilities may engage in body-rocking in their cribs before going to sleep or when awake. In addition to bedtime occurrences, body-rocking and head-banging may be increased when a child is ill. This increase may be interpreted in the context of self-comforting stimulation or social withdrawal.

One remarkable feature of the literature on stereotyped and self-injurious behaviors in very young children is that it tends to be descriptive. That is, although there is a large literature on older individuals, only a few studies have demonstrated an attempt to prevent or eliminate the behaviors in children from birth to Age 3. Martin and Conway (1976) for example, reported a successful treatment procedure for a 25-month-old typically developing child who engaged in 4-point nocturnal rocking. They presented a bright light contingent upon rocking, and in a few weeks, the behavior was completely eliminate. Likewise, Singh (1980) reported the use of facial screening to eliminate self-biting in an 11-month-old child with severe mental retardation. These studies show that abnormal stereotyped behaviors can be eliminated in infancy. Hopefully, nonaversive procedures will be developed in the future, perhaps centered on the management of the environment in which the behavior occurs (Tarnowski, Rasnake, Mulick, & Kelly, 1989).

Medical treatments in association with behavioral treatment may decrease self-injury in some cases where a medical condition is implicated (Bosch, Van Dyke, Smith, & Poulton, 1997). Prescribing drugs to eliminate self-injurious behaviors is another solution that may be espoused, although drug administration is not covered in this review. Relevant studies of children from birth to Age 3 are rare, but they are badly needed. Such studies should consider the conclusion drawn from Thompson, Egli, Symons, and Delaney (1994) who reviewed studies with older individuals and found that several treatments produced temporary reductions in problem behavior and ''interventions focusing only on one mechanism would be expected to produce evanescent effects'' (p. 136).

As indicated earlier, there has been some study of certain forms of stereotyped behavior as a form of vestibular self-stimulation. This is based on a notion that feedback from stereotyped behaviors is mediated by the kinesthetic-vestibular sensory system. Thus, feedback is intrinsically rewarding, feedback normally promotes motor development, and in turn, more mature motor development might be associated with fewer stereotyped behaviors (MacLean & Baumeister, 1982). This theory implies that providing vestibular stimulation might increase motor development with a concomitant decrease in stereotypy. Two studies, both of children in the birth to 3-year period, have tested whether providing vestibular stimulation promotes motor development and therefore, reduces stereotyped behaviors. Thompson and Thelen (1986) provided supplemental vestibular stimulation, twice a week for 4 weeks, to 5-month-old typically developing infants. No influence of the treatment on either motor development or motor stereotypies was observed. On the other hand, MacLean and Baumeister's (1982) results were more promising. They provided four children with developmental delay (age 17 to 42 months) with 10 sessions of vestibular stimulation over a 2-week period and found clear motor advances following treatment, although reduction of stereotyped behaviors was inconsistent. From these limited results, concrete conclusions about the relationship between motor development and a decreased rate of stereotyped behaviors can not be drawn. The study was pioneering, however, and indicates that relatively short-term interventions can have significant effects on motor development.

When a person interacts with the environment (playing with toys, engaging a novel problem), the level of body-rocking is suppressed (Davenport & Berkson, 1963). Thus,

another approach to the reduction of stereotyped behaviors has been to engage children in other activities. For example, exercising motor systems (i.e. through jogging programs) has been effective in reducing stereotypy and self-injury rates in older children (Baumeister & MacLean, 1984; Didden, Duker, & Korzilius, 1997; Ellis, MacLean, & Gazdag, 1989; Kern, Koegel, Dyer, Blew, & Fenton, 1982; Watters & Watters, 1980). Overall, elaboration of the environment is a means of reducing stereotypy that has empirical support.

Other kinds of stimulation such as music also are important in controlling body-rocking. By about Age 1, many children respond to music by bouncing, rocking, and swaying their bodies. Older children and adults with mental retardation also body-rock in response to music (e.g., Tierney et al. 1978). Because this generally observed phenomena represents a shift in the control level of body-rocking from an internal self-regulation to an increasing environmental influence, it is important in the study of emerging stereotyped behaviors. Using music to promote body-rocking when it is normatively functional in strengthening muscles and compete with abnormal body-rocking by encouraging dancing movements might mold more mature forms of motor behavior.

In some situations, the environment either increases or decreases stereotypy and self-injury. For example, social interaction generally tends to be negatively correlated with stereotypy, thus, person-to-person interaction can interfere with stereotypy just as any other environmental variables (Donnellan, Anderson, & Mesaros, 1984). On the other hand, Carr (1977) pointed out that responding socially to a self-injurious behavior may be involved in the maintenance of the behavior. For example, a self-injurious behavior may become instrumental in obtaining a parental response, yet, there are times when it might be practical, although not ethical, to withdraw parental response to an injurious behavior (see Carr for potential difficulties). Nevertheless, the idea that self-injurious behaviors might be prevented in some cases through management of the parent-child relationship is clearly worth investigation.

Perhaps the most promising general strategy to prevent stereotyped and self-injurious behavior is an individualized functional analysis (Taylor & Carr, 1994). This involves a systematic determination of the factors that seem to trigger and maintain self-injurious behaviors in individual children. Many studies indicate that a full functional analysis involves a description of the child's behavior and the environmental factors that influence the child. Also included in this analysis are factors that determine the parents' or teachers' behaviors and, in turn, influence the child. Functional assessment is a practical consideration for several reasons; (a) it is individualized; (b) trained professionals are not needed; and (c) it can be carried out in a variety of contexts (i.e. home, school) by a person in each setting who knows the child best. The collection of systematic data on the variables that elicit stereotyped and self-injurious behaviors will help facilitate the future development of treatments that, in turn, may help to eliminate these behaviors before they become socially stigmatizing or injurious.

Summary. Several organismic and environmental variables have been correlated with levels of stereotyped and or self-injurious behavior. Although in some cases, treatments have been effective in reducing and even eliminating these behaviors, there is no single solution. Understanding the range of possibilities can form the basis for prevention and early treatment because the persistence of stereotyped and self-injurious behaviors is likely due to a combination of factors. In individual cases, a full functional analysis may be an especially promising approach.

Conclusions

Several things are clear from a review of the work done over the half-century. Repetitive behaviors are a feature of early locomotor development in most children. These behaviors normally reach a peak soon after the first birthday, and, in almost all children, the behaviors decline during the preschool years. Although there is general agreement that re-

petitive behaviors occur maximally during the early development of locomotion, there is less agreement about their significance. The most conservative position suggests these behaviors are an *indicator* of transitions in development. Others, however, consider them a *determinant* of locomotor development and may believe that repetitive movements are helpful or actually necessary for motor development. There is no research on this issue, but it is likely that the study of children with cognitive delays or motor disabilities could help resolve it.

Typical repetitive behaviors of infancy also occur in children with significant disabilities, but the peak and decline are delayed. This delay in development may provide a prolonged opportunity for repetitive behaviors to become conditioned to factors in the environment. Thus, it is possible that socially stigmatizing and self-injurious behaviors that are permanent in adults with disabilities, may have originated during this early, extended, developmental period. In children with disabilities, however, more than delay of development may be involved. The form of normal and abnormal stereotyped behaviors may be different and kinematic techniques may help differentiate them. Furthermore, apparently similar behaviors at different ages may serve varying functions.

Eye-poking and eye-pressing are self-injurious behaviors that do not commonly occur in typical children, but do seem to originate in the early stages of development. It is particularly important to identify these behaviors because they can cause severe injury to tissues surrounding the eye and, once organized, these behaviors tend to become permanent. Eye-poking and eye-pressing behaviors occur most commonly in children with visual impairments, thus interventionists working with this population should focus on the origins of the behaviors. Treatments oriented toward eliminating ocular stimulation have not been successful. Research on the early development of eye-poking and eye-pressing is needed as a possible prelude to prevention.

To establish an empirical basis for the origin and maintenance of stereotyped and self-injurious behaviors, a considerable amount of future research is needed. It is remarkable that so few investigations have examined methods for preventing these abnormal behaviors. Perhaps parents and early interventionists regard these behaviors as normal and temporary, which they often are. Or perhaps other aspects of managing a child take higher priority. This review, however, shows that abnormal forms of stereotyped and self-injurious behaviors develop during the first years of life. Although prevention may be possible, early interventionists and others in the field of early child development must first become aware of the behaviors and the possible effects they may have if they become established in the behavior repertoire.

REFERENCES

Abelson, A. G. (1983). Infantile autism: An overview. *Journal of Psychiatric Treatment and Evaluation, 5,* 31–35.

Adrien, J. L., Lenoir, P., Martineau, J., Perrot, A., Hameury, L., Larmande, C., & Sauvage, D. (1993). Blind ratings of early symptoms of autism based upon family home movies. *Journal of the American Academy of Child and Adolescent Psychiatry, 32,* 617–626.

Bachara, G. H. & Phelan, W. J. (1980). Rhythmic movement in deaf children. *Perceptual and Motor Skills, 50,* 933–934.

Baranek, G. T., (1999). Autism during infancy: A retrospective video analysis of sensory-motor and social behaviors at 9–12 months of age. *Journal of Autism and Developmental Disorders, 29,* 213–224.

Baumeister, A. A. (1978). Origins and control of stereotyped movements. In C. E. Meyers (Ed.), *Quality of Life in Severely and Profoundly Mentally Retarded People: Research Foundations for Improvement* (pp. 353–384). Washington DC: American Association on Mental Deficiency.

Baumeister, A. A. & MacLean, W. E., Jr. (1984). Deceleration of self-injurious and stereotypic responding by exercise. *Applied Research in Mental Retardation, 5,* 385–393.

Baumeister, A. A., MacLean, W. E. Jr., Kelly, J., & Kasari, C. (1980). Observational studies of retarded children with multiple stereotyped movements. *Journal of Abnormal Child Psychology, 8,* 501–521.

Berkson, G. (1967). Abnormal stereotyped motor

acts. In J. Zubin & H. F. Hunt (Eds.), *Comparative Psychopathology* (pp. 76–94). New York: Grune and Stratton.

Berkson, G. (1983). Repetitive stereotyped movements. *American Journal of Mental Deficiency, 88,* 239–246.

Berkson, G. & Mason, W. A. (1964). Stereotyped behaviors of chimpanzees: Relation to general arousal and alternative activities. *Perceptual and Motor Skills, 19,* 635–652.

Berkson, G., Rafaeli-Mor, N. & Tarnovsky, S. (1999). Body-rocking and other habits in college students and persons with mental retardation. *American Journal on Mental Retardation, 104,* 107–116.

Bodfish, J. W., Powell, S. B., Golden, R. N., & Lewis, M. H. (1995). Blink rate as an index of dopamine function in adults with mental retardation and repetitive behavior disorders. *American Journal on Mental Retardation, 99,* 335–344.

Bosch, J., Van Dyke, D. C., Smith, S. M. & Poulton, S. (1997). Role of medical conditions in the exacerbation of self-injurious behaviors: An exploratory study. *Mental Retardation, 35,* 124–130.

Brambring, M. & Troster, H. (1992). On the stability of stereotyped behaviors in blind infants and preschoolers. *Journal of Visual Impairment and Blindness, February,* 105–110.

Brody, S. (1960). Self-rocking in infancy. *Journal of the American Psychoanalytic Association, 8,* 464–491.

Carr, E. G. (1977). The motivation of self-injurious behavior: A review of some hypotheses. *Psychological Bulletin, 84,* 800–816.

Davenport, R. K. & Berkson, G. (1963). Stereotyped movements of mental defectives: II. Effects of novel objects. *American Journal of Mental Deficiency, 67,* 879–882.

Davenport, R. K. Jr., Menzel, E. W. Jr., & Rogers, C. M. (1966). Effects of severe isolation on ''normal'' juvenile chimpanzees. *Archives of General Psychiatry, 14,* 134–138.

de Lissovoy, V. (1961). Head banging in early childhood. *Journal of Pediatrics, 58,* 803–805.

de Lissovoy, V. (1963). Head banging in early childhood: A suggested cause. *The Journal of Genetic Psychology, 102,* 109–114.

Didden, R., Duker, P. C., & Korzilius, H. (1997). Meta-analytic study on treatment effectiveness for problem behaviors with individuals who have mental retardation. *American Journal on Mental Retardation, 101,* 387–399.

Donnellan, A. M., Anderson, J. L., & Mesaros, R. A. (1984). An observational study of stereotypic behavior and proximity related to the occurrence of autistic child-family member interactions. *Journal of Autism and Developmental Disorders, 14,* 205–210.

Dykens, E. M., Hodapp, R. M., Walsh, K., & Nash, L. J. (1992). Adaptive and maladaptive behavior in Prader-Willi syndrome. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 1131–1136.

Ellis, D. N., MacLean, W. E. Jr., & Gazdag, G. (1989). The effects of exercise and cardiovascular fitness on stereotyped body-rocking. *Journal of Behavior Therapy and Experimental Psychiatry, 20,* 251–256.

Emerson, E. & Howard, D. (1992). Schedule-induced stereotypy. *Research in Developmental Disabilities, 13,* 335–361.

Evans, D. W., Leckman, J. F., Carter, A., Reznick, J. S., Henshaw, D., King, R. A., & Pauls, D. (1997). Ritual, habit, and perfectionism: The prevalence and development of compulsive-like behavior in normal young children. *Child Development, 68,* 58–68.

Foster, L. G. (1998). Nervous habits and stereotyped behaviors in preschool children. *Journal of the American Academy of Child and Adolescent Psychiatry, 37,* 711–717.

Gesell, A. (1954). The ontogenesis of infant behavior. In L. Carmichael (Ed.), *Manual of Child Psychology* (pp. 335–373). New York: John Wiley and Sons.

Gesell, A. & Amatruda, C. S. (1947). *Developmental Diagnosis: Normal and Abnormal Child Development.* New York: Paul B. Hoeber Inc.

Guess, D. & Carr, E. (1991). Emergence and maintenance of stereotypy and self-injury. *American Journal on Mental Retardation, 96,* 299–319.

Jan, J. E., Freeman, R. D., McCormick, A. Q., Scott, E. P., Robertson, W. D., & Newman, D. E. (1983). Eye-pressing by visually impaired children. *Developmental Medicine and Child Neurology, 25,* 755–762.

Jan, J. E., Freeman, R. D., & Scott, E. P. (1977). Stereotyped behavior. In *Visual Impairment in Children and Adolescents* (pp. 239–255). New York: Grune and Stratton Inc.

Jan, J. E., Good, W. V., Freeman, R. D., & Espezel, H. (1994). Eye-poking. *Developmental Medicine and Child Neurology, 36,* 321–325.

Jan, J. E., Groenveld, M., & Connolly, M. B. (1990). Head shaking by visually impaired children: A voluntary neurovisual adaptation which can be confused with spasmus nutans. *Developmental Medicine and Child Neurology, 32,* 1061–1066.

Jan, J. E., Groenveld, M., & Sykanda, A. M.

(1990). Light-gazing by visually impaired children. *Developmental Medicine and Child Neurology, 32,* 755–759.

Kern, L., Koegel, R. L., Dyer, K., Blew, P. A., & Fenton, L. R. (1982). The effects of physical exercise on self-stimulation and appropriate responding in autistic children. *Journal of Autism and Developmental Disorders, 12,* 399–419.

King, B. (1993). Self-injury by people with mental retardation: A compulsive behavior hypothesis. *American Journal in Mental Retardation, 98,* 93–112.

Koegel, R. L. & Koegel, L. K. (1989). Community-referenced research on self-stimulation. In E. Cipani (Ed.), *The Treatment of Severe Behavior Disorders* (pp. 129–150) Monograph of the American Association on Mental Retardation, 12. Washington, D.C.

Kravitz, H. & Boehm, J. J. (1971). Rhythmic habit patterns in infancy: Their sequence, age of onset, and frequency. *Child Development, 42,* 399–413.

Kravitz, H., Rosenthal, V., Teplitz, Z., Murphy, J. B., & Lesser, R. E. (1960). A study of head-banging in infants and children. *Diseases of the Nervous System, 21,* 3–8.

Lawrence, K. B. & MacLean, W. E. (1994). *Development and maintenance of stereotyped behavior: A longitudinal study of developmentally disabled and nondisabled children.* Paper presented at the Gatlinburg Conference, Gatlinburg, TN.

Levy, D. M. (1944). On the problem of movement restraint. *The American Journal of Orthopsychiatry, 14,* 644–671.

Lewis, M. H. & Baumeister, A. A. (1982). Stereotyped mannerisms in mentally retarded persons: Animal models and theoretical analyses. *International Review of Research in Mental Retardation, 11,* 123–161.

Lewis, M. H., Gluck, J. P., Bodfish, J. W., Beauchamp, A. J. & Mailman, R. B. (1996). Neurobiological basis of stereotyped movement disorder. In R. L. Sprague & K. M. Newell (Eds.), *Stereotyped Movements.* (pp. 37–67). Washington: American Psychological Association.

Lindsay, S. J. E., Salkovskis, P. M., & Stoll, K. (1982). Rhythmical body movement in sleep: A brief review and treatment study. *Behavior Research and Therapy, 20,* 523–526.

Lissy, S. S. (1997). Sensory stimulation as treatment for self-injurious behavior in severe or profound mental retardation. *Developmental Disabilities Special Interest Quarterly, AOTA, 20,* 1–4.

Losche, G. (1990). Sensorimotor and action development in autistic children from infancy to early childhood. *Journal of Child Psychology and Psychiatry, 31,* 749–761.

Lourie, R. S. (1949). The role of rhythmic patterns in childhood. *American Journal of Psychiatry, 105,* 653–660.

Lovaas, I., Newsom, C., & Hickman, C. (1987). Self-stimulatory behavior and perceptual reinforcement. *Journal of Applied Behavior Analysis, 20,* 45–68.

MacLean, W. E. Jr., & Baumeister, A. A. (1982). Effects of vestibular stimulation on motor development and stereotyped behavior of developmentally delayed children. *Journal of Abnormal Child Psychology, 10,* 229–245.

MacLean, W. E. Jr., Ellis, D. N., Galbreath, H. N., Halpern, L. F., & Baumeister, A. A. (1991). Rhythmic motor behavior of preambulatory motor impaired, Down syndrome, and nondisabled children: A comparative analysis. *Journal of Abnormal Child Psychology, 19,* 319–330.

MacLean, W. E. Jr., Lewis, M. H., Bryson-Brockmann, W. A., Ellis, D. N., Arendt, R. E., & Baumeister, A. A. (1985). Blink rate and stereotyped behavior: Evidence for dopamine involvement? *Biological Psychiatry, 20,* 1321–1325.

MacLean, W. E. Jr., Stone, W. L., & Brown, W. H. (1994). Developmental psychopathology of destructive behavior. In T. Thompson & D. B. Gray (Eds.), *Destructive Behavior in Developmental Disabilities* (pp. 68–79). Thousand Oaks, CA: Sage Publications.

Martin, L. J., Spicer, D. M., Lewis, M. H., Gluck, J. P., & Cork, L. C. (1991). Social deprivation of infant rhesus monkeys alters the chemoarchitecture of the brain: I. Subcortical regions. *The Journal of Neuroscience, 11,* 3344–3358.

Martin, R. D. & Conway, J. B. (1976). Aversive stimulation to eliminate infant nocturnal rocking. *Journal of Behavior Therapy and Experimental Psychiatry, 7,* 200–201.

Mason, G. J. (1991). Stereotypies: A critical review. *Animal Behaviour, 41,* 1015–1037.

Mason, W. A. & Berkson, G. (1975). Effects of maternal mobility on the development of rocking and other behaviors in rhesus monkeys: A study with artificial mothers. *Developmental Psychobiology, 8,* 197–211.

Murdoch, H. (1996). Stereotyped behaviors in deaf and hard of hearing children. *American Annals of the Deaf, 141,* 379–386.

Newell, K. M. (1996). The dynamics of stereotypic behaviors: Movement variance and invariance

in the classification of movement disorders. In R. L. Sprague & K. M. Newell (Eds.), *Stereotyped movements* (pp. 115–138). Washington: American Psychological Association.

Nyhan, W. L. (1994). The Lesch-Nyhan disease. In T. Thompson & D. B. Gray (Eds.), *Destructive Behavior in Developmental Disabilities.* (pp. 181–197). Thousand Oaks, CA: Sage Publications.

O'Reilly, M. F. (1997). Functional analysis of episodic self-injury associated with recurrent otitis media. *Journal of Applied Behavior Analysis, 30,* 165–168.

Osterling, J. & Dawson, G. (1994). Early recognition of children with autism: A study of first birthday home videotapes. *Journal of Autism and Developmental Disorders, 24,* 247–257.

Piaget, J. (1952). *The Origins of Intelligence in Children.* New York: International Universities Press.

Provence, S. and Lipton, R. C. (1962). Discovery of the body and the sense of self. *Infants in Institutions.* (pp. 105–121). New York: International Universities Press.

Rafaeli-Mor, N., Foster, L., & Berkson, G. (1999). Self-reported body-rocking and other habits in college students. *American Journal on Mental Retardation, 104,* 1–10.

Roy, F. H. (1967). Ocular autostimulation. *American Journal of Opthamology, 63,* 1776–1777.

Sallustro, F. & Atwell, C. W. (1978). Body rocking, head banging, and head rolling in normal children. *Journal of Pediatrics, 93,* 704–708.

Schroeder, S. R and Tessel, R. (1994). Dopaminergic and serotonergic mechanisms in self-injury and aggression. In T. Thompson & D. B. Gray (Eds.), *Destructive Behavior in Developmental Disabilities.* (pp. 198–210). Thousand Oaks, CA: Sage Publications.

Schneider, M. J., Bijam-Schulte, A. M., Janssen, C. G. C., & Stolk, J. (1996). The origin of self-injurious behaviour of children with mental retardation. *The British Journal of Developmental Disabilities, 42,* 136–148.

Schwartz, S. S., Gallagher, R. J., & Berkson, G. (1986). Normal repetitive and abnormal stereotyped behavior of nonretarded infants and young mentally retarded children. *American Journal of Mental Deficiency, 90,* 625–630.

Short, R. J. & Simeonsson, R. J. (1990). Stereotypical behaviors and handicapping conditions in infants and children. *Topics in Early Childhood Special Education, 10,* 122–130.

Singh, N. N. (1980). The effects of facial screening on infant self-injury. *Journal of Behavior Therapy and Experimental Psychiatry, 11,* 131–134.

Sprague, R. L. & Newell, K. M. (Eds.). (1996). *Stereotyped Movements: Brain and Behavior Relationships.* Washington, D.C.: American Psychological Association.

Stewart, J. D. (1985). *Sound intensity and stereotypic body rocking in severely-profoundly retarded children: A sensory reinforcement approach.* Unpublished doctoral dissertation, University of Illinois at Chicago.

Symons, F. J. & Thompson, T. (1997). A review of self-injurious behavior and pain in persons with developmental disabilities. *International Review of Research in Mental Retardation, 21,* 69–111.

Tan, A., Salgado, M., & Fahn, S. (1997). The characterization of stereotypic movements in nonautistic children. *Movement Disorders, 12,* 47–52.

Tarnowski, K. J., Rasnake, L. K., Mulick, J. A., & Kelly, P. (1989). Acceptability of behavioral interventions for self-injurious behavior. *American Journal on Mental Retardation, 93,* 575–580.

Taylor, J. C. & Carr, E. G. (1994). Severe problem behaviors of children with developmental disabilities: Reciprocal social influences. In T. Thompson & D. B. Gray (Eds.), *Destructive Behavior in Developmental Disabilities* (pp. 274–299). Thousand Oaks, CA: Sage Publications.

Thelen, E. (1979). Rhythmical stereotypies in normal human infants. *Animal Behavior, 27,* 699–715.

Thelen, E. (1980). Determinants of amounts of stereotyped behavior in normal human infants. *Ethology and Sociobiology, 1,* 141–150.

Thelen, E. (1981). Rhythmical behavior in infancy: An ethological perspective. *Developmental Psychology, 17,* 237–257.

Thelen, E. (1996). Normal infant stereotypes: A dynamic systems approach. In R. L. Sprague & K. M. Newell (Eds.), *Stereotyped movements.* (pp. 139–165). Washington: American Psychological Association.

Thompson, D. F. & Thelen, E. (1986). The effects of vestibular stimulation on stereotyped behavior and development in normal infants. *Physical and Occupational Therapy in Pediatrics, 6,* 57–70.

Thompson, T., Egli, M., Symons, F. & Delaney, D. (1994) Neurobehavioral mechanisms of drug action in developmental disabilities. In T. Thompson & D. B. Gray (Eds.) *Destructive Behavior in Developmental Disabilities.* (pp. 133–180). Thousand Oaks, CA: Sage Publications.

Thompson, T. & Gray, D. B. (Eds.). (1994). *De-*

structive Behavior in Developmental Disabilities. Thousand Oaks, CA: Sage Publications.

Thurrell, R. J. & Rice, D. G. (1970). Eye rubbing in blind children: Application of a sensory deprivation model. *Exceptional Children, January,* 325–330.

Tierney, I. R., McGuire, R. J., & Walton, H. J. (1978). The effect of music on body-rocking manifested by severely mentally deficient patients in ward environments. *Journal of Mental Deficiency Research, 22,* 255–261.

Troster, H. (1994). Prevalence and functions of stereotyped behaviors in nonhandicapped children in residential care. *Journal of Abnormal Child Psychology, 22,* 79–97.

Troster, H., Brambring, M., & Beelmann, A. (1991a). The age dependence of stereotyped behaviours in blind infants and preschoolers. *Child: Care, Health, and Development, 17,* 137–157.

Troster, H., Brambring, M., & Beelmann, A. (1991b). Prevalence and situational causes of stereotyped behaviors in blind infants and preschoolers. *Journal of Abnormal Child Psychology, 19,* 569–590.

Troster, H., Hecker, W., & Brambring, M. (1994). Longitudinal study of gross-motor development in blind infants and preschoolers. *Early Child Development and Care, 104,* 61–78.

Watters, R. G. & Watters, W. E. (1980). Decreasing self-stimulatory behavior with physical exercise in a group of autistic boys. *Journal of Autism and Developmental Disorders, 10,* 379–387.

Wehmeyer, M. L. (1991). Typical and atypical repetitive motor behaviors in young children at risk for severe mental retardation. *American Journal on Mental Retardation, 96,* 53–62.

Wehmeyer, M. L. (1994). Factors related to the expression of typical and atypical repetitive movements of young children with intellectual disability. *International Journal of Disability, Development, and Education, 41,* 33–49.

Werry, J. S., Carlielle, J., & Fitzpatrick, J. (1983). Rhythmic motor activities (stereotypies) in children under five: Etiology and prevalence. *Journal of the American Academy of Child Psychiatry, 22,* 329–336.

Williams, C. (1974). Self-injury in children. *Developmental Medicine and Child Neurology, 16,* 88–90.

Wolff, P. H. (1968). Stereotypic behavior and development. *The Canadian Psychologist, 9,* 474–484.

This work was supported by a grant from the National Institute of Child Health and Human Development (R01-HD27184). Thanks to Tami Andriacchi and an anonymous reviewer.

Address all correspondence to **Gershon Berkson, Ph.D.,** Department of Psychology (MC/285), University of Illinois at Chicago, 1007 W. Harrison St., Chicago, IL 60607-7137.