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REPORTS

BENEFITS OF NOE OVER ORIGINAL SSW ANALYSIS

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ORIGINAL (ORIG) SSW SCORING PROCEDURE vs. NUMBER OF ERRORS (NOE) ANALYSIS

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In the last issue of SSW Reports, a new analysis procedure was described that was felt to improve the SSW assessment in CAP cases. Although the SSW has been a sensitive and reliable test, the new method was felt to provide additional benefits.

The new approach is called the Number of Errors (NOE) analysis. NOE has some immediate advantages over the original (ORIG) procedure. For one thing it is quicker, with fewer calculations. Another advantage is that it provides an additional factor, Total Errors. This may help to negate a problem that has been noted. On occasion a patient has two or more scores that fall at the limit of normal, but they succeed in passing the test. The Total Errors assess the overall performance as well.

RATIONALE FOR NOE PROCEDURES

The ORIG SSW analyses were developed 30-35 years ago when little was known about central testing and CAP was unheard of. Thus, it was fortunate that the ORIG procedures have provided such good information for so long.

The NOE analysis appears to have a number of advantages that make switching to the new system desirable.

a) While most of us have gotten pretty fast at calculating R- and C-SSW scores, those who use the test less frequently may find the many calculations burdensome. In addition, the more calculations, the more likely that errors will creep in.

b) We have noticed, especially in younger children, that there may be reduced WDS in the face of perfectly normal hearing. The correction factor, which was designed to compensate for peripheral hearing distortion on this central test, may cancel a central problem for the wrong reasons. In some cases the poor WDS is associated CAPD and in others it is apparently due to initial anxiety. In either case it is not a good reason for neutralizing the central signs on the SSW. The NOE circumvents the above problem by not correcting for WDS.

It should be emphasized that the NOE analysis is appropriate only if hearing is normal and for CAP evaluations. For site-of-lesion evaluations the ORIG analysis using C-SSW scores is still the appropriate approach. In CAP evaluations, if a hearing loss is noted, it would be safest to use the ORIG analysis.

c) Related to "b" above is the issue of CAPD showing up in the discrimination score. We do believe that there is a group of children who have auditory processing problems who show reduced WDS (even on retest). Therefore we can look at WDS as we do any other CAP test. In this case we have decided to use the -2 sd cutoff as the limit of normal (as opposed to the 1 sd

cutoff used for the other NOE factors). We have chosen this cutoff because in some cases one error on a 25 item WDS list would suggest abnormality. The 2 sd point will also provide leeway for those who are somewhat inattentive or initially apprehensive.

d) Another apparent benefit of NOE is that it may provide a more sensitive assessment of response bais and one that is not more sensitive to anterior bias than to posterior bias.

Hernan Soto-Ramos has taken a statistical approach to response bias in his Spanish Language Version SSW (SLV-SSW) test as opposed to the ORIG method. We propose to do the same for the EC test. Because it is influenced by the normal tendency for Order H/L and Ear L/H, this should help to make the procedure more evenhanded.

e) It is not surprising that an individual will fall near the limit of normal on one condition, however, if the person tends to fall down on 2 or more conditions without some good scores to balance this out, there is a reasonable chance that we are missing a person who has a CAPD. Therefore we now look at the total score as well as the individual Condition scores.

f) Finally, in order not to over diagnose from the data, we need to guard against false positive findings. Typically, people from the general population are not referred, but rather those at high risk for CAPD. Thus, the likelihood of over diagnosing is reduced. However, one safeguard would be to use a higher level for significance (e.g., 2 sd) or to require 2 or more significant abnormalities for failure on the test. This is not an easy decision and will be made gradually over time.

For the present time we will consider 2 failures on the SSW test as significant and/or one score in excess of 2 sd poorer than the mean on any one factor.

CALCULATION OF NOE

The 8CN, the combined totals, and reversals are still the aspects of the SSW that are analyzed. However, we do not calculate R- or C-SSW scores and use a difference score instead of the actual Ear and Order ratios to obtain the NOE. The specific calculations are shown below:

a) <u>Scoring SSW Conditions</u> - use the combined totals (on page 3 of the scoring form) just as you would for the ORIG analysis. We generally bring these numbers forward to page one and put them in the top row for R-SSW. Instead of multiplying the number of errors, we simply look up the person's age and see if each score is within normal limits on Table 1. If not we circle the score.

To avoid confusion, we show the "NOE Norms" at the bottom (see Figure 1). Results are shown for a 10 year old.

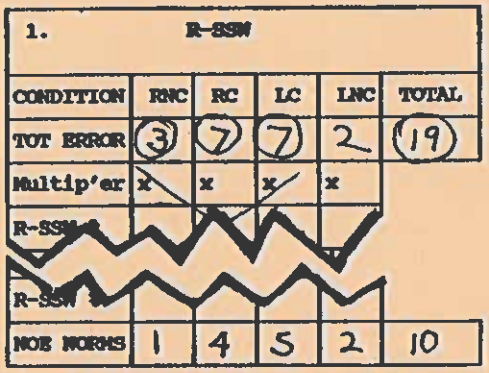

Figure 1. Analysis of the four Conditions of the SSW using NOE criteria.

b) <u>Scoring Total Errors</u> - use the total errors of the four Conditions as the measure of overall failure. Put this total at the right of the R-SSW box (see figure 1).

Precision Acoustics (411 NE 87th Avenue, Suite B, Vancouver, WA 98664 or call (206) 892-9367) should have a new form in several months. Please specify that you want the 1995 revised SSW form.

Table 1

SSW NORMS: NUMBER OF ERRORS (NOE) and WDS PERCENT CORRECT - JUNE 1994

AGE		RNC	RC	LC	LNC	TOT	REV	EAR LH	EAR HL	ORD LH	ORD HL	WDSR	WDSL
5 (n=24)													
	m*	1	7	8	2	18	0	-1		0		98	99
	sd	1	3	4	3	8	1	3		5		5	3
	nl	2	10	12	5	26	1	-4	+2	-5	+5	88	93
6 (n=14)													
	m	2	6	11	2	21	2	-2		1		97	96
	sd	2	4	4	3	9	2	4		8		4	4
	nl	4	10	15	5	30	4	-6	+2	-7	+9	89	88
7 (n=16)													
	m	2	5	9	2	17	2	-2		2		97	97
	sd	2	3	4	2	7	3	4		5		4	4
	nl	4	8	13	4	24	5	-6	+2	-3	+7	89	89
8 (n=30)													
	m	1	4	5	1	10	2	-1		0		98	97
	sd	1	3	4	2	6	4	4		4		3	4
	nl	2	7	9	3	16	6	-5	+3	-4	+4	92	89
9 (n=39)													
	m	1	2	4	1	7	2	-2		1		98	98
	sd	1	2	2	1	5	3	3		3		3	3
	nl	2	4	6	2	12	5	-5	+1	-2	+4	92	92
10 (n=31)													
	m	0	2	3	1	6	1	-1		0		98	98
	sd	1	2	2	1	4	2	3		3		3	2
	nl	1	4	5	2	10	3	-4	+2	-3	+3	92	94
11 (n=16)													
	m	0	1	3	1	5	1	-1		0		98	97
	sd	1	1	2	1	3	2	3		2		3	3
	nl	1	2	5	2	8	3	-4	+2	-2	+2	92	91
Adult 12-59 (n=122)													
	m	0	1	1	0	2	0	-1		0		98	98
	sd	0	1	1	0	2	1	1		2		3	3
	nl	0	2	2	0	4	1	-2	0	-2	+2	92	92
60-69 (n=28)													
	m	1	2	3	1	7	2	-1		1		95	95
	sd	1	2	3	1	4	3	3		3		4	5
	nl	2	4	6	2	11	5	-4	+2	-2	+4	87	85

NOE norms for scoring SSW/WDS, based on C-NS-85 data. Order (1st Spondee - 2nd Spondee) and Ear (REF - LEF) Effect difference norms are set ±1sd. Significant HL (high-low) and LH (low-high) values are beyond these limits. The nls for WDS are set at -2 sd below the mean. [m* = mean, sd= standard deviation, nl= limit of normal range, which is set at +1sd for first 6 columns] jk 2/9/95

Check the total errors for the patient compared to the norms for the appropriate age group. If the number is beyond the normal limits it is significant and should be circled (as shown).

c) Scoring Ear and Order Effects - for this analysis it is necessary to subtract LEF errors from REF. This can be done on page 3 of the scoring form or moved to page one. We will show it on page 1 (see Figure 2).

	RESPONSE BIAS SUMMARY		
	Significant	N O E	Norm
Rever	SIG (NS)		3
Ear	(L/H) H/L	Ear Diff = -7	-3
Ord	(H/L) L/H	Ord Diff = +5	+3
Col-	Type-A LC RC	(F) - (X)= ___	

Figure 2. Response bias information for a 10 year old child.

The difference score for Ear Effect is -7, which according to the norms is significant. Negative scores show Ear low/high and positive scores high/low. Circle the significant information.

The difference score for Order Effect is based on the subtraction of 2nd spondee errors from first spondee errors. Figure 2 shows this to be +5. Again significant negative scores denote Order low/high and positive scores designate Order high/low.

Care must be taken to maintain the correct sign for the difference score for both Ear and Order Effect.

d) SCORING REVERSALS - for NOE Reversals are statistically determined. Thus, the normal limits for certain age groups differ from the ORIG analyses. For 4 age groups the cutoffs are identical, for 2 age groups the NOE values are 2 points lower and at one NOE values are 2 points lower and at one age NOE is 2 points greater than the ORIG.

To determine significance the total number of reversals is compared to the table value. If the reversals exceed the normal limit it is considered significant and the number of reversals is circled.

e) SCORING WDS - unlike the ORIG analysis, NOE takes WDS directly into account. Each ear is considered whether it is more than 2 sd below normal. If the person has normal hearing and WDS is significantly depressed, then we might conclude that this is a reflection of a CAPD. In our experience, it is well to recheck WDS, before coming to this conclusion, to be sure that the score is not a function of initial anxiety.

Please note that this score is significant when the value is less than the cutoff (as this is recorded in percent correct), as opposed to the Condition and Total Error scores and Reversals. Calculations may be shown on page 1 (see Figure 3).

AUDIOMETRIC SUMMARY					
	SpAvg	SRT	WDS	WDS Norms	SSW HL
RE	5	-	92	92	55
LE	3	-	(88)	94	55

Figure 3. The summary table for the standard puretone and speech tests.

The remainder of this article is devoted to our findings when the NOE analysis was compared with the ORIG.

ABOUT THE STUDY

To determine whether the NOE has advantages over the ORIG analysis, SSW records for 120 children seen for CAP evaluation were studied. They were seen primarily at 3 centers (St. Cath-

erines, Ont., Niagara Falls, NY, and Princeton, NJ).

The children, 6 to 14 years of age, were referred because of learning difficulties. The 76 males and 44 females had no histories of CNS lesion and had hearing ≤ 20 dB in the speech frequencies, in each ear. There was no evidence of middle ear pathology (cases with flat tympanograms were excluded except for those with patent PE tubes).

The ORIG analysis was made by hand and then checked by the SSW-C*I*R computer program. The NOE analysis was carried out by hand and rechecked by a second audiologist.

In the ORIG analysis the 4 C-SSW Conditions, Ear and Order Effects, Reversals and Type A patterns were assessed. For NOE there were 3 additional measures, Total Errors and WDS for each ear. Only the Type A pattern which is the same for both procedures was not considered differentially.

The core comparisons to see whether one procedure was more sensitive than the other were the 4 Conditions, Ear and Order Effects and Reversals. The 3 additional measures of the NOE were considered later on.

RESULTS

Table 2 categorizes the performance of subjects for each factor in 1 of 4 ways: passed both NOE and ORIG; passed ORIG only; passed NOE only, and; failed both. The failures on either procedure are shown at the bottom of the table.

The top row of the table (pass both) shows the factors that were or were not sensitive to the problems of these children. Ear L/H and Order H/L picked up the fewest cases, however, Ear Effects taken together were negative in 71 cases and Order in 78. These values show a respectable pass rate.

The bottom row of Table 2 has complimentary data to the first column. It shows those who failed on either or both of the analyses. Interestingly, the new Total Errors factor has the greatest number of failures, 83 out of 120 (69%). The LC Condition is a close second with 79 cases failing (66%).

When taking Ear and Order as single factors, Type A identified the fewest cases 15 (12%) followed by WDS. A total of 34 cases failed WDS in either 1 or both ears (28%). It should be clear to the reader that Total Errors

#	SSW CONDITIONS					SSW RESPONSE BIAS							
S	RNC	RC	LC	LNC	TOT	EAR L/H	EAR H/L	ORD L/H	ORD H/L	REV	TYP-A	WDS RE	WDS LE
PASS BOTH	86	55	41	81	37	104	87	85	113	91	105	97	99
PASS ORIG	15	20	18	18	83	8	11	16	5	4	-	23	21
PASS NOE	0	4	4	2	-	0	0	0	0	1	-	-	-
FAIL BOTH	19	41	57	19	-	8	22	19	2	24	-	-	-
FAIL EITHER	34	65	79	39	83	16	33	35	7	29	15	23	21

Table 2. Number of subjects (out of 120) passing or failing NOE and ORIG analyses on 13 diagnostic factors. Nine factors compare the NOE and ORIG (Conditions, Ear and Order Effects, and Reversals). Total Errors and WDS for each ear were available for NOE only and Type-A was the same for both methods.

and WDS failures are part of the new scoring, but will not be used to contrast the ORIG and NOE.

To compare the unique contributions of NOE and ORIG methods, please look at rows 2 and 3 of Table 2. You will see that failures on NOE alone far exceed those for ORIG alone. Eleven times the subjects failed on ORIG factors only, compared to 115 times on NOEs only. Thus, it is clear that of the NOE is more sensitive method, overall. In fact, there is no factor in which ORIG was more sensitive than NOE.

Figure 4 provides a graphic comparison of NOE and ORIG results. It compares the performance on the two methods for the 9 factors for each of the 120 Ss (note, the maximum failures per subject is 7 because a person cannot have both a H/L and L/H Ear and Order Effect). If the two procedures were equally sensitive to CAPD we would see an equal number of findings above and below the line. Rather, we see the vast majority of subjects had greater numbers of errors above the diagonal line. This shows the NOE to be the more sensitive procedure.

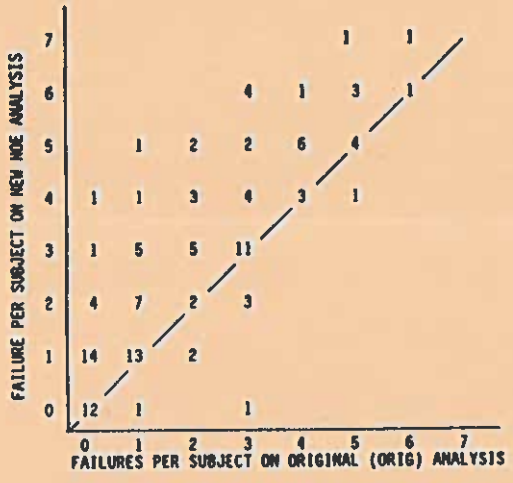

Figure 4. Number of failures on NOE v ORIG analysis. Maximum failure is 7 as subject can have only one Ear and Order failure. Value plotted is number of Ss with that NOE/ORIG combination.

Based on the same 9 factors, 47 Ss had equal failure using both methods, 65 had 1 to 4 additional NOE failures and 8 had 1 to 3 additional ORIG failures.

When the total failures on NOE (rows 2 & 4) are compared to the total failures for ORIG (rows 3 & 4), we see that both are sensitive, but NOE is more so. For the 120 Ss, on the 9 factors that could be compared, ORIG demonstrated 237 failures and NOE 341. This represents a 30% increase in the number of factors failed when comparing the same factors for both methods.

In reality, the NOE adds 3 new factors (Total Errors and WDS for each ear). With these factored in, the failures on all 13 variables is 252 for ORIG and 483 for NOE. This shows a 52% increase overall for the NOE.

The final consideration is age. Is the superiority of NOE over ORIG greater at certain ages? Table 3 shows the failures by age and the mean difference per child. At each age NOE was superior.

AGE	N	FAILURES ORIG	FAILURES NOE	DIFF NOE>	MEAN DIFF
6	28	48	71	23	0.82
7	22	39	57	22	1.00
8	22	45	46	1	0.05
9	17	34	46	13	0.76
10	9	15	28	13	1.44
11	6	15	21	6	1.00
12	4	12	17	5	1.25
13/14	12	21	33	12	1.00

Table 2. Failures using NOE and ORIG analyses by age.

As expected the greatest improvement was for those ≥10 years of age. Also assessments for those 6 and 7 yrs of age seem to benefit from the new NOE procedures, even when the new factors were not taken into account.

In summary, the NOE procedure was much superior to the ORIG analysis for the 120 Ss in this study.