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SSW and P300: Some Illustrations in Alzheimer's Disease

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A look at SSW results in patients in various stages of Alzheimer's Disease (AD) show performance characteristics consistent with central involvement (see Grimes: SSW Reports, Vol. 7 No. 4). Another procedure showing some promise in providing useful information about AD central function is the P300 event related potential. This component of the long latency cortical evoked response is a positive wave elicited by "active listening" i.e. the processing of relatively unexpected stimuli or events.

Both the SSW and P300 (P3) tasks are being used to investigate aspects of central nervous system processing. However, the two tasks differ significantly. The SSW is a complex behavioral test requiring a verbal response and the P3 is an evoked potential requiring a simpler response such as the counting of stimuli such as tones of one frequency and ignoring tones of another frequency. In addition, the generators of the P3 response, being non-modality specific, are not clearly known. (Note: the P3 can be elicited through visual and somatosensory stimuli as well as auditory).

Current wisdom, however, relates the P3 wave to areas of the Parietotemporal association cortex as well as to subcortical structures such as Hippocampus, Amygdala, and Thalamus-indicating some likely anatomic overlap with the SSW.

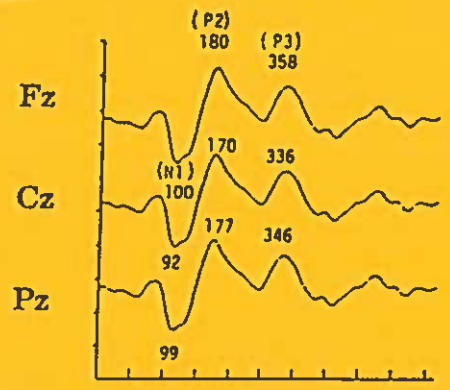
We thought it might be of interest to view some SSW and P3 test results for patients at various stages of AD. The three patients presented here were drawn from a sample of twenty AD patients, divided into four age-matched groups of normal, mild, moderate, and severe (five each group) using the Bollinger-Hardiman Rating Scale (an assessment of verbal and nonverbal pragmatic and semantic communicative function). Patients had hearing levels not exceeding 40dBHL at 1KHz and 2KHz. In general, patients with poorer behavioral rating scale scores also exhibited increased latency and decreased amplitude of the P3 wave. This is consistent with previous investigations showing similar results in patients with various dementing illnesses.

The P3s were elicited to a series of tones presented bilaterally at 80dBHL utilizing an "oddball paradigm". Patients were asked to count the occurrences of a 2000Hz rare tone presented only 20% of the time while ignoring a 1000Hz frequent tone presented 80% of the time. Brain activity was recorded at Cz (vertex) and referred to linked ear electrodes with a forehead ground.

Case 1: NORMAL SSW and P3
EM, a 70 year old male.
Diagnosis: hip fracture
Rating scale: 10; indicating normal communicative-cognitive function.
ABR: WNL

C-SSW:	RNC	RC	LC	LNC
	2	5	8	2

P300:



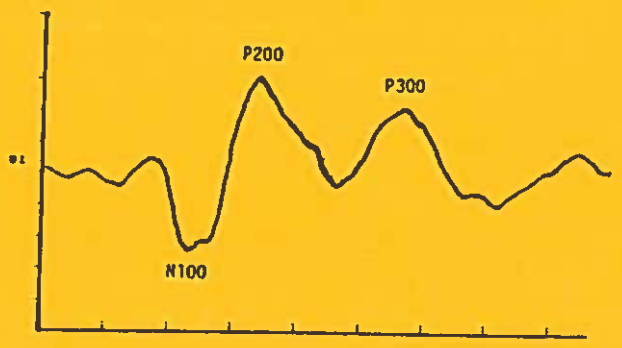
The P3 waveforms above for patient EM were recorded at three sites for illustration: The vertex (Cz), the midline frontal (Fz), and midline parietal (Pz). These waveforms show well defined morphologies: clear N1, P2, and P3 waves. The wave latencies are indicated next to the corresponding site. It is important to note that some increase in P3 latency and decrease in P3 amplitude is associated with the aging process.

N1 and P2 waves appear to reflect processing of the physical parameters of the stimulus without the attachment of meaning, whereas the P3 wave appears to reflect the processing of relatively unexpected events i.e. the rare stimulus items. Generally, the N1 is a fairly large negative peak at about 100msec to 150msec; the P2, a positive peak at 170msec to 200msec; and the P3, a positive wave from around 300msec but can extent to over 500msec (Spehlmann, 1985).

Case 2: Alzheimer's Disease -Mild.
SS, a 67 year old male.
Diagnosis: Alzheimer's Disease
Rating Scale: 8; indicating mildly impaired communicative cognitive function.
ABR: WNL

C-SSW:	RNC	RC	LC	LNC
	12	32	48	15

P300:

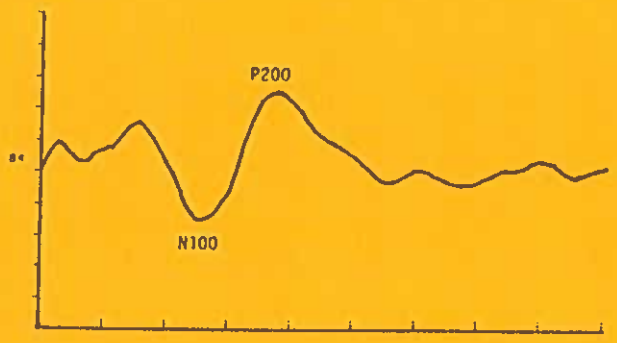


Evoked potential results for SS, recorded at Cz, show a well defined waveform with a clearly identifiable N1, P2 complex as well as a P3 peak. Interestingly, the generators of the N1, P2 complex are not well understood but are thought to arise from areas around the Frontal and Temporal Lobes with some mediation by the Reticular Formation. SSW results for SS reveal moderate and severe bilateral peaks for the right and left competing conditions respectively-consistent with the AD central dysfunction. The patient performed the P3 counting task well and the P3 waveform in this case was not particularly indicative of the central involvement. Importantly, direct SSW/P3 comparisons are difficult due, at least in part, to differences in task complexity and recording (behavioral vs. physiological).

Case 3: Alzheimer's Disease -Moderate
MM, a 66 year old male.
Diagnosis: Alzheimer's Disease
Rating Scale: 6; indicating moderately impaired communicative cognitive function.
ABR: WNL

C-SSW:	RNC	RC	LC	LNC
	30	65	75	35

P300:



The waveform above, recorded at Cz, shows a well defined N1, P2 complex indicating a CNS response to the physical parameters of the stimuli. However, a P3 wave requiring a higher level of cognition is not clearly identifiable. The SSW reveals severe competing conditions showing the behavioral as well as the evoked potentials to be consistent with the CNS involvement.

A few summary points: Clearly, eliciting a P3 wave requires some kind of task relevant processing although different than sensitized behavioral speech tests. Apparently, the wave is being elicited by the expectation or anticipation of a rare stimulus or event. In testing, some modifications were made in presenting both tests.

For the SSW, a good deal of reinforcement and encouragement was utilized with increased interstimulus intervals based on patient response time. For P3s, Patients were similarly encouraged to listen for the tones.
P3 comparisons with SSW could not be made using the severe AD group as these individuals were unable to respond to SSW items.
Although it is compelling to make direct P3 and SSW comparisons, they are very different entities. The cases presented here rely on general morphology of the waveforms rather than the specifics of latency and amplitude considering a great deal of P3 variability for individual subjects.

Some current P300 research centers around the use of speech stimuli. Hopefully, investigating discriminations among particular aspects of speech along a continuum may be productive in CNS study and may provide further SSW/P3 comparisons.

References:

Grimes, A. (1985) "The SSW in Alzheimer's Disease", SSW REPORTS, Vol. 7 No. 4.

Spehlmann, R. (1985) "Evoked Potential Primer", Butterworth Publishers, Boston.

SSW Performance of LD College Students on Repeat Test Administrations

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Central Auditory Assessment of individuals with learning disabilities (LD) is often made difficult by variability and subtlety of performance among test measures. The degree and nature of the disability does not effect performance on central tests in a predictable manner. In order to better assess performance deficits, it is critical to consider any variability between test administrations.

The purpose of this data presentation is to examine the consistency of SSW performance for college age individuals with learning disabilities. The college age LD population is of particular interest since they often display only subtle deficits and as adults performance is not affected by factors of neuromaturation (Carlson, 1986; Saul, 1987).

METHOD

Two administrations of the SSW test (list EC) were compared for twenty college students with identified learning disabilities. These students were undergraduates in the Achieve Program at Southern Illinois University at Carbondale. This program is specifically designed to aid the LD college student. The severity of their learning disability varied from mild to severe based on the Halsted Reitan neuropsychological test battery. The group was composed of 17 males and 3 females, ranging in age from 17 to 21 with a mean of 19 years at the time of initial test administration. All subjects had normal hearing (<20dBHL) in the frequency range from 250Hz-8000Hz and had negative otological history. Immittance measures were normal at each test administration. The second administration of the SSW test was given by the same examiner between 6 mos. and 1 year following the first test administration.

RESULTS

Table 1 and 2 summarize both raw and corrected SSW results for each test administration. The trend of the data show slightly poorer performance for the left competing condition on both test administrations. Though mean performance is poorer than that of the Combined National Sample norms (1985), the scores do fall within the limits of +1 standard deviation (SD) of the mean.

		RNC	RC	LC	LNC
Test 1	X	.4	2.3	5.0	.7
	SD	(1.2)	(3.5)	(5.7)	(1.6)
Test 2	X	.4	1.4	4.0	.3
	SD	(1.2)	(2.2)	(4.2)	(.7)

Table 1. Raw SSW results on two test administration for 20 college students with learning disabilities.

		RNC	RC	LC	LNC
Test 1	X	-.1	1.7	4.8	.5
	SD	(2.4)	(4.2)	(5.6)	(1.7)
Test 2	X	-.7	.2	3.2	-.6
	SD	(2.6)	(3.1)	(3.7)	(1.8)

Table 2. Corrected SSW results on two test administrations for 20 college students with learning disabilities.

Also, results of an analysis of variance with repeated measures show significant variance between conditions ($F=18.65$), however, the variance between test administrations did not represent a significant difference in performance ($F=3.84$).

DISCUSSION

The statistical analyses suggest that adult college students with learning disabilities demonstrate consistent performance on different administrations of the SSW test. At the same time, the data reveal that there is significant variance in performance between conditions. Examination of mean C-SSW performance scores show a greater deficit in the left competing condition and generally poorer performance for the left ear, a trend not observed in normal adults (N-CS-1985 SSW norms). Despite the favored right ear performance, average performance of the subjects in this analysis fall within the +1 standard deviation limits for all conditions. In view of the subtle nature of these performance differences, and the known heterogeneity of this population, it is of further interest to discuss the consistency of SSW performance in relation to its clinical significance. Table 3 shows the classification of C-SSW condition scores into categories of normal vs. abnormal. Results are shown using clinical criteria of both +1SDs and +2SDs.

	C-SSW	
	NORMAL	ABNORMAL
Criteria		
+1 SD Test 1	11 (55%)	9 (45%)
Test 2	12 (60%)	8 (40%)
+2 SD Test 1	12 (60%)	8 (40%)
Test 2	16 (80%)	4 (20%)

Table 3. Classification of C-SSW condition scores using clinical criteria of +1 and +2 standard deviations.

Using the criteria of +1SD, as recommended for college age learning disabled individuals (Katz, 1987), 40%-45% of the subjects showed abnormal scores for one or more condition. Proportionally, the breakdown of group performance was consistent for both test administrations. Less consistency was observed using the more commonly used criteria of +2SD. Unfortunately, the consistency in classification of results as a group is deceiving. Examination of individual data show that 30% of the group would changed classification of results from one test administration to the next. The direction of change varied, that is the abnormal performance occurred on either the first or second administration of the SSW. These observations were true regardless of the clinical criteria (+1SD or +2SD) used to evaluate performance.

The final issue of interest is the consideration of hit rate and performance consistency with the addition of response bias. Table 4 shows a breakdown of performance for each test using both condition scores (cond.) and response bias (bias). Classification shows 50%-55% normal SSW performance for each test administration. Once again there is consistency between tests in regard to group breakdown however, examination of individual scores reveals that 25% of the group showed a change in classification of performance between tests.

	C-SSW			
	Normal	Abnormal cond.	bias	cond +bias
Test 1	10 (50%)	6 (30%)	1 (5%)	3 (15%)
Test 2	11 (55%)	6 (30%)	1 (5%)	2 (10%)

Table 4. Classification of results for two administrations of SSW test. A +1SD criteria is used.

CONCLUSION

The data presented illustrates several points. Most prevalent is the notion of clinical significance. Those statistically significant differences between test administrations were not demonstrated, there were in fact performance differences with clinical significance. A change in classifications of test (normality) was true of a portion of these individuals and likely provides insight into the nature of their compensatory skills. Since these are adult, physiologically mature patients demonstrating only subtle performance deficits, common clinical practice would likely preclude the need for additional monitoring of central auditory function. As clinicians, we may be wise to consider the value of repeat testing or monitoring for some of these individuals.

Secondly, the suggested use of exercising a more stringent clinical criteria (+1SD) showed greater consistency in the evaluation of group performance between test administrations. This strategy is of particular use in this group of individuals with known fluctuation in general performance levels.

Both condition and response bias information provides subtle cues as to the breakdown in auditory abilities. Coupled with other sensory or integrative deficits this breakdown in auditory abilities is often enhanced. Finally, this group of individuals is truly a select group of those with learning disabilities, so these data represent performance of individuals with a wide range of learning deficits (Halsted Reitan Impairment Index of 0.9). All are individuals who may utilize a highly developed compensatory learning program to succeed in college. The consistency in other test performance for these individuals as well as adult LD patients with more severe central auditory deficits would be of interest.

References:

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