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AUDITORY MATURATION: ONE CHILD Thomas Tedeschi and Jack Katz

One can learn a great deal from just one child (most parents realize this early on). This is a report of the auditory maturation demonstrated on the SSW test in a young child over a 14 month period. Prior to each of the 3 tests we predicted what we would find on the next test, based on what we knew about CANS development and about the SSW test. Our predictions were quite accurate, giving us some more confidence in our conceptions and (at least in our first normal child) that the system seems to mature in a rather orderly and logical sequence.

"Ann" was 3-7 years of age at the beginning of this study. She had good speech for her age, was considered to be a bright child by her parents and had no significant medical history. Based on this knowledge we predicted her first SSW test scores.

Prediction for Test #1

1. Bilateral peaks, as many 5-yr olds show (so surely this was likely in a 3 1/2-yr old) and; presumably because her L (or language dominant) hemisphere was far from fully mature (we see bilateral peaks in many aphasic patients who have involvement of the L-hem alone), especially the posterior region (AR and/or corpus callosum). Finally, we thought the bilateral peaks as likely if they could also represent bilateral immaturity.

2. Posterior Bias, because this is sometimes seen in young normal children, perhaps reflecting the immaturity of the posterior region (as

we see in brain damaged adults).

3. Anterior Bias, provided that the number of errors are not too great nor that the posterior signs conceal the anterior ones. The posterior region presumably develops more fully before the anterior region, therefore if not masked by internal dynamics a 3 1/2 year old should surely have anterior signs.

4. Significant errors on NC words, as seen in some young children, either is associated with limited memory or capacity to deal with the SSW task.

Results of Test #1

Ann demonstrated normal puretone thresholds, SRTs, WDSs and tympanograms prior to each administration of the SSW test. She completed all 40 SSW items on each presentation. The latter certainly suggests that she is a remarkable 3-7 yr old. Ann did have a bilateral peak pattern on the test. An Order 19/31 provided evidence of posterior bias as we had predicted. While the 3 reversals that she produced may not be considered enough to represent significant anterior bias, it is possible that with fewer errors there might have been more. The reversals were the garden variety. The 10% for RNC and the 15% for the LNC conditions while not striking do represent poorer than expected performance than in more mature children. See table below for Ann's scores.

AGE	WDS		8 CARDINAL NUMBERS							
	RE	LE	A	B	C	D	E	F	G	H
3-7	96	96	3	6	11	6	0	10	13	1
4-3	100	100	1	10	14	3	3	15	5	0
4-9	100	100	0	8	5	2	0	11	6	0

Prediction for Test #2

1. Reduced Order Effect L/H, or possibly a change to Order H/L, because: a) as the posterior region of the temporal lobe continues to mature we can expect the anterior region to come under greater stress -offsetting the L/H with H/L errors (thus, neutralizing Order Effect), or b) if the maturation period is long enough or there is a sudden spurt it might permit us to see anterior bias that we know should be there in such a young child.

2. Improved RC score, because: a) we have seen this pattern of maturation in young children starting with bilateral peaks (at least for groups of children, see pg J-4 in the Workshop Manual). b) Also, this development probably would reflect L-hem maturation (the lack of parallel improvement for LC may either be due to the lack of further development in the right hemisphere (as language dependence shifts more to the L-hem) and most surely that the corpus callosum that becomes fully matured in most people around the age of puberty cannot handle this demanding task.

3. Better NC scores, because: a) we see this tendency in the NS data (e.g., at age 7 the +1 SD limit is 8 for the NC conditions, but by age 8 +1 SD is only 4). b) With posterior temporal and general maturation the child can deal more effectively with the task of which the NC portion is the easiest as memory improves.

4. No more than 1 reversal for every 10 items with 0 or 1 error, because on the first test she had 3 rev's out of a possible 31, or 1 for 10. With maturation we assumed that this pattern would either stay the same or the tendency would decline with age.

Results of Test #2

Ann was tested at age 4-3, or 8 1/2 months after the initial test. Her performance was much as we predict-

ed. It was interesting that she reversed her Order pattern to H/L, an anterior sign (29/22). This suggests that there was considerable posterior maturation (by reducing the number of errors on the second spondee it put additional pressure on the anterior centers and thus yielding more errors on the first spondee). A tell tale trace of posterior limitation in this young child can be gleaned from the Ear Effect 28/23. While it is true that a difference of 5 errors cannot be considered significant of a disorder in such a young child, it is quite possible that it does represent some limitation of a posterior nature in dealing with the SSW procedure. In the same way, it is not abnormal for a 7-yr old to show anterior signs (by adult standards). This is presumably because most such youngsters are not mature enough physiologically to handle SSW items fully in the anterior centers of the brain as anterior functions mature at a later time. While it is not an abnormal sign, the indicators are probably correct in suggesting where the child is breaking down. The second prediction was quite correct. There was a 10% improvement in R-SSW score for the RC condition. What was surprising though was that the LC condition got much worse (by 20%). It appears that the improvement in the RE was at the expense of the LE. The 8% improvement in the RE was offset by the 6% decrease in the left. Thus the overall capacity of the system appears to have remained fairly constant. If it is true that at a young age a child can use both hemispheres with almost equal ability for speech then perhaps as the functions shift the child may not be able to efficiently handle the heavy load that now depends on the corpus callosum. The last prediction, concerning the NC words, appeared to be correct with 8% improvement in the RNC but no change at all in the LNC. Thus it could be a function of a shift to L-hem language functions.

The one reversal that was noted on the second test was not considered to be significant. The ratio of rev was 1 for 29 possible reversals (a suggestion that the tendency to reverse had indeed lessened).

Predictions for Test #3

1. The Ear Effect will disappear, because it was meager in the previous test and because any amount of maturation posteriorly should eliminate evidence for this tendency on the SSW. We hesitated to make any further predictions as we felt that we were batting at 1000 (more or less) and could go nowhere but down. We hedged our bet in the following way:

2. It was not clear whether the development of the L-hem would be more significant than the development of the corpus callosum, as reflected on the SSW. If the L-hem had great gains but the corpus callosum did not, then we should see further improvement in the RC condition, but if the major strides for the R-hem had been seen on the previous test and now there was a rectification with improvement of corpus callosum function then the RE would remain essentially unchanged but the LE would improve.

Results of Test #3

Seven months after test #2, Ann was administered the SSW for the third time (at age 4-9). There was no longer an Ear H/L, as we had predicted. In fact, the tendency was going the other way (15/17), but this was far from significant and could have occurred by chance alone. The RC improved slightly, but the major change was for the LE. The LE was now better than the LE performance on the first test and far better than it was on the second test. If the second test was not a fluke it could represent a brief period of shifting functions or it

could suggest that as the CNS matures that a child can try out various strategies. If this is an accurate reflection of conscious or unconscious strategies, then her performance might be somewhat different on subsequent trials until her system has stabilized. Further testing with young children will be needed to resolve this question. We cannot ignore the accuracy of our hedged prediction for the improvement in the LE. That was to represent improved corpus callosum function. We have no reason to doubt this, but have no further evidence to support it.

The other findings on this administration of the SSW were: a) improved overall score, b) Order H/L (19/13) -still the tendency to be on the side of anterior bias, but no longer appearing significant (almost 9% of the NS had such an Order H/L difference). Although Ann is unlikely to be fully mature in the posterior temporal region, as we have seen so often, the anterior bias seems to predominate. There was 1 rev on this administration, but the ratio of reversals to potential reversals went down again (1 out of 38). There was a reduction of LNC errors from 6 on the first 2 tests to only 2 on the third.

What next?

Ann's maturation appears to be following a rather predictable path. We should expect on retest, if soon, that she will improve more in the RC than the LC. If there is too long a delay then the RE will still show greater gains, but the LE will improve to reduce the difference between them. Obviously, we expect Ann to be precocious on the SSW in the future. She is already scoring at about the median for 5-yr olds as shown on pg J-4 in the SSW Manual. We should see no further posterior bias and the anterior signs should continue to melt away. Unless she

gets bored with the task we should expect no reversals on retest (certainly not more than 1).

We hope that these results will stimulate many more of you to test very young children. Of course, don't expect the children to be able to take all 40 items at such a young age nor should they do so well. In fact, the results will be even more interesting if we can now follow some children who are a little more typical in their auditory development. It would be so interesting if the child was able to get no words on the first test and then just 1 or 2 on the second. We have no reason to believe that the first word will be RNC or that it would be RNC for REF items. At a very young age children may have equal abilities for language in the R-hem or indeed the R-hem may be superior. By the way, we have already collected a handful of 4 year old subjects on the SSW.

USE/MISUSE OF THE SSW TEST:
NATIONAL SAMPLE PUT TO USE

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In August 1980, I wrote about the "Seven Semi-Deadly [SSW] Sins". The first one was, "Interpreting children's results as though they were adults". It is time to reiterate this caution but also time to provide current and convenient information which can be used in the evaluation of children.

The NATIONAL SAMPLE has provided us with a great deal of information about the performance of normal children on the SSW test. Forty audiologists throughout the US and Canada contributed data for 131 children who had no history of a learning disability, neurological condition nor significant middle ear

pathology. The age range sampled was from 5-12 years.

The present report deals with four sources of information on the SSW which can be used in the evaluation and programming for children with central auditory problems. This report is a summary, interpretation or extension of material that has appeared in previous SSW REPORTS. They are: studying the four C-SSW Conditions (Nov. 1981), considering Reversals (Aug. 1982), calculating Order and Ear Effects from the 8 CNS (Feb. 1981) and finally the application of Type A information to better understand the auditory processing difficulties.

C-SSW Conditions. The child's overall reaction to the complex dichotic task that is represented by the SSW can be obtained by comparing the child with the large group of children in the National Sample (NS) and other important studies involving normal children. The following table can be used in the evaluation of those 7-11 years of age.

AGE GROUP	C-SSW CONDITION SCORES (TENTATIVE)			
	RNC	RC	LC	LNC
7	8	17	29	8
8	4	13	20	4
9	4	10	19	4
10	4	7	17	4
11	4	4	10	4

These scores represent the points 1 SD above the mean. If a child reaches or exceeds these scores this is likely to represent a significant deviation, indicating auditory processing (AP) difficulty. Children who exceed normal limits on one or more conditions is likely to have significant difficulties in listening in a background of noise.

Reversals. Reversals are another important indicator in the eval-

uation of children with suspected AP difficulty. These auditory reversals are common in children who have sequencing difficulties as well as reversals in writing. Lucker has pointed out importantly that these children are frequently highly disorganized youngsters. White (1977) pointed out that the criteria for abnormality of response bias must be adjusted for age just as we do for the SSW Conditions. The following are the criteria for abnormality:

AGE GROUP	NUMBER OF REVERSALS (TENTATIVE)
5- 7	6
8-12	5

Order and Ear Effects. Order and Ear Effects are forms of response bias that provide some insight into the processing disturbance that a child may have. In particular, Order bias is associated with memory problems. The Order H/L represents the typical (fading) memory problem while the L/H, I consider to be more of faulty decoding skills. The latter would require more time to process the SSW words causing a backlog affecting the second spondee more than the first. The following criteria can be used in deciding the significance of observed differences on 2 halves of the test.

AGE GROUP	SIGNIFICANT EAR/ORDER EFFECTS (TENTATIVE)
7-12	Difference \geq 8

Type A Pattern. The Type A pattern been found to be quite useful in helping to understand the auditory and related problems of learning disabled children. We have known for many years that the Type A pattern is associated with tenacious reading and spelling difficulties. Lucker (1981) has pointed out that the problems are particularly

apparent in those with spelling problems, whether there is reading difficulty or not. I have been interested in thinking about Type A as an indication of difficulty in crossing over from one side of the CNS to the other.

The rules governing Type A still hold until we find out otherwise. That is, there must be particularly poor performance in columns 'B' or 'F' and this cardinal number must be atleast twice as great as the next highest one. The following are the tentative recommendations for Type A difference score (between it and the next highest score):

AGE GROUP	TYPE-A SIGNIFICANT DIFF- ERENCE SCORE (TENTATIVE)
5-10	6
11-12	3

Application of the NS Information. Based on the information that was obtained in the NS it seems clear that although many normal children would pass the adult norms on the SSW test, it may not be reasonable to expect all of them to achieve such scores. This is particularly true for the younger children. The categories on the SSW category table are rather meaningless for children. They were established to maximally differentiate between adult patients with auditory reception lesions and those with lesions in other parts of the brain. At the lower level it was an attempt to maximize the differences between normal adults and NAR lesion cases. These boundries may have no bearing whatever on differentiating normal children from those with auditory processing problems. Thus, obtaining a TEC on young children seems inappropriate to me. This is not to say that by use of these child-age modified criteria that we don't miss some borderline (or maybe some not so borderline cases). It all depends

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on your philosophy.

My advice to the practicing clinician is to score the test on children using the above criteria. If your clinical sense tells you that you are missing an important child or that the parents/teachers should know that the performance was only borderline then you could report that usually children of this age fall within the limits of normal for adults.

Space does not permit us to demonstrate how the norms could be applied to a real child and how you would report it. PERHAPS ONE OF YOU OUT THERE would be so kind as to contribute such a case.

NATIONAL SAMPLE II is still under way. We are trying to determine the more precise non competing scores for all of the age groups, checking on the validity of the competing scores and response bias shown here and to establish sufficient reasonable data for 5, 6 and 12 year olds. Please test a normal child for NS-II and use the enclosed form and the SSW form to report it. For 5-yr old children 20 items will be sufficient on the SSW (EC) and live voice PBKs are probably preferable to the W-22s (Hirsh) that we use for the others.