Visually Monitored Postrotary Nystagmus in Seven Autistic Children

(vestibular system, sensory integration, autism)

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Therapists who evaluate the sensorimotor functions of autistic children have become increasingly interested in monitoring their responses to vestibular stimulation. In this study, the duration of the nystagmus reflex is visually monitored and then measured by means of a stop-watch. Each of 7 autistic subjects received 18 sessions (36 trials) of horizontal semicircular canal stimulation during a period of 25 days. In each trial a graduated acceleration in a hand-operated rotating chair preceded an abrupt stop, with a rapid deceleration from 180°/second to 0°/second. Although subject option (intentional response) imposes limitations on the data interpretation, inspection of the nystagmus functions over time suggests the following: substantial trial-to-trial variability; substantial subject-to-subject variability; greater scores following trials to the subjects' left (the direction of the second trial in each session) than to the right (the direction of the first); and no evidence of consistent change for most subjects in nystagmus duration across the 36 trials. Implications for clinical evaluation of nystagmus are discussed.

Several researchers and clinicians in the field of autism have suggested that disordered sensorimotor and perceptual processes are typical of this developmental disorder (1-5). Recently Ornitz (6) suggested the possibility that a central disorder of the vestibular system could explain much of the sensorimotor dysfunction present in autistic children. In part, Ornitz based his hypothesis on studies of the nystagmus response in autistic and schizophrenic children, several of which suggest that their responses differ significantly from normal controls (7-11). Thus, therapists trying to evaluate and improve the sensorimotor and perceptual functions of autistic children have become increasingly interested in their response to vestibular stimulation (12, 13).

Vestibular nystagmus is a pattern of eye movements elicited by stimulation of the semicircular canals. When the stimulation is the result of accelerating or decelerating rotation about the vertical axis with the head approximately in a position of...
30° flexion, the horizontal semicircular canals receive stimulation and the eyeballs tend to move in a rapid side-to-side fashion. Bhatara, Clark, and Arnold (14) presented an excellent review of the mechanics of the vestibular-ocular reflex.

This study investigates postrotary nystagmus in 7 autistic children during an 18-session course of vestibular stimulation. In this study the duration of nystagmus is visually monitored by a trained observer. Although more sophisticated methods involving electronystagmography currently exist, the clinician and the clinical researcher seldom have access to such technology. The clinician and clinical researcher need to know more about visual monitoring of nystagmus, which is the method customarily used in occupational therapy settings.

Of particular interest to therapists is the question of individual differences within the autistic population. Piggott (15) suggests that the syndrome of autism might be caused by any of several different basic physiological disturbances. He suggests that different subtypes of nystagmus responses among autistic children might reflect different etiological subtypes. It is always important to document the presence of substantial individual differences on an important variable within an identified clinical population; if such differences are ignored, we are in danger of overgeneralizing.

Another critical question is that of day-to-day variability in nystagmus duration for any given subject. By investigating nystagmus for 18 sessions during a 25-day period for each of 7 subjects, this study assesses the stability or variability of nystagmus over time. The clinician who evaluates nystagmus on a pre- and post-therapy basis needs to know how stable that measure is. The clinical researcher who wishes to use nystagmus duration as a dependent measure also needs such information. The only previous study reporting on session-to-session variability of nystagmus in autistic children (11) relied on electronystagmography and depended on only three repeated measures.

**Methods**

**Subjects.** Seven children, participating in the Summer Intensive Program for Autistic Children, Queens, New York, were selected on the following four criteria: past diagnosis of autism by a physician; possession of all five subclusters of the behavioral symptoms of autism as identified by Ornitz and Ritvo (16); parental consent; and age less than 9 years. All subjects accepted a short pre-trial of vestibular stimulation without any problems. Their ages ranged from 5 years-10 months to 8 years-2 months, with a mean age of 6 years-10 months. Their social quotients as measured by the Vine- land Social Maturity Scale (17) ranged from 42 to 82, with a mean of 55.1. Six were boys and one was a girl.

All subjects lived at home with their parents and participated in a 5-hour-a-day summer program designed to meet their individual developmental needs. The only study-related stipulation given to staff working with the seven subjects was to refrain from programming activities designed to provide vestibular stimulation, such as somersaulting, swinging, or playing on vestibular-stimulation equipment. No attempt was made to control for vestibular stimulation received while swimming or during out-of-program hours, and no child was restrained from vestibular self-stimulation.

**Apparatus and Procedure.** A hand-operated rotating chair, fitted with a hoop around its perimeter, provided the subjects with angular deceleratory stimulation to the horizontal semicircular canals. A rotating chair has often been used in the measurement of nystagmus (11, 14). Although norms have been published on the use of a rotating board in measuring nystagmus (12), the chair method was chosen for the study because six of the seven autistic subjects refused to remain immobile on the SCPNT board; the chair provided the necessary structure and security. One of the experimenters, previously trained in the evaluation of postrotary nystagmus, timed and operated the chair. Light in the area was just intense enough to allow the experimenter to observe the child’s eye movements, and the area was bare except for a clock on the wall.

The experimenter timed each 60-second trial of vestibular stimulation as follows:

<table>
<thead>
<tr>
<th>Trial</th>
<th>10 seconds</th>
<th>Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>3</td>
<td>rotation</td>
</tr>
<tr>
<td>2nd</td>
<td>1-4</td>
<td>rotations</td>
</tr>
<tr>
<td>3rd</td>
<td>2</td>
<td>rotations</td>
</tr>
<tr>
<td>4th</td>
<td>3</td>
<td>rotations</td>
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<tr>
<td>5th</td>
<td>4</td>
<td>rotations</td>
</tr>
<tr>
<td>6th</td>
<td>5</td>
<td>rotations</td>
</tr>
</tbody>
</table>

Total: 60 seconds: 16 rotations

With 5 rotations in the last 10 seconds, the maximal velocity was approximately 180°/second.

At the 60-second mark, the experimenter brought the chair to an abrupt stop; therefore, the vestibular stimulation administered in this study is of the deceleratory type, with a rapid deceleration from 180°/second to 0°/second.

It is important to note that data collected in this manner are not directly comparable to data collected...
Figure 1: Nystagmus duration following right (first) and left (second) rotations across 18 sessions (36 trials of vestibular stimulation). Nystagmus duration was not measurable in 24 percent of total trials, and values for these trials are not plotted. Age: age in years; Sex: male (M), female (F); S.A.: Vineland Social Age.

by the Southern California Postrotary Nystagmus Test (12) in which the subject attains maximal velocity immediately.

The purpose for the gradual build-up of acceleration in the study was to separate out any confounding effects on acceleration on the subsequent deceleration; the study aimed to assess the effects of deceleratory stimuli only.

In this study, the average rate of acceleration was $30^{o}$/second$^2$, which is near or below the sensory threshold for humans (19). Without such a gradual build-up, it would be impossible to say whether the observed nystagmus was caused by acceleratory stimuli, deceleratory stimuli, or by some interaction.

The headrest of the rotating chair encouraged positioning of the subject's head in $30^{o}$ flexion, but subjects retained some option for head movement.

Each treatment session consisted of two trials of vestibular stimulation: the first to the subject's right, and the second to the subject's left. The minimum amount of time between spins was 1 minute. Following each abrupt stop, the experimenter, while standing just to the subject's left, visually monitored the subject's eye movements. A stop watch was used to measure nystagmus duration in seconds. The experimenter then recorded the measurements on a prepared form, and also made subjective notes describing the subject's responses to each trial.

Each subject received 18 sessions (36 trials) of vestibular stimulation during a period of 25 days. No sessions took place on weekends. Except for two instances, each subject received only one session of stimulation per day.

Results

Figure 1 presents nystagmus duration data for each of the seven subjects. Nystagmus was not measurable in 24 percent of the trials when subjects exercised their option to close their eyes or move their heads in such a way as to make visual monitoring of nystagmus impossible.

Within that limitation, inspection of the data suggests the following:

1. There is substantial session-to-session variability in nystagmus duration for each subject, which is graphically illustrated by the jaggedness of the lines in Figure 1. Each subject had a score that was at least twice as great as another score, often on successive sessions.

2. There is substantial subject-to-subject variability. For example, all 30 of the scores of Subject 3 and all 23 of the scores of Subject 5 fall below all but one of the 34 scores of Subject 7.

3. Left scores (the direction of the second rotation) are greater than right scores (the direction of the first rotation) in most sessions, especially for Subjects 2 through 6.

4. For most subjects, there is no clear increase or decrease in nystagmus duration as a function of the 36 trials of deceleration. A possible exception is Subject 4, whose nystagmus duration appears to decrease.

In subjective notes made following each trial, the experimenter fre-
Quently documented smiling, laughing, and eye contact on the subject's part in association with vestibular stimulation. Another indication of affective response is that no child refused to sit in the chair for any of the 252 stimulations.

Discussion

Session-to-Session Variability. Colbert and coworkers (8) found that schizophrenic children had greater within-subject trial-to-trial variability of nystagmus duration than normal children. Similarly, Ornitz and coworkers (11) reported that the frequency of the nystagmus beat as a function of time following rotation is significantly more variable in autistic than in normal children. Ornitz suggests this high trial-to-trial variability in the nystagmus reflex is one of many examples of how autistic children are unpredictably inhibited or exaggerated in their motor responses to sensory stimuli.

Alternative explanations for the variability found in this study are that subjects may have occasionally exercised their option to move their heads out of the plane of stimulation.

Subject-to-Subject Variability. Some subject-to-subject variability in nystagmus duration is routinely found in normal individuals; however, Colbert and coworkers (8) found more subject-to-subject variability in schizophrenic children than in normal controls. Furthermore, they found that postrotary nystagmus duration was more likely to be suppressed in schizophrenic children than in normal individuals. Ornitz and coworkers (11) confirmed earlier findings that postrotary nystagmus duration is likely to be suppressed in autistic children as long as the child receives visual input.

Although it remains an open question as to whether or not the responses of the subjects in this study vary more than those of normal children, two findings lend some support to this possibility: the absence of any observable nystagmus whatsoever in some of the subjects' trials; and the wide discrepancies between Subjects 3 and 5 on the one hand, and Subject 7 on the other.

Left-Right Differences. There are at least two possible explanations for the substantial right rotation-left rotation differences found in most of the subjects. Eviatar and Wassertheil (20) found that directional preponderance of nystagmus in one direction or the other was highly correlated with central nervous system dysfunction in children. However, Ornitz and coworkers (11) did not find more directional preponderance in autistic children than in normal controls.

The second possibility is that the right series of rotations (always the first) tended to potentiate the left series (always the second). Perhaps the central nervous system accommodation to the first series peaked before the stimulation provided by the second series. Ayres (12) reports that children with minimal brain dysfunction customarily show an increase in nystagmus duration from the first series of rotations to the second.
Lack of Habituation. With the exception of Subject 4, who may have demonstrated an habituation to vestibular stimulation over the 18 sessions, there is no evidence that the stimulation had a cumulative effect. Perhaps a series of repeated measurements different in degree or kind from that presented in this study would show evidence of nystagmus potentiation or habituation in autistic children.

The subjective data indicating that vestibular stimulation often appeared pleasurable to the subjects is consistent with widespread clinical observations that autistic children often self-administer vestibular stimulation by rocking or whirling. Freeman, Frankel, and Ritvo (21) report experimental evidence that contingent vestibular stimulation has reinforcing properties for autistic children.

Conclusions
High variability from trial to trial, from session to session, and from subject to subject characterizes the nystagmus data presented in this study. Further research is necessary to clarify the precise nature of this variability. Might the variability be the result of measurement error due to subject option? If not, is the variability a function of environmental events (i.e., time of day or prior exposure to vestibular stimulation), or is it a function of periodic changes occurring within the central nervous system? The answers to these questions should explicate the role of nystagmus as an indicator of sensory processing in autistic children.

This study might also have implications for using visually monitored postrotatory nystagmus as part of the clinician's evaluation of an autistic child. Unless the therapist is able to take many repeated measures of nystagmus under controlled conditions, high variability from day to day makes nystagmus duration scores difficult to interpret. One day the autistic child might appear to have no nystagmus, and the next day the same child might present an entirely different picture. Certainly, subject option to tilt the head during stimulation or to make measurement impossible altogether by closing the eyes presents the therapist with additional difficulties. For these reasons, clinicians are cautioned that visually monitored postrotatory nystagmus, particularly if not repeatedly monitored, might be of only limited value in the overall assessment of the sensory processing of an autistic child.

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Note: Parties interested in replicating or advancing this study may write to David Nelson for more detailed information about the rotating chair.

REFERENCES
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