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REPORTS

MEMORIES SWEET MEMORIES

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HIPPOCAMPUS, MEMORY AND THE SSW

Jack Katz[1], Peggy Waggoner[2], Gary Gaffney[3] and Sandy Cox[2]

The hippocampus is known to be a vital organ in establishing "long term memory" traces. It is thought to imprint the information in the chemical structure of molecules. The hippocampus lies medially in the floor of the temporal lobe, just below the inferior horn of the lateral ventrical.

If both hippocampi are damaged it will be difficult to develop long term storage of experienced events. Long term memory can refer to events from childhood or events as recent as 15 or 20 sec before. Our concern here is with recent events (e.g., 15 to 30 sec ago) and therefore, to reduce confusion, we will use the term "recent memory (RM)" instead of long term memory.

Short term memory is often termed "primariy memory, working memory" or "immediate recall (IR)". It covers a span of perhaps 1 to 5 sec. For example, IR is sufficient in most people to write down an entire phone number (adult memory span being 7 ± 2). A RM disaster is when you meet 5 people in a group and promptly forget all but the last one. Because the introductions take longer than 5 seconds it could well represent a failure in RM.

If a person loses the ability to form long term memory traces, how would this influence SSW results? We had the opportunity to observe this in a case that we saw recently at the Kansas University Medical Center.

CASE HISTORY

"Chris", a 6 year old girl, was stricken with herpes encephalitis following an upper respiratory infection. By the time that she was seen by a physician, the virus had destroyed a large portion of the temporal lobe, including the hippocampus on either side (Fig. 1). The right side and inferior regions were the most heavily involved. The MRI demonstrated no destruction of the corpus callosum in the mid saggital section, but involvement of the commissural pathways is likely in the temporal and to some extent in the parietal lobes.

Kansas Univ. Med Ctr.: [1]Visiting Professor, [2]Hear & Speech Dept, [3]Psyciatry Dept.

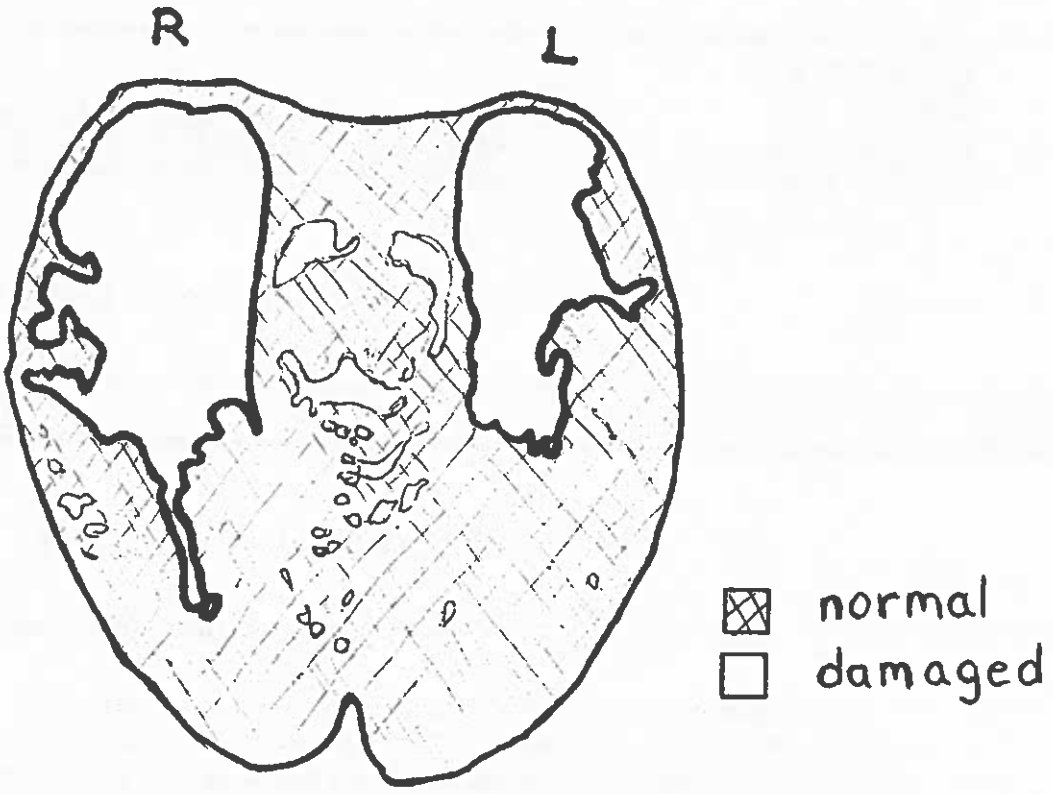

Fig. 1. Involvement of middle temporal lobes seen on horizontal view of MRI scan (with greater lesion in R-hemisphere).

Behaviorally, Chris was erratic. She often indicated that she could not hear what was said to her, but it was not clear if this was a loss of hearing or discrimination. She continually requested food, drink and to go to the bathroom. These rituals were not based on need. She did not seem to remember that her wishes had been fulfilled and kept on requesting them. If she was not given what she requested she became quite insistent. When she went to the lavatory she had to be reminded to wash her hands eventhough she had just followed this routine a number of times within a half hour period. She had to be told where the paper towel dispenser was situated each time, but knew how to dry her hands.

The psychiatric report indicated that memory for prior events, 15 to 20 seconds before were completely lost. The speech-language pathologist reported that Chris had perfectly normal short term memory for words and sentences and only failed if the material was unusually long or required a delayed response.

SSW RESULTS

Chris demonstrated a large LC peak of errors on the SSW test (Fig. 2) with a symmetrical pattern for the 8 CNs. A large left-sided peak is associated with a R-AR (Heschl's gyrus) or commissural (corpus callosum or anterior commissure) disorder. In this case R-AR region was surely involved as well as the anterior commissure and probably the posterior corpus callosum (splenium).

A "crossed pattern" on the SSW-CES tests would have supported a lesion of the splenium of the corpus callosum (as opposed to AR or body of the CC), but we were unable to evaluate her CES performance. Chris did not seem to know the practice sounds of the test, a dog barking and music, with or without benefit of the four pictured choices. Therefore, testing was discontinued.

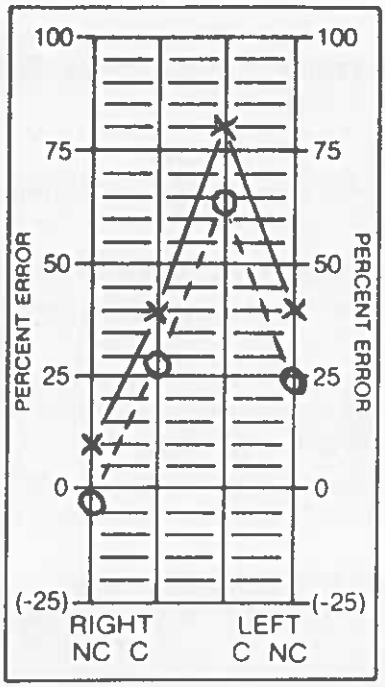

Fig. 2. SSW-gram shows poor performance in the LE (especially LC Condition). This is consistent with a corpus callosum, anterior commissure and/or R-AR sites of dysfunction.

DISCUSSION

The great deal of damage to the right temporal lobe, extending into the parietal region, most likely affected 1) R-AR and 2) commissural pathways (in addition to the hippocampus). Thus, the sharp RE peak could well represent a combination of these two sites of lesion. This along with the severe damage to the anterior temporal region could easily account for the poor perception of environmental sounds.

This case is instructive in a number of ways. The major importance here is that Chris, with a recent memory disorder but normal immediate recall, did <u>not</u> show evidence of a memory problem on the SSW. If IR had been involved we would have expected to see a significant Order H/L Effect, but no such result was obtained. Thus, when we are told that a memory problem exists we should be aware that only the short term memory problem should show up on the SSW. Afterall, the SSW is a fairly brief task (see the following artical on the temporal aspects of the test) and therefore does not require secondary memory.

It was also of interest to see that although the SSW test was not sensitive to Chris' amnestic disorder, it appeared quite sensitive to the sites of lesion. We generally expect that site of lesion cases will be adults who have had strokes or tumors. It was instructive to see that Chris' brain damage was reflected despite the fact that she is only 6 years old. The question is whether we would be able to differentiate her results from the more typical learning disabled youngsters of the same age. Her sharp peaked pattern is one possible indication that this is not merely a developmental delay.

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TEMPORAL/MEMORY ASPECTS OF THE SSW

Jack Katz[1] and Jennifer Wann[2]
[1]Visiting Professor and [2]Graduate Student, University of Kansas

The well known memory tests must be quaking in their boxes because the SSW is getting into the memory business. But they needn't fear because the SSW is measuring too many other factors to provide precise information about auditory memory. SSW items should not demand much of ones capacity for immediate recall were it not for the dichotic presentation which makes it more taxing. A child of just 2 years should be able to remember two words (albeit spondees), or if one thinks of the SSW as a four (monosyllabic) word task then an average child of 4 years should be capable of this level of immediate recall.

Floyd Rudmin once speculated that pathological cases might deal with the SSW as a four-monosyllable test instead of a two-spondee procedure. This would surely increase the memory load of the test. Michael Brunt and his colleagues (1980) studied the relationship of the SSW and competing CV tests to the memory subtest of the WISC-R in normal achieving children. They found a significant correlation for the SSW but not the CVs. Competing CVs are indeed very brief and come only two to an item, so it is not surprising that it failed to show a significant correlation with auditory memory. It is logical to conclude that the SSW contains the characteristics needed to challange the auditory memories even of normal children.

It is not surprising that certain brain damaged adults find the SSW demanding of their capacity to recall. Over 20 years ago we noted the response bias Order Effect high/low, but only in the past 10 years did we associate this with a fading memory. The Order H/L is defined as having a significantly greater number of errors on the first spondee than on the second. Because the errors are not related to a particular ear, it is reasonable to assume that it is a result of their position at the beginning of the items. If short term memory fades quickly then we are likely to lose the first words heard and not the last ones.

Over the years we had many reasons to suspect that the SSW could tap memory deficits. However, the variations of the memory task across items must depend on many factors (e.g., the degree of overlap). One parameter that is likely to be important is the actual duration of the 4 test words. An assumption is made here that the person does not give a quick (Q) or very quick (QQ) responses which would alter the temporal task.

THE PRESENT STUDY

The purpose of this project was to evaluate the (standard) EC tape with regard to timing. Both the previous (Auditec) and the current (Precision Acoustics, 411 N.E. 87th Ave., Suite B, Vancouver, WA. 98664) versions were analyzed using a VisiPitch scope. A template was used to measure each item in cm and then this number was converted to msec by a constant multiplier depending on the time base of the scope.

We were aware that some of the low energy portions of the speech message may be lost when using an oscilloscopic measurement. Rudmin & Katz (1982) pointed out this error in the work of Freeman & Beasley (1976). Nevertheless, because of the measurements here are of such large temporal units, the error of measurement is considered to be minor.

The temporal characteristics that were measured are shown in Figure 1, using the first item as an example. The time period A1 to B1 represents the introductory phrase, B1 to C1 is the pause after it, C1 to D1 is the most important measure, that of the 4 test words and finally the D1 to A2 is the time allowed for the person to respond.

TEMPORAL MEASUREMENTS

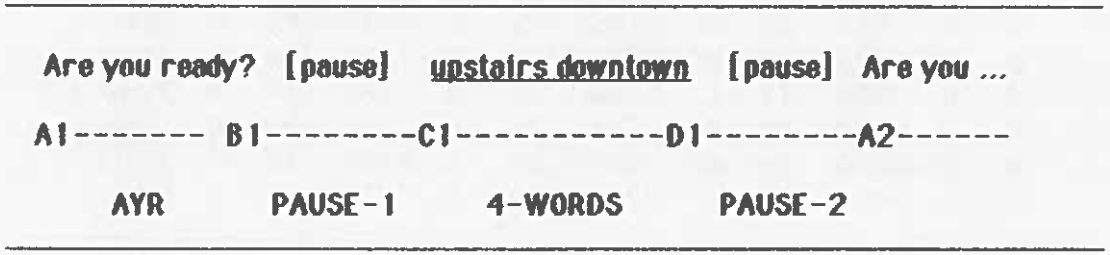

Fig. 1. Measurement points of the first SSW test item and the respective labels.

Table 1 shows the mean results in msec for AYR, PAUSE-1&2 and 4-WORDS. Pause-2 is shown separately for the 2 tapes because this factor is the only major difference between them. Because the differences between the tapes for the other portions were felt to be errors of measurement, the approximate mid points were chosen. The mean duration for the 4 test words on the Auditec (A) version was 2330 msec (SD=165) while the mean for the Precision Acoustics recording was 2322 msec (SD=170). Most of the readings for the 2 tapes were within 33 msec or 1 cm because this was the smallest unit of measurement. The Are you ready's were all dubbed from the same master tape. The total duration of an Auditec item is about 8.65 sec and for Precision Acoustics 12.7.

AVERAGE TIMING FOR PORTIONS OF SSW ITEMS (IN MSEC.)

AYR	PAUSE-1	4-WORDS	PAUSE-2	
1226	550	2330	A=4540	PA=8595

Table 1. Means for time periods on SSW items (in msec.) are shown. The major difference is for pause-2 in which the original (A) time intervals for response were extended in the new Precision Acoustics (PA) version.

Table 2 shows the time period for the 4 test words which were the same on the 2 taped versions. The items are divided up into 4 groups of 10 (A,B,C,D) based on their durations. It should be pointed out that some durations (e.g., 2240 msec) are represented in two different groups because of the way the numbers fell. By use of these categories one could determine if errors were more likely on the longer or shorter items.

DURATION OF THE 4 TEST WORDS

#	CAT	WDS.	#	CAT	WDS.	#	CAT	WDS.	#	CAT	WDS.
1	A	2240	11	C	2400	21	D	2453	31	C	2293
2	A	2240	12	D	2506	22	B	2240	32	C	2293
3	A	2226	13	D	2613	23	C	2346	33	A	2026
4	B	2240	14	B	2240	24	B	2240	34	A	2186
5	A	2186	15	C	2346	25	C	2400	35	B	2240
6	A	2026	16	D	2506	26	C	2400	36	D	2453
7	B	2400	17	C	2400	27	D	2666	37	B	2240
8	D	2880	18	A	2186	28	B	2293	38	C	2346
9	B	2240	19	A	2186	29	A	2186	39	C	2293
10	D	2453	20	B	2240	30	D	2453	40	D	2453

Table 2. The categories and time periods of the 4 test words for each item. The results are shown for the Precision Acoustics tape.

As you may have realized, the practice items are the best test of short term memory on the SSW test. The durations are a) 3466, b) 3360, c) 3520 and d) 3360 msec. It is for this reason that some of the people do less well on these than on the test (competing) items. This of course assumes that they have waited for the second spondee before responding.

We do not know if there are additional ways to document a memory problem on the SSW test other than the present approaches (e.g., Order H/L, quick responses, if the person omits the first word, or has difficulty on the practice items and not on the test items). However, you might try out these categories and see if they provide any further help. Perhaps those with problems of IR will have more errors on category A items than category D or A&B vs. C&D. If not, it would seem to suggest that the difficulty level (or other aspects of the items) regardless of these temporal variations are likely the important factors that tax the fading memory capacity of our clients.

Finally, by combining the information that was obtained from Rudmin & Katz with the present results, we are able to visualize the components of the 4-WORD time span. The mean 4-word portion is 2330 msec. Rudmin & Katz found the competing words to average 550 msec each and the inter-spondee pauses to be 370 msec. This would leave about 1040 msec for the two non competing words (520 msec ea). We can diagram the SSW item as follows: [NC-1 (520)] [PAUSE-1 (370)] [C (550)] [PAUSE-2 (370)] [NC-2 (520)] = 2330 msec.