Relationship of the Southern California Sensory Integration Tests, the Southern California Postrotary Nystagmus Test, and Clinical Observations Accompanying Them to Evaluations in Otolaryngology, Ophthalmology, and Audiology: Two Descriptive Case Studies

(auditory sequential memory, research, sensory integration, testing procedures, vestibular system)

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A preliminary investigation was conducted into the relationship of the Southern California Sensory Integration Tests (SCSIT), the Southern California Postrotary Nystagmus Test (SCPNT), and clinical observations accompanying these tests to evaluations in otolaryngology, ophthalmology, and audiology. The subjects were two children with vestibularly based sensory integrative dysfunction. The results revealed that there was no agreement between the results of the SCPNT and the otolaryngological evaluation. There was some agreement between the ophthalmology evaluation and the clinical observations accompanying the SCSIT. Both subjects scored poorly in two areas of auditory processing. Possible reasons for these results are discussed as well as implications for occupational therapy research and practice.
The Southern California Sensory Integration Tests (SCSIT), the Southern California Postrotary Nystagmus Test (SCPNT), and clinical observations accompanying these tests have been developed by Ayres as a method of evaluating sensory integrative dysfunction in learning-disabled children (1, 2). These diagnostic procedures are derived from Ayres' theory of sensory integration as proposed in her book, *Sensory Integration and Learning Disorders* (3). A few researchers, such as Ottenbacher (4, 5) and DeGangi (6) have attempted to clarify and identify characteristics of sensory integrative dysfunction in children.

Other researchers have begun empirical examinations by correlating the SCSIT to other tests (7). Kimball (8), correlating the SCSIT to the Bender-Gestalt, found that, since the Bender-Gestalt could predict children's performance only for certain components of the SCSIT, the Bender-Gestalt might effectively serve as a screening device for sensory integrative dysfunction if observations of the child's postural mechanisms were included. Some investigators have related the SCSIT, or components of it, to particular disabilities (7). To illustrate, Stilwell and others, studied postrotary nystagmus (measured by a procedure based upon the SCPNT) as a function of communication disorders (9). It was found that hyporeactive nystagmus related to disorders of articulation and language. Other researchers, using the SCSIT as a basis for occupational therapy procedures, compared the relationship between occupational therapy and physical therapy test scores (10). They concluded that each discipline’s evaluation was important.

With regard to the SCSIT, however, there is an apparent lack of cooperative research among disciplines interested in the learning-disabled child. Consequently, it is often difficult to relate characteristics of sensory integrative dysfunction, measured by the SCSIT, the SCPNT, and clinical observations accompanying these tests, to data from other professionals. Moreover, areas for further research may be defined more clearly with an interdisciplinary approach to the evaluation of sensory integrative dysfunction in the learning-disabled child. Therefore, researchers need to investigate the relationship of results of the SCSIT, the SCPNT, and clinical observations accompanying these tests to the results of other evaluations.

Ayres (11, 12) concluded that particular forms of vestibular system dysfunction, characterized by hyporeactive nystagmus, could be ameliorated by sensory integrative treatment. In consideration of the importance of a diagnosis of vestibularly based sensory integrative dysfunction (as revealed by the SCSIT, the SCPNT, and clinical observations), the medical specialty of otolaryngology should be included in an interdisciplinary evaluation. Otolaryngologists have long been involved in testing of the vestibular system, particularly since Barany first introduced the spinning test in 1907 (13).

More recently, otolaryngologists use caloric testing with electronystagmography during evaluation of the vestibular system (14). A study by Mathog compared normal and abnormal adult male's performance during caloric and sinusoidal evaluation of the vestibular system (14). He found that use of the sinusoidal test, in addition to caloric testing, revealed a more complete understanding of the vestibular system than caloric testing alone. Therefore, in order to further examine occupational therapy procedures that theoretically examine vestibular system function, the SCPNT and clinical observations of hypersensitivity to movement and gravitational insecurity will be compared to results obtained from an otolaryngological examination.

Rotational stimulation of the horizontal semicircular canal, which occurs during any spinning test, excites neurons in the cat's hypoglossal nuclei and nuclei within the reticular formation near the abducens nucleus; these regions are thought to be important in oculomotor control (15). Since components of the SCSIT evaluate visual perception and some of the clinical observations accompanying the SCSIT evaluate visual-motor integration, ophthalmology could be used to further examine the SCSIT.
tic tool to supplement the SCSIT, the SCPNT, and clinical observations accompanying these tests (17). Consequently, audiology was the third discipline chosen to assess the results of a sensory integrative evaluation.

Initial investigation into the relationship of the SCSIT, the SCPNT, and the clinical observations accompanying these tests to evaluations in otolaryngology, ophthalmology, and audiology will be explored by studying two descriptive case studies.

Methods

Subjects. Two learning-disabled children were subjects. Subject 1 was referred to occupational therapy because his first grade teacher felt he was distractible, with problems in visual tracking and language skills. Subject 2 was referred to occupational therapy because a psychological evaluation revealed possible sensory integrative dysfunction. The parents, who had initially sought help when informed that he would not pass fifth grade; felt him to be distractible, passive, and immature.

An occupational therapy evaluation indicating vestibularly based sensory integrative dysfunction was a criterion for subject selection. The subjects' scores on the SCSIT are presented in Table 1. Finally, parental consent to allow their child to participate in extensive and somewhat time-consuming testing was another criterion for subject selection.

Procedure. Subjects were scheduled for evaluations in otolaryngology, ophthalmology, and audiology. Except for occupational therapy, testing occurred over a 2-week period. Occupational therapy evaluations occurred 5 months (subject 1) and 2 months (subject 2)
before the testing period. Table 2 presents the specialty area, apparatus used, and method of evaluation.

Limitations of the Study. Since the current study merely initiates preliminary investigation into the SCSIT, the SCPNT, and the clinical observations accompanying these tests, two subjects were used. As such, only tentative conclusions can be made.

Inter-rater reliability was not computed on the more subjective testing procedures employed by the different examiners. However, each occupational therapy evaluation was performed by a therapist certified in sensory integration, and each of the other discipline's evaluations were performed by licensed professionals.

Analysis of the Data

Results (Subject 1)
Occupational therapy (3/27/79): Inadequate specialization of the cerebral hemispheres was indicated by Space Visualization Contralateral Hand Use Score of 27, lack of agreement for preferred hand and eye, and marginal skill in the preferred hand. Vestibular system dysfunction was indicated by hyporeactive nystagmus (SCPNT S.s. = -1.8), coupled with poor prone extension, and bilaterally involved postural mechanisms. Evidence indicates poor tactile discrimination and poor bilateral integration as well as poor ocular-motor control.

Otolaryngology (8/1/79): There is no significant spontaneous or horizontal gaze nystagmus. Dix-Hallpike and position testing were entirely normal. Hot and cold caloric testing shows no significant reduced vestibular response or directional preponderance. This is essentially a normal ENG.

Ophthalmology (8/1/79): Normal ocular pursuits were observed. Some skipping of the midline while tracking with the eyes was evident, but this was within normal limits. Mild esophoria was noted, also within normal limits. Difficulty with visual acuity was noted with the Snellen Eye Chart.

Audiology (8/7/79): During 60 trials of the Berlin Dichotic Consonant Vowel Test presented in the simultaneous condition, the subject answered correctly 44 times with 29 right ear responses and 15 left ear responses. The Staggered Spondaic Word Test, the Speech-in-Noise Test, and the test of Impedance Audiometry were within normal limits. However, the subject displayed total inability to perform during the Wepman and Morency Test of Auditory Sequential Memory.

Results (Subject 2)
Occupational therapy (8/2/79): Developmental dyspraxia was indicated by a below normal score on Imitation of Postures. Design Copy S.s. of -1.6, and marginal skill in use of both hands on Motor Accuracy. Such dyspraxia originated from poor integration of tactile and vestibular information evidenced by the following. Three of the five tactile tests were significantly low and the other two were questionable. Difficulty in processing vestibular information was evidenced by gravitational insecurity, intolerance to spinning during the SCPNT (he would not complete the test after spinning to the left), inability to perform Standing Balance with Eyes Closed, and duration of nystagmus on the SCPNT of 6 seconds after spinning to the left. The subject was tactually defensive, had poor bilateral motor coordination, poor visual spatial skills, poor ocular motor control, and inadequate hemispheric specialization indicated by a Contralateral Hand Use score on Space Visualization of 26.

Audiology (8/9/79): ENG testing shows no significant spontaneous horizontal gaze nystagmus. Standard position testing and Dix Hallpike position testing were negative. Optokinetics and pendular tracking were symmetrical. Hot and cold caloric testing demonstrated no significant reduced vestibular response or directional preponderance. This was essentially a normal ENG.

Ophthalmology (8/1/79): Normal ocular pursuits were observed. Some skipping of the midline while tracking with the eyes was evident, but this was within normal limits. Mild esophoria was noted, also within normal limits. Difficulty with visual acuity was noted with the Snellen Eye Chart.

Audiology (8/7/79): During 60 trials of the Berlin Dichotic Consonant Vowel Test in the simultaneous condition, the subject answered correctly 48 times with 22 right ear responses and 26 left ear responses, indicating a left ear advantage. The subject could not perform the Staggered Spondaic Word Test, which indicates a problem with competing type stimuli. He performed twice as poorly with his left ear as he did with his right. Speech-in-Noise Test and Impedance Audiometry were within normal limits. The subject was definitely lacking in the ability to perform the Wepman and Morency Auditory Memory Test.

Discussion
Relationship of the SCPNT and Clinical Observations to the Otolaryngology Evaluation. Inspection of the data from the evaluations in occupational therapy and otorlaryngology reveals contradictory infor-
Table 2

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<th>Specialty Area</th>
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<th>Method of Evaluation</th>
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<td>Occupational Therapy (1, 2, 3, 17)</td>
<td>SCSIT Test Kit</td>
<td>Southern California Sensory Integration Tests</td>
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<td>SCPNT Spinning Board</td>
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<td></td>
<td>SCPNT Angle Guide</td>
<td>Clinical observations of muscle tone, reflex development, ocular and oral motor control, eyes and hand preference and movement through space</td>
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<td>Irrigation equipment and temperature controlled water reservoir for caloric stimulation</td>
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<td>Lights mounted in the ceiling for eye tracking for calibration</td>
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<td>Staggered Spondaic Word Test</td>
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<td>Impedance Audiometry</td>
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<td>Wepman and Morency Auditory Memory Span Test</td>
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mation. The SCPNT evaluation on subject 1 revealed hyperactive nystagmus (1.8 s.s.), whereas the otolaryngology evaluation determined the subject’s nystagmic response as within normal limits. Similarly, the SCPNT and clinical observations revealed Subject 2 as hypersensitive to movement, gravitationally insecure and demonstrating a questionable nystagmic response (6 sec), whereas the otolaryngology evaluation found the nystagmic response within normal limits. Consideration of the tests may give insight 1 and 2 months (subject 2) before the testing period. Table 2 presents the specialty area, apparatus used, and method of evaluation.

Limitations of the Study. Since the current study merely initiates preliminary investigation into the SCSIT, the SCPNT, and the clinical observations accompanying these tests, two subjects were used. As such, only tentative conclusions can be made.

Differences in test mechanics should be considered. The SCPNT, like the Baranay spinning test, stimulates both of the subject’s ears simultaneously, but limits caloric stimulation to one ear at a time (20). The SCPNT allows for visual fixation with the subject’s eyes open and the subject positioned in a light room. Conversely, ENG recorded nystagmus during caloric stimulation allows for removal of visual fixation by having the subject close his eyes while positioned in a darkened room; this allows for a greater and more easily measured nystagmus (20). The SCPNT has the subject perform no concentration task and therefore allows for central suppression of nystagmus. During otolaryngological examination, in
order to minimize central suppression of nystagmus, the subject is instructed to perform a concentration task aloud (20). Consequently, the combination of differences in test mechanics may account for the discrepant results between evaluations in occupational therapy and otolaryngology.

The SCPNT measures duration of nystagmus, whereas electronystagmography during caloric stimulation measures amplitude of nystagmus. During occupational therapy clinical observations, the subject's physiological and emotional responses to movement are monitored. These aspects are not monitored during the otolaryngological examination. Thus, it may be that during occupational therapy clinical observations of a subject's emotional and physiological responses to movement, different aspects of vestibular system functioning are considered which are as important as the nystagmic response for diagnosis of vestibular dysfunction (23).

Differences in the normative sample must also be considered as possible reasons for differences in the occupational therapy and otolaryngology test results. The results of the occupational therapy evaluation were compared to norms developed by Ayres and replicated by Royeen for children aged five through nine. (2, 24). Inspection of some of the research from which otolaryngology derives normative data revealed the youngest subject to be 19 (25). Consequently, the otolaryngological evaluation uses adult norms as a reference, whereas the occupational therapy evaluation uses children's norms. This difference may account for the discrepancy between the evaluation results in occupational therapy and otolaryngology.

Finally, the following statement implies the possibility of caloric-rotational dissociation.

Occasionally, the caloric and rotational test results do not agree. For example, there may be a rotational directional preponderance but not a caloric directional preponderance; or there may be a caloric bilateral weakness but normally intense rotational nystagmus. Animal experiments suggest that such caloric-rotational dissociation may be a central sign. However, this possibility has not been systematically studied in humans. (25, p 750)

M. H. Stroud found that caloric abnormalities persisted longer than postrotary abnormalities (caloric-rotational dissociation) when brainstem lesions were performed on cats (26).

It is provisionally hypothesized that a similar phenomenon, dissociation or lack of agreement between caloric and spinning tests, may also occur in learning-disabled children and hence, explain why the results were discrepant between the otolaryngology and occupational therapy evaluations.

In addition, it should be noted that the duration of nystagmus as measured by the SCPNT may, in fact, have no direct correlation with the vestibular system. Rather, it may reflect the subject's state of central alerting, anxiety, visual acuity, and ability to visually fixate and suppress nystagmus more accurately than it directly measures vestibular system integrity.

The need for continued research in this area is the major conclusion drawn from this discussion regarding the discrepancy between the evaluation results in occupational therapy and otolaryngology. A study with a large enough sample to allow for statistical analysis investigating the correlation between caloric testing and the SCPNT is needed. Also, research investigating the reliability of the SCPNT with a learning-disabled population needs to be conducted in order to determine if central alerting and anxiety of the subject significantly affect the SCPNT's reliability. In conjunction with otolaryngologists, occupational therapy researchers may develop normative data and operationally define procedures for measurement of hypersensitivity to movement (physiological response) and gravitational insecurity (emotional response) to movement. Finally, norms for children tested by caloric stimulation may be further developed.

Relationship of the SCS1T and Clinical Observations to the Ophthalmology Evaluations. Generally, there was agreement between the occupational therapy and ophthalmology evaluation concerning Subject 1, and disagreement between the evaluations concerning Subject 2. Occupational therapy clinical observations of Subject 1 revealed poor ocular motor control as evidenced by his inability to smoothly cross the midline with his eyes. In addition, the ophthalmological evaluation revealed that the subject could not smoothly track an object across the horizontal plane with his eyes, and that the subject was probably amblyopic due to a persistant pupillary membrane in his right eye.

However, consideration of the evaluation results of Subject 2 disclosed the following discrepancies between the occupational therapy and ophthalmology evaluations. First, occupational therapy clinical observations revealed that the subject frequently manifested a midline skip while tracking an object with his eyes. Ophthalmology evaluation revealed that the subject
manifested a midline skip but judged the problem to be within normal limits. Second, the occupational therapy clinical observations found poor overall quality of the subject's eye tracking. The ophthalmology evaluation found the subject's eye tracking ability within normal limits. Third, occupational therapists clinically observed that Subject 2 had difficulty with eye convergence. Conversely, the ophthalmologist determined that the subject's eye convergence was within normal limits. Of additional interest was the tentative finding by the ophthalmologist that Subject 2's visual acuity was depressed; a full eye examination was prescribed. Upon hearing this, the subject's mother commented, "I'm surprised, he is always the first one to read the road signs." It may be that the subject's very poor visual spatial skills, as indicated during occupational therapy evaluation of a Space Visualization s.s. of -2.5, affected his ability to perform visual acuity tasks as tested by the ophthalmologists.

One explanation for the discrepancies in evaluations by the ophthalmologist and occupational therapist can be testing error by the occupational therapist. Or, it may be that the lack of standardized norms and consequent use of clinical judgment by the occupational therapist and the ophthalmologist allowed them to view the phenomenon differently. What one professional considers abnormal may be considered normal by the other. Thus, it may be that in working with a population of learning-disabled children, occupational therapists are evaluating and judging very subtle problems, whereas, the ophthalmologist may be evaluating from a reference point of pathology and disease. Additionally, many learning-disabled children are inconsistent in their responses and may vary in performance from day to day. Such fluctuation in performance might account for the discrepancy.

Unfortunately, none of these explanations can be appraised empirically due to the lack of experimental data on the subject. Instead, operationally defined procedures of ocular performance in children may offer more objective and meaningful information.

**Relationship of the SCSIT, the SCPNT, and Clinical Observations Accompanying These Tests to the Audiology Evaluation.** Among the auditory tests administered, both subjects performed poorest during the Wepman and Morency test of Auditory Sequential Memory. Subject 1 could not perform the task at all and Subject 2 scored well below minus 1 standard deviation. In consideration of this, and in consideration of the possible vestibular system dysfunction common to each subject, the correlation between vestibular system functioning and auditory sequential memory abilities needs further investigation. The possibility of such a correlation is especially important in consideration of recent research by Fishbein (27). He discovered that young, learning-disabled children with relatively strong auditory memory skills benefited most from an intervention program using braille as a tactual modality for language instruction. Those learning-disabled children not benefiting from such an intervention program might display signs of possible vestibular system dysfunction in conjunction with poor auditory sequential memory.

The other auditory test that was atypical for both subjects was the Berlin Dichotic Consonant Vowel Test, which is a form of a dichotic listening test. Subject one obtained a right to left ear ratio of 1.9. This is a very high score that can be considered abnormal (28). Subject 2 obtained left to right ear ratio of 1.1, which indicated atypical lateralization of language (17). Results of the Berlin Dichotic Consonant Vowel Test on Subject 2 are similar to the findings of Pettit and Helms, who reported that children with language disorders do not have lateralized cerebral dominance for language (29).

In spite of these findings, the experimental nature of the dichotic listening test must be remembered; however, its possible value as a clinical tool must not be underestimated. This sentiment is summarized as follows:

> Although the dichotic listening test is primarily a research tool with little practical application, limited longitudinal testing, and considerable controversy regarding its interpretation, theoretically it provides a measure of asymmetry of ear perception. Dichotic listening represents a new approach for investigating hemispheric specialization and its development in children. (30, p 28)

Again, consideration of the possible vestibular system dysfunction common to both subjects, the correlation between vestibular system functioning and the dichotic listening test, reflecting lateralization of language, needs to be further investigated.

**Implications for Occupational Therapy**

In reflecting upon the results of the two descriptive case studies, two implications for occupational therapists are evident. First, occupational reports delineating the results
of evaluations must necessarily include the specification of the procedures used. Therapists should understand the tests and clinical observations they use, as well as somewhat understand tests used by those in other disciplines. Therefore, when our findings do not corroborate with the findings of other disciplines, therapists can begin to understand why.

Second, therapists need to develop continued collaborative research with other disciplines. Many of the areas targeted for future research may be best investigated by an interdisciplinary team. Only by effective communication and research with other disciplines can occupational therapists achieve their maximum potential.

Summary
This preliminary study investigated the relationship between the results of two SCST's with the results of evaluations in the areas of otolaryngology, ophthalmology, and audiology. Generally, there was little agreement between the evaluation results of oto-laryngology and occupational therapy. Occupational therapists and ophthalmologists were in partial agreement over the results. Considering the results of audiology and occupational therapy evaluations, particular tests in audiology were atypical for both subjects. Reasons for the lack of agreement between evaluations were discussed. Areas of future research to help resolve the discrepancies were delineated. Finally, implications for occupational therapy were presented.

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