Effects of a Vestibular Stimulation Program on Stereotyped Rocking Behavior

(mentally retarded, stereotypic behavior, sensory stimulation)

Penny Bonadonna

This study measures the effect of a vestibular stimulation program on the stereotypic rocking behavior of three severely mentally retarded persons within both experimental and natural settings. A multiple baseline design was used. Frequency and duration of stereotypic rocking behavior were measured by a partial-interval time sample. Results indicated a statistically significant reduction of both frequency and duration of rocking behavior directly after receiving vestibular stimulation and 1 hour after stimulation. The rocking behavior remained reduced after 6 days without the vestibular stimulation program. It was concluded that vestibular stimulation resulted in a reduction of the stereotypic rocking behavior of these subjects.

Penny Bonadonna, OTR, is an occupational therapist for Title I, Chicago Regional Program, Chicago, Illinois.
The implementation of Public Law 94-142 (1), which ensures the right to a free and appropriate public education to all handicapped children, has resulted in increased therapeutic and educational services for the severely/profoundly handicapped, aged 3 to 21. Professionals and the families of severely/profoundly handicapped have been challenged to find the most efficient yet effective strategies for assisting these children in learning. Inappropriate behaviors, which occur at a high frequency, and multiple handicaps are some of the obstacles educators encounter when planning an educational program for these students.

Stereotypic behaviors have been identified as interfering with the student's abilities to respond to their environment (2, 3). Risley (2) and Koegel and Covert (3) reported an increased ability to learn a task, corresponding with a decrease in stereotypic behaviors of autistic children. The presence of stereotypic behaviors has reduced the severely/profoundly handicapped student's potential for living and learning in a "least-restrictive environment" (4, 5). Reduction of stereotypic behavior may improve the quality of life and result in greater benefits from educational programs.

Rocking behavior is one of the most prevalent forms of stereotypy (6). Baumister and Forehand (7) and Hollis (8) noted that severely/profoundly handicapped children's general awareness changed upon engaging in stereotypic rocking behavior. Internal and environmental factors have been identified as possible causes for the behavior. These factors can be grouped into two basic causes:

1. Rocking provides an increased level of stimulation for individuals unable to perceive or process a sufficient amount of the environmental stimuli (9-11).

2. Rocking provides a general inhibitory or relaxing effect on the individual, thereby decreasing frustration, anxiety, tension, and/or blocking out an over-stimulating environment (7, 11, 12). Rocking may occur in the same individual as a result of either or both of these causes. Essentially, it is believed that stereotypic behavior occurs as a means of regulating and maintaining an optimum level of arousal.

Researchers methods of reducing stereotypic rocking behavior concentrate on behavior modification. Three problems identified in the use of behavior modification strategies were maintenance, generalization of the reduced rocking behavior, and a simultaneous increase in other stereotypic behaviors (11, 13). Furthermore, strategies used in the reduction of stereotypic rocking behavior have been based on learning theories, although the possible cause of stereotypic rocking is based on changes in arousal level.

Stereotypic rocking behavior provides proprioceptive and vestibular stimulation that affects arousal level (14-16) through the neurological relationship of the vestibular system to other parts of the central nervous system (17, 18), specifically the reticular activating system (RAS). The composition of the RAS is largely the reticular formation, an integrating substance composing the matter of the brain stem, which mediates stimulation from the sensory neurons within the brain stem by inhibiting or facilitating the stimulation through its neural pathways (17, 19). Thus, the reticular formation responds as a homeostatic mechanism to environmental stimulation, allowing a focus of attention. The inhibition and facilitation within the reticular formation allows for various levels of arousal or consciousness (19).

The vestibular system, which also produces an effect on the arousal level, is anatomically connected with the reticular formation since the vestibular nucleus is located within the reticular formation of the brain stem. Vestibular stimulation, received by the vestibular apparatus in the inner ear, is transmitted via the vestibulo-cochlear nerve to the vestibular nucleus within the reticular formation of the brain stem. The vestibular apparatus responds to changes in equilibrium, which are composed of angular or rotary movements, through the sensory endings within the semicircular canals, and utricle. Both of these sensory endings respond to the beginning and ending of movement, that is, continuation of movement in the same plane of direction at the same speed no longer causes vestibular stimulation.

Repeated vestibular stimulation has been found to produce an effect on the arousal level of infants (16, 20). Changes resulting from vestibular programs have generalized across time to other situations in premature infants (21) and the developmentally delayed (22). Subjective observation of severely/profoundly mentally retarded persons receiving a vestibular stimulation program indicated a decrease in stereotypic behavior (23). These results indicate the possibility of a lasting effect on the arousal level of the neurologically immature and developmentally disabled after a vestibular stimulation program.

Vestibular stimulation, in addition to the arousal level, effects changes in muscle tone, equilibrium, the autonomic nervous system, and the vestibular-ocular reflex or nystagmus (14, 16, 17, 23). Infants, the developmentally delayed and
neurologically impaired young persons receiving vestibular stimulation programs have shown adaptive changes as improvements in motor development and arousal levels generalized to other situations (15, 21, 22). These results, coupled with data about the vestibular system’s effect on the arousal level, could indicate that a vestibular stimulation program would affect a severely/profoundly mentally retarded person’s stereotypic rocking behavior.

This study employed a multiple baseline design to test the following hypotheses: that severely retarded persons engaging in a vestibular program will show a reduction in their stereotypic rocking behavior, and that the changes in stereotypic rocking behavior will be generalized to either 1, 2, and/or 3 hours after receiving vestibular stimulation.

Method

Subjects. Four severely mentally retarded persons exhibiting a frequency of greater than three body-rocking behaviors in 10 minutes of free play were selected as subjects. The subjects were enrolled in a private school for severely/profoundly handicapped in Chicago. One subject was subsequently excluded from the study because of a lengthy absence from school. The remaining subjects were a 13-year-old male, a 14-year-old female, and a 22-year-old female. Diagnoses consisted of Down’s syndrome, psychomotor retardation, and severe mental retardation. All three subjects had been classified as severely mentally retarded and were seizure free.

Setting. The study was conducted at the subjects’ school, using two situations for data measurement: the experimental setting, and a natural setting (whatever situation or setting the subject was in when being observed).

The experimental setting was a room approximately 10 x 12 feet (3.65 meters) containing a large inflatable ball, 4-point free-standing hammock, rocker board, pinball machine, wall shelf with various toys on it, and two chairs. One to two persons recording data were present in the room at all times.

The subjects were observed in their natural setting three times daily. It was not possible to control the activities that occurred within the natural settings, other than to maintain a consistent time to record data for each subject. The natural settings consisted of the subjects’ classroom, a large room with various toys used in free play, and the school’s adjoining private park. The frequency of each of these situations varied with the daily class schedule.

Procedure. Prior to the study, the subjects received two preintervention phase sessions that allowed them to become familiar with the equipment. They were provided 30 seconds of vestibular stimulation in each plane of movement used in the program. During this time automatic nervous system responses were observed and recorded to test for possible adverse effects. None of the subjects demonstrated adverse responses at any point of the experiment.

A multiple baseline design across subjects, recommended for research of the severely handicapped, was used (5, 24). This design includes three phases: baseline, intervention, and post-intervention. All the subjects begin the baseline phase at the same time.

During the baseline phase, the frequency and duration of stereotypic rocking behavior was recorded within the experimental setting after the subject had received 20 minutes of attention. The attention consisted of sitting next to the subject and making social comments of “Hello, how are you?” while giving eye contact. This occurred in the natural setting. The recording of stereotypic rocking behavior was repeated 1, 2, and 3 hours later within the natural setting.

After 3 days, Subject 1 began the intervention phase, which consisted of receiving the vestibular stimulation program and recording stereotypic behavior directly after stimulation in the experimental setting as well as 1, 2, and 3 hours later in the natural settings. When the subject’s intervention data showed a 30 percent change from the baseline data, the next subject began the intervention phase. Therefore, each subject was in the baseline phase for different lengths of time that varied from 3 to 9 days. This staggering of initiating the intervention phase allowed the subjects to act as their own controls and indicated that the change in data is a result of the intervention phase factors. After 15 days of the intervention phase, the subjects did not receive any contact for the next 6 days. This 6-day break was followed by the post-intervention phase, which consisted of a 3-day repetition of the baseline phase.

The vestibular stimulation program provided 1 minute of rocking in a linear direction in each of the following positions:

1. Prone on a large inflatable ball, movement was provided in anterior-posterior, lateral, and up and down directions.
2. Supine on a large inflatable ball, movement was provided in anterior—posterior, lateral, and up and down direction.
3. Seated on a rocker board, movement was provided in anterior-posterior, and lateral movement.
Figure 1 The duration of stereotypic rocking behavior at the 1 hour after vestibular stimulation setting for all three subjects.

**KEY**

- B = baseline phase
- I = intervention phase
- P-I = post-intervention phase
The latter movement also seemed to provide some vestibular stimulation in an up and down direction, depending on how the subject's body adapted to the movement.

4. Seated in a 4-point free-standing hammock, movement was provided in a lateral direction.

The vestibular stimulation was provided at a rate of 40 rocking movements per minute. The rate was regulated by a metronome placed in a clear, soundproofed box. By watching the metronome the investigator was able to provide a consistent rate of vestibular stimulation for all the subjects without providing rhythmical auditory stimulation.

The vestibular stimulation was provided for 1 minute in each direction with approximately a 1-minute pause between different directions. The program was given daily during the 5-day school week for a total of 15 sessions. Directly after stimulation, the subject was brought to the middle of the room and allowed to interact with any of the objects present, and for 10 minutes the frequency and duration of stereotypic rocking behavior were recorded.

Data were recorded by using 30-second partial interval time samples, which are frequently used for recording frequency and duration of severely/profoundly handicapped behaviors (25). The first 30 seconds of a given minute were spent in observing the student's behavior and timing the duration of rocking behavior with a stop watch. The second 30 seconds of that given minute were spent recording whether stereotypic rocking behavior occurred during the observation interval and total duration of rocking behavior for that interval. Every 30 seconds, "beeps" on a tape recorder noted whether it was an observation or recording interval.

Frequency of rocking behavior was defined as the occurrence of stereotypic rocking behavior during an observation interval. Duration was defined as the total time engaged in stereotypic rocking behavior within the observation interval. The stopwatch was started upon the initiation of rocking behavior and stopped upon cessation of rocking behavior. It was started again upon recollection of stereotypic rocking behavior for that observation interval. The stopwatch was set at zero again at the beginning of each observation interval. In addition, other stereotypic behaviors were also recorded in the same manner as frequency of stereotypic rocking behaviors.

A second independent recorder was used two to three times a week to increase the reliability of observations. The recorders spent a 2-day training period in recording data before the beginning of the study. The inter-rater reliability, found with a nonparametric Kendall test, was 97 percent.

Results
Hypothesis 1: that subjects receiving a vestibular stimulation program will show a reduction in stereotypic rocking behavior.

All three subjects showed reductions varying from 9 percent to 96 percent in frequency and duration of stereotypic rocking behavior. Every situation showed decreases in rocking behavior for each subject during the intervention phase. Fig-

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Mean Frequency and Duration of Stereotypic Rocking Behavior in the Experimental and Naturalistic Settings (N = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental Setting</td>
</tr>
<tr>
<td></td>
<td>freq</td>
</tr>
<tr>
<td>Baseline Phase</td>
<td>7.9</td>
</tr>
<tr>
<td>Intervention Phase</td>
<td>5.6†</td>
</tr>
<tr>
<td>Post-intervention Phase</td>
<td>5.5‡</td>
</tr>
</tbody>
</table>

* = abbreviations: freq = frequency; dur = duration
† = significant difference at p ≤ .05 from baseline phase
‡ = significant difference at p ≤ .05 from baseline and intervention phases
1 AVS = 1 hour after vestibular stimulation
2 AVS = 2 hours after vestibular stimulation
3 AVS = 3 hours after vestibular stimulation
Figure 1, a series of graphs representing the percentage of change in behavior, shows these results. The decrease in stereotypic rocking behavior after receiving vestibular stimulation program was found to be statistically significant at the $p \leq .05$ level for both frequency and duration in the experimental setting and 1 hour after vestibular stimulation settings (see Table 1).

Hypothesis 2: that the reduced rocking behavior would generalize to 1, or 2, and/or 3 hours after stimulation.

Table 1 shows statistically significant reductions ($p \leq .05$) in stereotypic rocking behavior 1 hour after receiving the vestibular stimulation program. Results from the natural settings of 2 and 3 hours after vestibular stimulation show decreases in frequency and duration of stereotypic rocking behavior, but these were not found to be statistically significant. In the natural setting, the activity in which the subject was engaged did not seem to affect the frequency of stereotypic rocking behavior as the occurrence of rocking behavior was approximately equal to the occurrence of the activity.

The reduction of rocking behavior remained statistically significant during the post-intervention phase for the experimental setting and 1 hour after vestibular stimulation setting (see Table 1). This implies that the decreased rocking behavior remained decreased after 6 days without the vestibular stimulation program. Two hours after vestibular stimulation, the frequency and duration of stereotypic rocking behavior were significantly less than during the baseline or intervention phase. Duncan’s Multiple Range Test was used to determine statistical significance (26).

Other stereotypic behaviors showed both increases and decreases in frequency during the intervention phase; however, no specific pattern per subject or specific behavior could be found. The frequencies of other stereotypic behaviors returned to the baseline frequency during the post-intervention phase.

Subjective results from the families and teachers of the subjects indicated a concurrent increase in social and exploratory behavior. There was a reported increase in eye contact and variety of methods of spontaneous manipulation of objects.

Discussion

A significant reduction in stereotypic rocking behavior occurred after three subjects participated in a vestibular stimulation program. Since, as previously discussed, the behavior may occur as a mechanism for attaining optimum arousal, it is speculated that the program produced a sufficient change in the subjects’ level of arousal so as to reduce the need for engaging in stereotypic rocking behavior. That the behavior was significantly reduced 1 hour after completing the program indicates that the effect of vestibular stimulation lasted up to 1 hour. The decreases noted in the frequency and duration of the behavior 2 and 3 hours after the program were not statistically significant. In addition, the reduced stereotypic behavior remained reduced during the post-intervention phase, which was 6 days after the program ended. These results indicate that the effect of vestibular stimulation generalized across time and space. Speculated reason for this response is: repeated stimulation to the vestibular system produces adaptive responses, which in time may have an effect on the stereotypic rocking behavior until sufficient stimulation occurs again to change the arousal level.

The change in frequency of other stereotypic behaviors indicates that either vestibular stimulation or the change in rocking behavior temporarily produces a decrease in some behaviors, and an increase in others. Subjective results of increasing social and exploratory behaviors may be due to the vestibular stimulation program as well as to the effect of the teachers’ awareness that their students were in an experiment.

Recommendations

Therapists using vestibular stimulation with the severely mentally retarded should observe the possible effects on stereotypic rocking behavior. In addition, therapists should generally be concerned with and involved in the behavior management of this population. Possibly therapists can help the severely mentally retarded learn by reducing their stereotypic rocking behavior. Moreover, observation is needed to determine the effects of vestibular stimulation on other stereotypic behavior. The significant results of this study achieved in a rather short time indicate that occupational therapists as change agents need to support and promote intensive treatment programs for this population.

Further investigation with a larger sample size could assist in validating the results of this study and indicate the feasibility of generalizing the effect of vestibular stimulation to the population of the mentally retarded. The long-term effect of using vestibular stimulation as a method to reduce stereotypic behavior also needs to be investigated: for example, manipulating the rate of vestibular stimula-
tion might further change its effect on stereotypic rocking behavior.

Research reported on the use of vestibular stimulation programs with the severely/profoundly handicapped has been limited. Therefore, it is strongly recommended that only therapists familiar with the effects of vestibular stimulation use this method of intervention.

Summary
This study measured the effects of a vestibular stimulation program on the stereotypic rocking behavior of three severely mentally retarded persons. Frequency and duration of rocking behavior were measured directly after the subjects received the vestibular stimulation program and within natural settings at 1, 2, and 3 hours after intervention. The design used was a multiple baseline design consisting of baseline, intervention, and post-intervention phases. Subjects received 20 minutes of a vestibular stimulation program 5 days a week for 15 days. Data from the intervention phase, baseline phase, and post-intervention phase were compared with one another. Significant reductions in frequency and duration of stereotypic rocking behavior were found during the experimental setting and 1 hour after vestibular stimulation. The vestibular stimulation program had a decreasing effect on stereotypic rocking behavior of the severely mentally retarded seen in this study. Recommendations were made for further investigation of the use of a vestibular stimulation as a treatment method for reducing vestibular stimulation and of the generalizing and/or latency effects of vestibular stimulation.

Acknowledgments
Sincere appreciation is extended to the staff, families, and students of New Horizon Center for the Developmentally Disabled, Chicago, Illinois, for their assistance and support. This study was supported by a grant awarded by the American Occupational Therapy Foundation. Research was conducted as partial fulfillment of the requirements for an Advanced Master's Degree in Pediatric Occupational Therapy at Virginia Commonwealth University.

REFERENCES
8. Hollis JH: Analysis of rocking behavior: In Monograph of the American Association of Mental Deficiency, No. 3. Laurence, Kansas: University of Kansas and Bureau of Child Research Laboratories at Parsons State Hospital, 1976

The American Journal of Occupational Therapy