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REPORTS

SCAN vs. SSW

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Sensitivity of the SCAN in CAP Testing

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The purpose of this investigation was to evaluate the sensitivity of the SCAN: A Screening Test for Auditory Processing Disorders in identifying children at risk for auditory perceptual problems who may need more comprehensive auditory perceptual testing. The SCAN was administered as part of an auditory perceptual battery which consisted of the Staggered Spondaic Word (SSW), Phonemic Synthesis (PS), Speech-in-Noise (SN), and in some instances, the Competing Environmental Sounds (CES) Test.

Subjects

The CAP results of twenty-four children between the ages of 6-8 and 11-11 years, four females and twenty males were analyzed. All children underwent an audiological evaluation immediately prior to the auditory perceptual testing and were determined to have normal hearing (SRT no greater than 15 dB and no single threshold greater than 25 dB) and essentially normal middle ear functioning (no more than -150 middle ear pressure) bilaterally. Most of the children had been referred for testing through their school system with appropriate medical referral or through private psychologists due to various degrees of academic difficulty, primarily reading and/or reading related subjects.

Equipment

Results were obtained using a Grason-Stadler GSI-10 Diagnostic Audiometer with an Aiwa AD-WX808 stereo cassette deck and a Madsen ZS77-MB Impedance Audiometer. Testing was conducted in an IAC sound suite.

Methods

Standard audiological protocol was adhered to for determination of the status of the child's peripheral auditory system. The auditory battery consisted of: 1) Assessment of speech discrimination in quiet using W-22 words presented live voice with V.U. monitoring at 40 dBSL relative to the SRT, 2) Assessment of speech discrimination in quiet using the CID W-22 recording presented at 40 dBSL relative to the SRT, 3) Assessment of speech discrimination in noise using the

standard scores below the normal range for their respective ages. A breakdown of the individual subtests revealed: 1) 7/24 children had an abnormal score on the auditory figure-ground (AFG) subtest, 2) 6/24 had an abnormal score on the competing words (CS) subtest, and 3) No abnormal scores were obtained on the filtered word (FW) subtest. Three children had normal composite scores but demonstrated below normal performance on the AFG subtest and one child who had a normal composite score demonstrated below normal performance on the CW subtest.

All 20 variables were compared in a correlation matrix. All but CES had an N=24 (with 22 df). Therefore, significance at .05 was .404 and at .01 it was .515.

The SCAN correlated well with itself (not generally advantageous in a test battery), but did not correlate with any other measure of central function except the SSW LC condition (.503) with the SCAN CW and SCAN Comp. (.524). These are mild correlations in which 33% of the variation on the SSW LC is predicted by the SCAN Comp and CW or 67% is of the SSW LC condition is related to other

CID W-22 recording presented at 40 dBSL relative to the SRT with a +10 dB signal to noise ratio (diotic speech noise), 4) Administration of the CES at 50 dBSL relative to the PTA in each ear, and 7) Administration of the SCAN at 50 dBSL relative to the PTA in each ear.

Results

A total of seventeen of the twenty-four children tested were identified as having auditory perceptual problems based on their performance on the central auditory perceptual battery (SSW, PS, S/N, CES). A further breakdown of the individual CAP tests revealed: 1) 17/24 children were identified with bilateral speech-in-noise deficits, 2) 6/24 children presented with a unilateral speech-in-noise deficit, 3) 1/24 children demonstrated normal speech-in-noise performance, 4) 8/24 children had abnormal phonemic synthesis results, 5) 7/24 children had abnormal CES results, and 6) 17/24 children had abnormalities on the SSW significant enough to support various auditory perceptual problems (Table 1).

Results of the SCAN revealed six of the twenty-four children to have composite

Table 1. Means and standard deviations of the test data.

	Age	WDS-Q R	WDS-Q L	WDS-N R	WDS-N L
Mean	8.83	96.8	96.33	50	49.75
SD	1.46	4.1	3.85	12.6	11.07
	RNC	**RC**	**LC**	**LNC**	**Rev**
Mean	1.46	8.46	22.91	2.75	4.21
SD	4.72	8.75	3.97	3.97	5.99
	FW	**AFG**	**CW**	**Comp**	**PS**
Mean	10.38	7.71	8.38	91.21	17.75
SD	1.58	2.07	3.03	15.25	4.16

factors not associated with the SCAN. The LC condition is associated with many central problems (Tolerance-Fading Memory, Decoding, and Integration).

Conclusion

In this investigation, less than half of the children identified to have significant perceptual deficits had a SCAN composite standard score below the norms established for their particular age. The FW subtest with a 32 dB/octave filtered roll-off of low pass filtered words at 1KHz appeared to be too easy of a task for all age groups evaluated by the SCAN. On the AFG subtest compared to Speech-in-Noise results, less than half of the children had a subtest standard score below age norms. The AFG subtest with multi-talker speech babble at a +8 dB signal-to-noise ratio appears to be an easier task than the CID W-22 words with a competing speech noise at a +10 dB signal-to-noise ratio. On the CW subtest, with monosyllable words matched within 5 milliseconds duration with simultaneous onset times, less than half the children demonstrated abnormal responses compared to the total number identified by the comprehensive battery. Also, the CW subtest does not provide for the recording or analysis of responses in reverse order which may hold some diagnostic significance. The results of this investigation appear to indicate that the SCAN, used as a screening tool to determine if further auditory perceptual testing may be indicated, may not be a sensitive enough measure when analyzed against the results of a comprehensive auditory perceptual test battery.

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Comparison of SSW and SCAN Results

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Although there are several behavioral measures of central auditory processing (CAP) function being used by audiologists today for assessing children and adults, there is still a significant demand for information "regarding these tests and procedures" (ASHA, 1988). Keith (1989) reports that audiologic evaluation of CAP disorders (CAPD) lags behind psychological and language assessments of CAP in terms of test documentation and norms. Therefore, much more needs to be investigated regarding standardization of audiologic assessment of CAP.

The SSW has been reported to be the most common test used for CAP in children and adults (Oliver, 1987). Possible reasons include: ease of administration, well-established norms, time of administration (7.5 min.), response bias norms and test sensitivity.

The SCAN test was published by Keith in 1986 as a rapid, normed test of CAP. The purposes of the test according to the author are to determine CANS disorders by assessing auditory maturation, to identify those at risk for CAPD and receptive language delay who need further testing and to identify those who would benefit from specific management strategies (Keith, 1989). The SCAN is comprised of three subtests: Filtered Words (FW) in which 1000 Hz low-pass filtered monosyllabic words with a 32 dB/octave roll-off are presented to one ear at a time; Auditory Figure Ground (AFG) in which monosyllabic words and a multitalker noise are competing ipsilaterally at a +8 dB S/N; and Competing Words (CW)

in which monosyllabic words are presented dichotically with simultaneous onset times. A Composite (Comp) Score is also derived from the three subtests. It is suggested by the author that the test be given in a quiet environment with a portable stereo cassette player and two quality earphones (Keith, 1986). The test is normed for ages 3 to 11 years.

For this investigation, the SCAN test was added as a standard part of the CAP battery to evaluate whether any additional diagnostic or management information could be gained. Secondly, overlap and correlation between the SSW and SCAN was investigated.

Method

All eight children seen for a CAP evaluation at the University at Buffalo Speech-Language and Hearing Clinic and who met the age criterion were administered the SCAN test in addition to the CAP protocol. Basic audiometric data were collected. Each child had pure tone averages of better than 15 dB bilaterally. All children had normal middle ear compliance and pressure (+/- 150 daPa) bilaterally on the day of testing. Word discrimination in quiet was assessed using Hirsh W-22 Lists.

A speech-in-noise test using other W-22 lists was carried out ipsilaterally and binaurally using speech noise at a +10 dB S/N. Only four of the eight children completed this test because age or fatigue. The SSW was administered and scored according to standard pro-cedure. The Phonemic Synthesis Test was administered to five of the eight children because of age limitations. The SCAN test was carried out with all children. Table 1 summarizes the means and standard deviations for the children.

Table 1. Means and standard deviations of the test data.

	Age	WDS-Q R	WDS-Q L	WDS-N R*	WDS-N L*
Mean	7.5	93	90.5	38	36
SD	2.2	5.95	10.24	10.58	19.86

	RNC	RC	LC	LNC	REV
Mean	2.87	18.8	30.9	-0.25	13
SD	8.32	16.66	13.38	5.6	9.9

	FW	AFG	CW	Comp	PS**
Mean	8.75	7.5	7	86.88	19.6
SD	1.75	2.72	1.77	8.81	5.68

**N=5

Table 2. Percentage of total subjects displaying abnormal CAP test results.

Data	SSW	SCAN Sub.	SCAN Comp.	PS	S in N
Stecker	100	75	25	40	100
Bedient	78	48	28	33	100

Results

Test results were studied individually to investigate consistency and among tests for correlation of test measures. On the SSW test, six of the eight children displayed a primary Tolerance-Fading Memory (TFM) pattern with one also evidencing a Decoding problem and another an Organizational problem. Two children demonstrated a primary Decoding pattern, one also having a TFM pattern. One child had a Type A, Integration pattern with an Organizational problem. All eight (100%) of the children had abnormal SSW test results when looking at these patterns.

Only six or 75% had abnormal SCAN results on the individual subtests. On the SCAN test, four of the eight children had abnormal AFG standard scores. Only one child had an abnormal FW score and two demonstrated a CW score outside normal limits. The criterion score, the SCAN Comp score was outside normal limits in only two or 25% of the children. Each of four children tested had abnormal speech-in-noise test scores ranging from mild to severe. Of the five children administered the PS test, two had scoes outside normal limits.

When examining the consistency between the SSW and SCAN test results, five of the eight children or 63% had similar patterns on both tests. In other words, 63% would have been diagnosed similarly if the tests were used alone. Table 3 displays the percentage of abnormal results found for each test when considered in isolation.

In order to contrast the SCAN test results with the SSW results, sixteen variables were compared in a correlation matrix using four of the eight children (N=4, df=2). This was necessary because not all children were administered the PS and speech-in-noise tests due to age and fatigue constraints. When those variables were omitted, all eight children's data were analyzed (N=8, df=6). Significance for the N=8 comparison was .707 and .811 when N=4 , both at the .05 confidence level. Other than the SCAN correlating with itself, the only significant correlation of note was the SCAN AFG subtest with the SSW LC condition (.821).

Discussion

The results of this investigation indicate that the SCAN test does not appear to be as sensitive of a CAP test as the SSW and speech-in-noise tests. Also, the SCAN Composite score does not seem to be a useful measure of CAP function but the individual subtests

could be used as separate measures. The FW subtest was least sensitive, which is consistent with Bedient's data. The AFG subtest results were not consistent with the speech-in-noise test results. Only one child had an abnormal score on both of these measures. Of the remaining three children that completed the speech-in-noise testing with abnormal results, all had normal AFG results. This result may indicate that the speech-in-noise test employing W-22 word lists in speech noise is a more difficult test and that the AFG subtest may be measuring a different skill. This data is again consistent with Bedient's data. The CW subtest was abnormal in only two of the eight children. Bedient's results also showed that less than half of her subjects had abnormal CW scores.

In 1986, Sanger and DeShayes compared results on several measures of CAP function. They found significant correlations between the SCAN and the SSW RC condition. Keith in 1989 reported on significant correlations between all subtests of the SCAN and the SSW RC and LC conditions. In this investigation, the only significant correlation was between the AFG subtest and the SSW LC condition. In Bedient's study, the SCAN CW and Comp scores were correlated mildly with the SSW LC condition. Although there seems to be a trend noted with mild correlations between the SSW and the SCAN tests in these studies, the results are not consistent when considering individual subtests. Therefore, if there is any relationship between these two tests of CAP, it is minimal at best.

The SCAN test has been used as a screening tool for CAPD by various professionals. This investigation suggests that the Composite score not be considered alone, rather each subtest be considered individually when using the test for screening or diagnostic purposes. Those using the SCAN for screening purposes must be aware that normal performance on this test does not rule out CAPD and that positive signs such as behavioral and other test results may be used for referral for a complete CAP diagnostic evaluation by an audiologist.

In summary, the SCAN test does not appear to provide additional diagnostic information beyond that already gained from the SSW test. Secondly, the SCAN test takes longer to administer and qualitative results are not considered in the scoring. Also, the SCAN does not appear to be as sensitive in identifying CAPD as the SSW. Therefore, when diagnosing CAPD in children, the SSW test appears to be the most sensitive and informative test for this purpose.

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