Effects of Linear Vestibular Stimulation on Body-Rocking Behavior in Adults With Profound Mental Retardation

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The effects of linear vestibular stimulation on body-rocking behaviors in adults with profound mental retardation were studied. A single-system multiple baseline design across 3 subjects was used. The design included three phases spread over a period of 9 weeks. An interval time sampling procedure was used to collect data. Data from the 3 subjects were graphed and interpreted through visual inspection. Trend lines were computed with the celeration line approach to supplement the visual inspection of the data. The results demonstrated a decrease in body-rocking behaviors during the treatment and follow-up phases for Subject 2 but no obvious change in performance for Subjects 1 and 3. A lengthier treatment period and selection of subjects with similar body-rocking frequencies are suggested for further research.

Persistent, stereotyped behavior is a salient characteristic and a frequent behavior problem in many persons with developmental disabilities. Persons with profound or severe mental retardation often exhibit stereotyped behaviors that could be self-stimulatory or self-injurious. According to Baumeister and Forehand (1973), the term stereotypy refers to a wide assortment of nonfunctional motor and posturing movements. Typically, these are repetitive, topographically invariant motor acts or sequences for which reinforcing or controlling stimuli are unknown and that are in a functional sense maladaptive. Self-stimulatory behavior is undesirable when it is frequent and interferes with the person’s ability to learn, communicate, and interact adaptively with the environment (Storey, Bates, McGhee, & Dycus, 1984).

Stereotypic Behavior

In reviewing research on behavior procedures used to manage self-stimulatory behaviors, Storey et al. (1984) concluded that a variety of behavioral approaches have been used. Although successful in many cases, these behavioral procedures are primarily consequence strategies, that is, they involve a reaction after occurrence of a self-stimulatory behavior. Storey et al. used sensory awareness training procedures in a child with profound mental retardation and concluded that there was a reduction in the frequency of self-stimulatory behaviors.

Besides behavioral and sensory awareness training procedures to manage self-stimulatory behaviors, other approaches are also available. One frequently described alternative is the use of sensory reinforcement or sensory stimulation to reduce self-stimulatory or self-injurious behaviors (Bonadonna, 1981; Weeks, 1979; Wells & Smith, 1983).

In reviewing the vestibular system, Weeks (1979) mentioned that, ontogenetically, vestibular function is said to be the second earliest appearing sensory perception, just after oral tactile function. The early development of the vestibular system has led some authorities to suggest that controlled vestibular stimulation may be effective in reducing stereotypic behaviors (Bonadonna, 1981; Sandler & Coren, 1980).

Bonadonna (1981) has done an extensive review of the literature pertaining to the physiology of the vestibular system and its influence on rocking behavior. Bonadonna reported that internal and external environmental factors have been identified as possible causes for the occurrence of stereotyped rocking behaviors.

Bonadonna (1981); Bright, Bittick, and Heeman (1981); Wells and Smith (1983); and Brocklehurst-Woods (1990) have conducted effectiveness studies using sensory-integrative treatment techniques to reduce self-stimulatory or self-injurious behaviors. Sensory integration procedures include vestibular stimulation activities as one component of the intervention. The studies re-
ferred to above were all conducted with the use of subjects with severe and profound mental retardation and related disabilities. The above-mentioned studies demonstrated a decrease in stereotypic behaviors (i.e., self-stimulatory or self-injurious) with the use of tactile stimulation, vestibular stimulation, or both. Though research has been done with vestibular stimulation for decreasing stereotypic body-rocking behaviors (Bonadonna, 1981), there is limited evidence of its effectiveness in adults aged 35 years or older.

**Study Purpose**

The purpose of this study was to determine the effectiveness of a program of clinically applied vestibular stimulation in decreasing stereotypic body-rocking behaviors in adults with profound mental retardation. Specifically, we hypothesized that vestibular stimulation would produce both short- and long-term decreases in stereotypic behavior in the subjects. Body rocking was observed under three conditions: (a) during the baseline (placebo-treatment) phase, (b) immediately after treatment with vestibular stimulation, and (c) in the follow-up phase.

**Method**

**Subjects**

Subjects for the study were recruited from a state-supported residential facility located in western New York State. Persons with body-rocking behavior were referred to me by therapists at the facility. Another therapist and I screened the referred persons for the presence and frequency of body-rocking behaviors. The screening was done according to the operational definition of body-rocking behavior (see the Variables section, below).

Final selection of subjects was based on availability of consent from parents or guardians, the subject's cooperation, and the subject's ability to tolerate vestibular stimulation, which was determined through observation conducted before the study. For example, if the subjects resisted sitting on the swing board, appeared fearful, or made an effort to resist or stop the swinging motion by using their feet, they were not included in the study.

Three adults with profound mental retardation who exhibited stereotyped body-rocking behaviors and responded positively to trial vestibular stimulation were chosen for the study. All three subjects resided at the state facility. Subject 1 was a 44-year-old ambulatory man who was congenitally blind and had been institutionalized at the age of 3 years 6 months. He could communicate verbally and had functional hearing. He was born prematurely and had a history of delayed milestones. He exhibited behavioral problems in addition to body rocking, such as picking and pulling his nails and tearing and shredding his clothes. He loved music and liked sitting in a rocking chair. The results of the Slosson Intelligence Test (Slosson, 1985) revealed a mental age of 1 year 3 months and an IQ of less than 20.

Subject 2 was a 47-year-old ambulatory woman (she used leg braces for ambulation) who had been institutionalized at age 3 years. She had a history of delayed developmental milestones. She was nonverbal and had residual, usable vision and hearing. She presented with spastic quadriplegia and facial-oral tardive dyskinesia. Like Subject 1, she loved to sit in a rocking chair. In addition to stereotypic rocking behavior, she exhibited grunting behavior and became easily agitated. When agitated, she would hit her neck with her fists. The Slosson Intelligence Test revealed a mental age of 9 months and an IQ of less than 20.

Subject 3 was a 35-year-old nonambulatory woman with a childhood history of seizures. She was institutionalized at age 3 years. She was nonverbal, had nondysfunctional hearing and vision, and had spastic quadripareis, with mild to moderate flexion contractures of the upper and lower limbs. She displayed kyphoscoliosis, involving rotary scoliosis of the lumbar spine with convexity to the left. She persistently tapped the fingers of her right hand on any surface with which the hand came in contact. The Slosson Intelligence Test revealed a mental age of 6.5 months and an IQ of less than 20.

All three subjects were seizure-free at the time of the study, were not on any psychotropic medications, and were not resistive to vestibular stimulation.

**Equipment**

An indoor Deluxe Vestibulator II® swing frame made by Tumble Forms® was used to provide the vestibular stimulation. A Platform Swing made by Southpaw Enterprises® was used for the two ambulatory subjects. A Southpaw® Therapy Net (hammock) with a Therapy Form® L-shaped feeder seat (with an H belt for torso positioning and a hip positioning strap and an integral leg abductor) made by Preston was used for the nonambulatory subject. The height of the swing was kept constant at 1.71 m for the two ambulatory subjects. The Therapy Net with seat was suspended at a constant height of 1.60 m for Subject 2. A Therapy Mat 6.35 cm thick was placed under the swing (and Therapy Net with seat) for the subjects' safety.

The Platform Swing was suspended from the indoor Deluxe Vestibulator II® frame at a single suspension point. The two ends of the Therapy Net were suspended from a common point (same as the Platform Swing). The midportion of the Therapy Net was suspended by a Therapy Rope and Eye Splice attachment (which aided in maintaining a constant back angle at approximately 120°).

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1Available from Preston, PO Box 89, Jackson, MI 49204.
2Southpaw Enterprises, Inc., 800 West Third Street, Dayton, OH 45407, 800-228-1698
to another point of suspension of the indoor vestibulator frame with an additional Safety Snap. A Height Adjustor was attached to the end of the Therapy Rope and Eye Splice and to the Therapy Net with a Safety Snap. The distance over which the Therapy Rope passed through the Height Adjustor was marked with a red pen, so that it could be kept constant. The two ends of the therapy net were then separated by a wooden spreader bar, which assisted in transferring the subject in and out of the Therapy Net with ease. The Therapy Rope and Eye Splice, Height Adjustor, Therapy Net, wooden spreader bar, and Safety Snap were made by Southpaw Enterprises® (see Figure 1).

Design
A single-system multiple baseline design across three subjects was used (Bondadonna, 1981; Ottenbacher, 1986; Storey et al., 1984). The design involved three phases: baseline, intervention, and follow-up. The introduction of the independent variable (vestibular stimulation) was staggered across the subjects. All phases of the study were scheduled consecutively for each subsequent subject in a series (see Figure 2).

Variables
Linear vestibular stimulation was defined as the independent variable. Linear vestibular stimulation involved seating the subject in the platform apparatus and passively swinging him or her in one direction at a slow, constant rhythm. The swinging motion occurred within an arc of 3.05 m. The complete pendulum motion (one complete swing) lasted approximately 3 sec. The direction of the swinging motion was always from right to left right.

Figure 2. Frequency of body-rocking behaviors in baseline, treatment, and follow-up phases for Subjects 1, 2, and 3. Treatment phase includes only the posttest treatment data points. Introduction of treatment intervention phase in staggered fashion is also shown.
The individual treatment session lasted for 10 min for all three subjects in the study.

Body-rocking behavior, the dependent variable, was operationally defined as a repetitious, rhythmical, and sustained to-and-fro swaying movement of the upper torso in the sitting position (Hollis, 1978). The intervening factors, such as routine medications, nursing and other treatment plans, and daily interaction of the subjects with other staff members could not be controlled. These intervening variables were monitored to track any changes. No changes in routine medications, nursing care, or other treatment programs were observed during the study period.

Data Collection

The 3 subjects were observed and treated in the same experimental setting, which was a conventional occupational and physical therapy treatment area. One to two persons recording data were present in the room at all times. The frequency of body-rocking behaviors was recorded with an interval time sampling recording procedure. The observer and I recorded simultaneously for the occurrence or nonoccurrence of the targeted stereotypic body-rocking behaviors during each interval. The frequency of body-rocking behaviors was observed over a period of 5 min, divided into 15-sec intervals. The behavior was observed during each recording interval as cued by a musical note on a tape recorder. The audio cassette, which helped to note intervals for the time sampling procedure, produced a musical tone every 15 sec, for a duration of 2 sec, for a period of 5 min. The tape recorder was turned on upon initiation of the 5-min interval and turned off upon cessation of the 5-min interval. The tape recorder served as a timer for both myself and the observer and helped to keep track of the interval time sample.

To collect data for interrater reliability, two observers were given a training session regarding recording data for the dependent variable. I explained to them the operational definition of body-rocking behavior, and they observed body-rocking behavior on persons who were not study subjects. During the reliability trials, the occurrence or nonoccurrence of the targeted behavior was independently noted on data collection forms by both myself and the observer.

Interrater reliability was computed with the formula for the percentage of interobserver agreement (Brocklehurst-Woods, 1990; Ottenbacher, 1986; Storey et al., 1984) Interrater reliability was collected for 45% of the sessions for all three subjects in the study.

Procedure

Before the study, the subjects received three preintervention sessions to familiarize them with the equipment and the experimenter. During each of these sessions the subjects were brought to the experimental area. They were given individual attention and were informed through either words or gestures that they would sit in the swing. In the first preintervention session, they were seated for 3 min. Because they did not show any resistance to or fear of the vestibular stimulation in the first session, they were seated for 5 min in the second session and 10 min in the third session.

Baseline. A baseline measure for body-rocking behavior was taken for each subject. The baseline for all three subjects started on the same day. The subjects were seated on a mat table (or in a wheelchair for the nonambulatory subject) for the collection of baseline data. Before this collection of data, the subjects were involved for 10 min in a placebo treatment, in which a timer was used. During this placebo treatment period, the subjects were given individualized attention and were involved in conversation. This conversation was verbal with Subject 1, who had verbal ability, and was done with gestures for Subjects 2 and 3. After the placebo treatment, body-rocking baseline data were collected for a 5-min period with 15-sec intervals, as described previously. In the first 2 weeks, 10 data points were collected for all three subjects. Baseline data were collected for Subject 1 for 2 weeks, for Subject 2 for 3 weeks, and for Subject 3 for 4 weeks. From the third week, baseline data for Subjects 2 and 3 were collected once a day for 3 consecutive days each week with the same time schedule. Baseline data in the first and second weeks were collected by two independent raters. In the third and the fourth week, 1 alone collected the data.

Intervention. Treatment was introduced in a staggered fashion for each subject (see Figure 2). Intervention occurred on 3 consecutive days during each week of the treatment phase. Treatment was administered to each subject at the same time each day (before lunch) and was implemented by the experimenter. Before the treatment sessions, pretreatment data on body rocking was recorded with procedures similar to those used in the baseline phase.

The subjects were treated with linear vestibular stimulation through rhythmic, slow, swinging motion sideways for 10 min during each treatment session. The treatment was administered as previously described. During the treatment intervention phase, the subject was observed for any side effects, such as nausea, vomiting, or drowsiness. However, no such side effects occurred.

Immediately after intervention, posttreatment data on body rocking was recorded for 5 min with procedures similar to those used in the baseline phase. The pretreatment and posttreatment data were collected only by myself on a pretreatment-posttreatment data collection form. I noted the occurrence or nonoccurrence of the targeted body-rocking behavior with the use of an interval time sample procedure similar to that used in the baseline phase.
Table 1
Subjects' Average Response Levels of the Frequency of Body-Rocking Behavior

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline Phase</th>
<th>Treatment Phase</th>
<th>Follow-up Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretreatment</td>
<td>Posttreatment</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>20.00</td>
<td>19.72</td>
<td>17.44</td>
</tr>
<tr>
<td>2</td>
<td>16.00</td>
<td>15.45</td>
<td>8.00</td>
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<tr>
<td>3</td>
<td>11.40</td>
<td>14.50</td>
<td>10.41</td>
</tr>
</tbody>
</table>

Follow-up. The ninth week was the follow-up phase for all three subjects in the study. During this phase, an observer and I collected data once a day for 5 consecutive days. This data was collected at the same time and in the same manner as previously described for the baseline phase.

Results
An average of 97% agreement was obtained for the interrater reliability for all three subjects. The percentage of agreement method has been criticized for not controlling chance agreement among raters when recording high-or-low occurring behavior (Ottenbacher, 1986). The stereotypic behavior occurred at a variable rate that was not considered high or low, and no correction for chance agreement was considered necessary.

During the intervention phase, the averages of the pretreatment scores for body-rocking behaviors for all three subjects were compared with the averages of the posttreatment scores. Subject 2 showed the best response, followed by Subject 3. Subject 1 showed the least change in the average response across the pretreatment and posttreatment phases (see Table 1).

Visual inspection was used to interpret the graphic data for each of the three subjects across all design phases (see Figure 2). The celeration line approach was used to compute the trend lines as an adjunct to visual inspection (Brocklehurst-Woods, 1990; Ottenbacher, 1986).

The celeration line establishes a pattern of performance during the baseline (no-treatment) phase in which half the data points fall above the celeration line and half fall below the line. If the pattern of performance remains unchanged during the treatment phase, then the same proportion of data points should fall above and below the line. Inspection of the data for Subject 2 (see Figure 2) reveals that substantially more data points fall below the line than above the line in the treatment phase.

For subject 3 (see Figure 2), the opposite pattern of performance occurred during the treatment phase. The celeration line was not computed for data from Subject 1, because the response pattern during the baseline phase resulted in a flat line. This response pattern represents a ceiling effect, and computing the celeration line would not have assisted in the interpretation of this graph (see Figure 2).

Visual analysis of the graph for Subject 1 implies that during the intervention phase treatment appeared to have a minimal effect. Visual inspection also reveals that there was no change in performance during the follow-up phase for Subject 1.

Discussion
Subject 2 demonstrated a positive response to the linear vestibular stimulation, as reflected in the decreasing frequency of body-rocking behavior across the baseline and intervention phases of the design (see Figure 2). The graphed data indicated a moderate follow-up effect. However, the variability in the follow-up phase for Subject 2 made the pattern of responses difficult to interpret.

The graphed results for Subjects 1 and 3 did not indicate any clinically significant decrease in body-rocking behavior throughout the 9-week period of the study (see Figure 2). Subject 1 displayed a very high rate of body-rocking behavior during the baseline phase. His body rocking was continuous throughout the baseline period. During the intervention phase, some decrease in body-rocking behavior was noted toward the end of the treatment phase. However, the decrease was not consistent enough to clearly suggest a treatment effect. The duration and frequency of body-rocking behavior in Subject 1 indicated that the behavior was extremely persistent. One might argue that for such persistent and frequent behavior, the effect of the intervention was not immediate, but that after approximately 8 to 10 treatment sessions, the intervention was beginning to produce an effect. The treatment phase ended before sufficient data were collected to determine the ability of the intervention to maintain a treatment effect. As soon as the treatment was removed, that is, in the follow-up phase, the body-rocking behavior increased dramatically.

Subject 3 demonstrated a variable and inconsistent response during all three phases of the study (see Figure 2). During the intervention phase, the graphed data suggest a minimal treatment effect. The effect does not appear to be statistically or clinically significant.

During the treatment phase, all of the subjects were calm and relaxed, smiled, and vocalized as if they were happy. This finding is consistent with Bonadonna's (1981) suggestion that vestibular stimulation provides a calming, relaxing, and inhibitory action.

Study Limitations
A quiet environment could not be maintained because of factors such as the telephone ringing, the presence of other clients in the treatment area, and people moving in and out of the room. These factors could not be eliminat-
ed because of space limitations and the need for assistance in transferring subjects. Nevertheless, these extraneous factors remained constant across all phases for all subjects and are part of the clinical environment. Two subjects were treated once in the afternoon (after lunch) because they had to attend routine medical checkups. This change in routine did not appear to affect performance.

The musical tone of the audio cassette (used to note intervals for time sampling procedures) may have contributed to body-rocking behavior in Subject 1, who loved music. Additionally, for Subject 3, a slightly different piece of equipment (a hammock with seat) was used to provide stimulation. This may have contributed to the variability in the response pattern displayed by Subject 3.

Implications

A longer study period might have produced clearer evidence of a treatment effect, particularly in the graph for Subject 1 (see Figure 2). Most of the previously reviewed effectiveness studies were conducted with children or subjects younger than 35 years of age (Bonadonna, 1981; Bright et al., 1981; Brocklehurst-Woods, 1990; Storey et al., 1984). In contrast, this study included subjects 35 years of age or older. Subjects involved in this study also had more years of ingrained stereotyped body-rocking behaviors and hence may need a more intense or longer period of vestibular stimulation to produce positive results.

It may be important in future studies to develop a mechanism to quantify frequency of body rocking and to control this variable in subject selection. This control would be achieved by including subjects with similar rates or intensity of body-rocking behavior.

The possibility exists that vestibular stimulation is an effective means of treatment to decrease body-rocking behaviors over an extended period of time (i.e., several months). Further, research on adults older than 35 years of age with severe and profound mental retardation is needed to empirically document the effectiveness of clinically applied vestibular stimulation as a form of therapeutic intervention for reduction of stereotypic body-rocking behavior in this population. ▲

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References


