A Task for Assessing Vertigo Elicited by Repetitive Head Movements

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Vertigo is the illusory sense of motion, such as a sensation of spinning or falling. Although momentary vertigo is normal after an intense movement experience, such as a ride on a roller coaster, it is abnormal when elicited by normal head movements or when it occurs without head movement. Vertigo is a defining characteristic of many vestibular disorders (Barber & Sharpe, 1988; Halmagyi, 1996; Rubin & Brookler, 1991).

Since the seminal work by Cawthorne (1944, 1946) and Cooksey (1945, 1946) on exercises to remediate vertigo, other authors have also described similar exercise schemes for treating the vertigo and disequilibrium caused by vestibular disorders. Curiously, neither the Cawthorne and Cooksey papers nor those that followed (Dix, 1984; Hecker, Haug, & Herndon, 1974) described ways to assess vertigo, although physicians routinely question their patients about vertigo (Halmagyi, 1996). The standard diagnostic tests (e.g., caloric testing, harmonic acceleration testing, computerized dynamic posturography) reliably assess motor behaviors that indicate the physiological state of the vestibular system (Black, 1985; Coats, 1986; Jenkins & Goldberg, 1988; Zane, Rauhut, & Jenkins, 1991), and the results can suggest the presence of physiological impairment. These tests do not, however, elicit or assess vertigo or indicate the related functional limitations (Cohen, 1995).

Vertigo assessments in the literature vary. Two recent studies used analog scales to assess vertigo but did not use specific provoking stimuli; instead, they relied on participants’ memories of vertigo (Cohen, Kane-Wineland, Miller, & Hatfield, 1995; Herdman, Clendaniel, Mattox, Holliday, & Niparko, 1995). These scales separate vertigo from other symptoms and are reliable for measuring change within a person. Because they rely on the person’s memory of a sensation that may not have been evoked in the immediate past, however, they may be inaccurate.

Norré (1984) developed the first vertigo assessment described in the literature. In this test, the patient's head was moved through 19 positions to elicit vertigo, and the patient was asked to estimate the intensity and duration of the sensation in each position, using a three-point qualitative scale. The clinician then used a complicated formula to obtain a vertigo score. Although it was a useful first attempt, this assessment was rather cumbersome, and no rationale was given for the complex formula or for so many positions. Additionally, some positions were redundant and probably did not represent realistic stimuli. Moreover, the assessment's validity, reliability, and ability to detect differences from the normal population were never determined.

Smith-Wheelock, Shepard, and Telian (1991) modified Norrë's test. They used 16 positions, expanded the vertigo rating scale to five levels, changed the duration measure to an ordinal scale, and used a different formula for calculating...
the final score. Despite these improvements, the positions of their test were still somewhat redundant and possibly not representative of daily life movement problems, and the formula for the final score was still cumbersome. Therefore, the assessment still provided no more information about vertigo than the simple ordinal rating scale. Horak, Jones-Rycewicz, Black, and Shumway-Cook (1992) reduced Norre’s test to 12 positions, expanded the vertigo rating scale to 11 levels, used duration in seconds, and simplified the computation of the final score. Nonetheless, the scoring procedure remained complicated, and many head positions were used. Furthermore, Norre’s test and its modifications all require some training for administration, so they are best suited for use in specialized clinics where a trained staff is used.

Requirements for an Appropriate Assessment

An assessment that elicits vertigo under more naturalistic conditions and obtains data that differentiate patients from asymptomatic adults would be useful. Patients with vestibular disorders typically report vertigo when they perform tasks that require rapid, repetitive head rotations. Therefore, an assessment should include a task that requires such head movements. Additionally, people usually move their heads through complex trajectories that vary slightly over repetitions, so an assessment should allow for differences in head movement trajectories over trials. Occasionally, some patients who have no nystagmus after Dix-Hallpike maneuvers (Dix & Hallpike, 1952) and no significant weakness on sinusoidal rotatory testing or caloric testing—standard diagnostic tests of the vestibular system—deny having vertigo after they perform simple, repetitive head rotations. These patients do become vertiginous, however, when they are fatigued slightly. Therefore, an assessment of vertigo should include an innocuous procedure to induce fatigue.

Most activities of daily living (ADL) involve head rotations performed through more than one plane in space simultaneously. These kinds of tasks are problematic for patients with vestibular disorders (Cohen, 1992). An appropriate assessment would simulate these types of tasks and involve movements similar to many in daily life (e.g., putting away utensils or groceries in cupboards, emptying a dishwasher). Finally, the current trend in health care is shifting delivery of care to less expensive settings, such as home health care, geriatric day-care centers, and small community-based clinics where space, equipment budgets, and professional staff are limited, which suggests the need for a reliable assessment tool that requires minimal training and minimal equipment.

Development of the Assessment

We developed a vertigo assessment that meets the requirements discussed previously. The movement required was rapid head rotations involving more than one plane in space. Hence, to encourage participants to move quickly, the task is timed.

The requirement of multiplanar head movements demanded some combination of motions in pitch, roll, or yaw—the three cardinal head motions. (Pitch is flexion-extension of the neck; roll is tilting the head so that the ear approaches the shoulder while the nose points straight ahead; and yaw is rotating the head to look left or right [Hain & Hillman, 1994].) To make sure that participants used head rotations, without substituting eye movements with the head relatively stable, the task had to require relatively large displacements in space, and it needed some easily observable motor behavior that would indicate that the participant had actively looked in the desired directions. Therefore, the manipulative task of picking up beanbags and moving them from one basket to the other was chosen for the test, and the baskets were placed relatively far apart. Except for an extraordinarily tall person with long arms, the participant must use observable head rotations through more than one plane in space to find the next basket and make sure that the beanbag is tossed into the basket. Beanbags can be tossed rapidly because fine placement, which would slow down the head movements, is not a requirement. Manipulating the beanbags also has the benefit of distracting patients from the vertigo, which could otherwise cause too much discomfort for them to continue the test.

Beanbags were chosen for several reasons. They can be easily manipulated with a variety of prehension patterns, so varying levels of fine motor skill would not confound the test as long as the participant has functional grasp. They are lightweight and pose no significant load to weak or arthritic hands. They are colorful and easy to see even with the blurred vision during head movement caused by decreased gain of the vestibulo-ocular reflex. They are familiar objects to most persons, so they are not intimidating. They are inexpensive, and they are readily available. Beanbags also pose no physical threat if they are accidentally thrown at the examiner. The test requires no unfamiliar movement components, no unusual technical instructions, and is psychologically nonthreatening for patients. Some of our beanbags have amusing dinosaur print designs to make the test more fun.

We sought to determine whether this vertigo test differentiated asymptomatic adults from patients with peripheral vestibular disorders that cause vertigo. If so, we then sought to determine its test–retest and interrater reliability.

Method

Participants

The sample included 16 participants who were asymptomatic (asymptomatic adults) and 27 patient participants (patients) who had been diagnosed by their otolaryngologists with chronic vestibular disorders (i.e., vertigo of 3 months or longer), excluding benign paroxysmal positional vertigo, Ménière’s disease, and post-surgical vertigo. Asymp-
tomatic adults included 9 men and 7 women who were 18.0 to 59.2 years of age ($M = 31.0 \pm 12.2$ years) and had no history of vestibular disorder, hearing loss, orthopedic limitations, or neurological problems. Patients included 8 men and 19 women who were 25.4 to 84.7 years of age ($M = 52.9 \pm 14.4$ years) and were without significant hearing loss, as determined by audiometric testing; orthopedic limitations; or other neurological problems. Asymptomatic adults were recruited from among the staff members of the department; patients were recruited from the caseload of patients referred to the senior author for vestibular rehabilitation. No participants reported having vertigo in the 5 min preceding the test.

Materials

Materials for the test are inexpensive. They include 25 multicolored beanbags 12 cm $\times$ 12 cm, 2 plastic baskets 21 cm $\times$ 30 cm $\times$ 14 cm, 2 stopwatches, a standard arm chair 45.7 cm high, and one 17.5-cm $\times$ 12.5-cm laminated card with white background and black print in 18-point type showing a 10-point scale of vertigo intensity. The vertigo scale was qualitative, from 1 (no vertigo) to 10 (extreme vertigo with nausea and vomiting).

Procedure

Participants sat in the chair with the basket of beanbags placed 45.7 cm in front of the chair. The investigator stood 15 cm behind the basket with the beanbags, holding the empty basket, the bottom of which was .91 m above the floor (see Figure 1). These distances were chosen because during pilot testing, participants of various heights could all reach these distances easily without falling off the chair.

Participants were instructed to use the dominant hand only, determined by asking which hand was used for writing, to take the beanbags out of the basket on the floor one at a time and place them in the basket held by the investigator, moving as quickly as possible. Head movements were not controlled. To see the baskets, however, the spatial constraints of the task required participants to move their heads with combined yaw and pitch motions.

Before the start of testing, participants were told that the test would be timed and were shown the laminated card with the vertigo rating. Participants were told that the word vertigo means a sense of motion evoked by head movement and that they would be asked to rate themselves on the vertigo scale. The investigator timed the duration of the task with the stopwatch. Within 10 sec of completing the task, participants were shown the card with the vertigo scale and asked to rate the level of vertigo induced by the task. They were told that they could not choose an intermediate number from the scale, such as 3.5, but had to pick an integer. To verify that a participant meant “no vertigo” when reporting Level 1, the investigator asked the participant whether he or she actually meant no vertigo.
To determine interrater reliability on time, a second rater timed the task simultaneously for 13 asymptomatic adults and 3 patients. To determine test–retest reliability on time, the 16 asymptomatic adults repeated the test the next week. Only asymptomatic adults were used because the patients were participants in an ongoing study of vestibular rehabilitation; their status could have changed on a second test date because of the treatment received in that study.

Results
The median level of vertigo elicited by this task in asymptomatic adults was 1 (i.e., no vertigo); a one-sample sign test comparing the pretest level of vertigo in all asymptomatic adults (Level 1) to the vertigo elicited by the task was nonsignificant. A one-sample sign test comparing the pretest level of vertigo in all patients (Level 1) to the vertigo elicited by the task was significant, \( t(41) = 5.91, p < .001 \). The median level of vertigo elicited by this task in patients was 4 (range = 1–9); the mode was 7. As indicated by a \( t \) test, asymptomatic adults performed the test significantly faster than did the patients, \( t(41) = 5.91, p < .0001 \). Asymptomatic adults also had significantly less vertigo than did the patients, as indicated by a Mann–Whitney \( U \) test, \( U = 68.0, p < .001 \) (see Figure 2).

Test–retest reliability was determined with a paired \( t \) test on test duration and a Wilcoxon signed rank test on vertigo intensity. These tests indicated no significant differences between Tests 1 and 2 on either measure (see Figure 3). As determined by a \( t \) test, interrater reliability on test duration did not differ significantly (see Figure 4).

Discussion
This test brings a fundamental concept of occupational therapy into the battery of available assessment tools for vestibular rehabilitation, a treatment area in which occupational therapists have recently begun to practice (Stahl, 1995). Occupational therapists understand that people behave in reference to the physical and psychological environments or that the constraints of the environment shape behavior. This defining principle of occupational therapy differentiates it from other health care professions and is a tie that binds the diverse specialties of the profession. A corollary to this principle, expressed independently by the physiologist–mathematician Bernstein (1967), is that normal movement is goal directed.

Occupational therapists use this concept every time they set up therapeutic occupations for patients, rather than exercises without associated meaning. For any occupation to be appropriate for evaluation or treatment, the task must be designed in such a way that the patient will demonstrate the desired behavior when he or she performs the task successfully. In motor control terms, the environmental constraints of the task determine the requirements of the movement needed. For example, the size and shape of a coffee cup determine the type of grasp and the size of the grasp pattern needed to pick it up. If the hand does not conform to the size and shape of the cup, picking it up will be impossible.

The conditions under which vertigo is experienced by patients with vestibular impairments in daily life determined the movement requirements for the task used in this assessment. The data suggest that this test differentiates asymptomatic adults from patients with peripheral vestibular impairments and has good interrater and test–retest reliability. The significant difference in the time needed to perform the task may reflect unconscious efforts by patients to avoid eliciting vertigo. This finding is consistent with previous work showing that patients with chronic vestibular impairments perform many routine daily life tasks more slowly than they did before developing vertigo (Cohen & Downs, 1996), and it may partially explain why patients

![Figure 2. Asymptomatic adults versus patients. Note. A = mean trial duration (error bars = standard deviations); B = median level of vertigo (error bars = ranges).](image-url)
with vestibular impairments have decreased independence in ADL (Cohen, 1992). Thus, even on a simple task, vertigo affects performance.

The test has some disadvantages. It was normed on patients with peripheral vestibular disorders, so the data do not address the responses of patients with vertigo caused by lesions of the central vestibular pathways. Task performance requires at least weak grasp and release, functional range of motion in the neck and back, a functional level of coordination when performing manipulative tasks, and functional dynamic sitting balance, so it is not appropriate for patients who lack any of these characteristics. The patient population did not include participants who lacked these characteristics. It also requires a certain level of cognitive skill because the participant must be able to use the qualitative scale and must be able to follow the instructions for the test.

The advantages of this test outweigh the disadvantages. The use of a purposeful activity is an advantage over other methods of assessing vertigo. While being tested, many patients focused on the task rather than on the noxious sensation of vertigo; some were competitive and tried to move more quickly than anyone else, which also distracted them from the noxious sensation of vertigo during task performance. Previous studies have also shown the value of using an occupation when unpleasant sensations, such as pain or fatigue, will be elicited by movement (Heck, 1988; Yoder, Nelson, & Smith, 1989).

The materials for this test are easily obtained and cost less than $25, making it affordable for any facility or health care provider. The instructions are simple, so even patients with mild cognitive impairments or borderline mental retardation should be able to perform the task. The motor requirements of the task are also simple, so even patients with mild limitations in cervical or shoulder range of motion should be able to perform the task. The procedures are simple and were easily learned by a high school student, so even nonprofessional staff members with minimal training should be able to administer the test competently after a few minutes of instruction.

This test can be adapted for use in a variety of settings or for patients with unique problems. In the home care setting, where a standard chair and the amount of space described here may not be available, the test can still be administered in a modified form, with the understanding that if the same setup is used on each test session, patients could be compared to their own pretreatment scores as measures of improvement although they might not be appropriately compared to scores reported in this study.

Figure 3. Test-retest reliability. Note. A = mean trial duration (error bars = standard deviations); B = median level of vertigo (error bars = ranges).

Figure 4. Interrater reliability for mean trial duration (error bars = standard deviations). Note. Only data from asymptomatic adults are shown for comparison with Figure 3.
Likewise, in a home care setting, small boxes could be substituted for the baskets and other small, lightweight objects could be substituted for beanbags, with the same understanding that doing so changes the test so that it is not identical with the test described here. When using it in the home or with a frail, elderly patient, the therapist should be careful to use a sturdy chair with arms and to make sure that the patient is fully seated on the chair. The therapist should also be certain that large, rapid head rotations are not contraindicated if the patient has arthritis affecting the cervical vertebrae or has a cardiac condition. The test could be adapted at home or in the clinic for patients with back or neck pain by changing the locations of the baskets, although this change, too, would put the test outside of the parameters defined in this article. This test might be particularly useful in the home care setting as a screening tool with patients who are homebound. It can provide some useful data to discuss with the physician if the therapist is concerned about the possibility of a vestibular disorder, especially in the case of a patient who has had a change in status between infrequent visits to the physician. This assessment is not, however, a diagnostic test.

Summary

This simple test may be a useful addition to an assessment battery for patients with vestibular impairments. The well-known "Foam and Dome" test, also known as the Clinical Test of Sensory Interaction and Balance or CTSIB, is a useful screening tool and therapy assessment for balance problems in elderly persons and patients with vestibular disorders (Cohen, Blatchly, & Gombash, 1993; Shumway-Cook & Horak, 1986). In the same way, this equally inexpensive test may be a valuable screening tool and therapy assessment in settings where nonphysician health care professionals often screen patients before they are referred to physicians for evaluation and where therapists or paraprofessionals supervised by therapists provide rehabilitation services for these patients. ▲

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References


