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CAP EVALUATION OF 120 CHILDREN

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A STUDY OF AUDITORY PROCESSING IN CHILDREN: CATEGORIZING AP RESULTS

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ABSTRACT

A system for categorizing AP dysfunction has been suggested previously. This report provides information for 120 children who were referred for AP evaluations. Both useful findings and problems were noted. Thirty measures which are indications of the different categories are listed and criteria for choosing the primary category for a patient are provided.

THE CHALLENGE

Auditory processing (AP) disorders is an area of professional activity that is often confusing for parents and professionals alike. Perhaps one reason for this is the heterogeneous nature of the test population and the wide-ranging disabilities that are associated with AP. There is generally no problem in demonstrating the disorder on central tests, in fact, the numerous varieties of procedures that challenge these weak auditory functions only adds to the confusion. Brain tests as well as those associated with brainstem function seem to be effective, as are dichotic, diotic and monaural procedures which all seem to do the trick. While most of the children have reading problems, some also have math or foreign language difficulties (of course others in this population do quite well in math and languages). Most of the individuals do pretty well in art and mechanical activities (although, this is surely not universal either).

Because of the close association of AP with disabilities in language-based subjects, there has been a concern that we are merely measuring language deficits. However, we see many children who have AP difficulties but no problem with language and vice versa (as demonstrated in severely retarded individuals - see November, 1991 issue SSW Reports).

It is our perspective that AP dysfunction is relatively easy to demonstrate, in most cases (e.g., in this study all but one case demonstrated an AP problem). What is a greater challenge is to understand how the AP problems relate to the person's difficulties in life and what can be done about them. In order to get a handle on these relationships we have 1) categorized AP problems into 4 groups, 2) tried to investigate their bases, 3) studied to what they relate in scholastic and communicative areas and 4) considered how the different problems might be resolved.

A CLASSIFICATION SYSTEM

When a problem is too complex to comprehend then it is appropriate to narrow down the topic to see if the component parts can be understood. A category system was developed based on the SSW response biases which indicate different loci of lesion. It was reasoned that if these important regions of the brain process the SSW test materials, then the same centers might be important for some of the more typical auditory functions that we depend on in daily living. A three- and later a four-category system has been suggested (Katz & Smith, 1991; Katz, 1992). The system relates the SSW signs to the regions that they

mplicate in the cerebrum and then to he known functions of those regions. ased on this information hypotheses ere formulated regarding the behavior xpected in children who are impaired n these functions. The system has orked out very well and the approach as been used clinically for 5 or 6 ears by each of the investigators. e have been very pleased with the linical success of the category sys- em. Not only has the approach helped s to understand the communicative and earning problems of our clients, but, mportantly we have also been able to ake useful recommendations to aid hose with AP impairments.

Briefly, the four category system s as follows:

. Decoding (DEC) category. These ndividuals have difficulty quickly nd accurately understanding speech at he phonemic level. They are slow isteners and often have problems with eading, phonics and receptive lang- uage.

2. Tolerance-Fading Memory (TFM) ategory. This group is most recog- nizable because of their great diffi- culty dealing with noisy listening nvironments. A large percentage of this group, when they have learning roblems, also have limited short-term (fading) memory.

3. Integration (INT) category. Type 1 subgroup-- has auditory-visual inte- gration problems and phonemic diffi- culties. Type 2 subgroup-- has diffi- culty in noise, short-term memory and other, as yet unspecified, problems.

4. Organization (ORG) category. This group has difficulty in maintain- ing the correct sequence of auditory information and keeping themselves organized.

These classifications are not mutually exclusive. As expected they frequently overlap one another. That is, the regions of the brain indicated by the SSW response biases represent adjacent and oftentimes overlapping regions.

DESIGN OF STUDY

This sample represents the first half of the 200 subjects that we set out to evaluate. The subjects who were referred because of suspected AP difficulties primarily were seen at 4 participating centers in the U.S. and Canada. It was our intent to obtain consecutive (consenting) cases to avoid selection bias. Subjects 7 to 15 years of age were sought, how- ever, a large sample of 6-year-olds were contributed and therefore are included here. A further criterion for inclusion was to have complete test data for puretones, word discrim- ination scores, SSW, Phonemic Synthe- sis (PS) and speech-in-noise (S-N) tests as well as completed question- naires from the parents and school.

RESULTS

AGE AND GENDER

Table 1 shows the percentage of children at each age as well as the gender distribution of the subjects. It is of interest, to those of us who have been around for a few years, that this group is younger than CAP groups that we have worked with in the past. Perhaps this means that audiologists are getting to see children with lear- ning disabilities (LD) earlier in the natural history of the problem or perhaps that AP is more recognized by parents and professionals than in the past (let us hope that is the case). The sex ratio (61% boys to 39% girls) is roughly the 2/3 male-to-female ratio that we often see in the LD population.

AGE	%	MALES	FEMALES
6	25	17	13
7	18	15	6
8	25	19	11
9	12	7	8
10	6	4	3
≥11	14	11	6
	100%	73	47

Table 1. Percentage of children at each age level and sex ratio.

TENTATIVE LIST OF MAJOR AND MINOR SIGNS INDICATING AP CATEGORIES

TEST	INDICATOR	SIG	MAJOR/MINOR	CATEGORY
SSW				
	RC	*	M	DEC
	LNC	*	M	DEC
	O L/H	*	M	DEC
	E H/L	*	M	DEC
	Perseveration	2#	m	Dec
	Quiet Rehearsal	1	m	Dec
	delay	3	m	dec
PS				
	Significant Score	*	M	Dec (Int-1)
	Non-Fused	1	m	Dec (Int-1)
	delay	2	m	dec (int-1)
	discrimination	3	m	dec (int-1)
	o/l	1	m	dec (int-1)
	perseveration	2#	m	dec (int-1)
S-N (in poorer ear)				
	mild	*	m	dec
	moderate	*	m	dec/tfm
	SEVERE	*	M	TFM
SSW				
	O H/L	*	M	TFM
	E L/H	*	M	TFM
	LC	*	m	tfm (1st consider)
	quick	1	m	tfm
	are you ready/yes	2	m	tfm
	tongue twister	1##	m	tfm
	smush	1	m	tfm
PS				
	quick	2	m	tfm
	first-sound errors	3###	m	tfm
SSW				
	TYPE A	*	M	INT (1 or 2)
	Type-1			(similar to DEC)
	Type-2			(similar to TFM)
	Sharp LC Peak		m	Int (1 or 2)
	Extreme Delay	1	m	Int (1 or 2)
	REVERSALS	*	M	ORG
PS				
	Reversals	2	m	Org

TABLE 2 TENTATIVE list of signs found on the SSW, Phonemic Synthesis (PS) and Speech-in-Noise (S-N) tests that appear to provide insight into the underlying AP category of dysfunction. The 4 categories are Decoding (DEC), Tolerance-Fading Memory (TFM), Integration (INT) (with subclassifications Type-1/-2 (INT-1/-2)) and Organization (ORG). Capitalized indicators are felt to be strongest, capital-lower case are not quite so strong while the lower-case-only, are considered supportive. Significant (SIG) value is the number shown or "*" specifies to use the test norms. # Also, one perseveration on the SSW plus one on the PS are considered significant. ## One classical (e.g., "chee chain") or 2 false starts. ### With normal PS test score.

UESTIONNAIRES

Parents who were willing to articipate in this study were given wo questionnaires before the child as seen for evaluation. One was to e filled out by the school and one hey were to complete themselves and o return both to the clinic at which hey were seen.

We began to realize early on that he questionnaires were not going to e as informative as we had hoped. or one thing, we believe that a sig- ificant number parents and teachers ere putting relatively little thought nto their responses as shown by in- onsistencies. In addition, we began o realize how confused many of the arents are before the AP evaluation. erhaps a good sign of the effective- ess of the evaluations is how the acts of the case come together and ake sense <u>after</u> the evaluation. herefore parents, and probably teach- rs too, have important misconcep- ions which were reflected on the uestionnaires.

We originally thought that teach- rs had all sorts of standardized data hich they obviously don't have. We hink they probably had overall read- ng scores, but because the levels for eading comprehension and phonics were o similar to the general reading core, we suspect that teachers often imply used the same values.

To say the least we were disap- ointed in losing this important sour- e of information. What we could lean will be reported here and in a ubsequent issue in August, 1992.

ATEGORIZING AP BY TEST RESULTS

Table 2 shows the various indica- ors from the three AP tests and which f the 4 categories they implicate. he table is listed as "tentative" ecause it is presently under study. e do not expect major changes, but ome refinements are probable. "Major" igns may be considered "hard" signs, hile "minor" signs are not quite as trong.

Table 3 provides the rules that may be used to determine the primary category for an individual. Because some cases may not have signs that are strong enough to place the individual into one of the 4 categories, the "Other" option was included. When a client passed all of the tests, they were listed as normal. It should be noted that a mild speech-in-noise score was permitted for the normal group. Only 1 of the 120 children fell into the normal group. He is not included in Table 4 that provides demographic information for the other 5 groups.

GROUP	%	MEAN AGE	PERCENT MALES	PERCENT FEMALES
DEC	47	8.4	68	32
TFM	22	8.7	62	38
INT	19	8.9	59	41
ORG	3	10.5	50	50
OTHER	8	8.8	30	70

Table 4. The percentage of children falling into each of the 4 AP categories and those who had problems but could not be placed into one of the categories.

The table above shows that almost 50% of the cases were placed in the primary category of DEC. This was a surprise to us as we thought that TFM would be more common. Perhaps this finding was due to the fact that there were more DEC factors on the tests (15 DEC vs. 10 TFM). We are presently looking to see what are the most commonly found signs, as this might help to explain our results. In about 50% of the cases a second category was identified. These were primarily TFM followed by DEC. A relatively small percentage fell into a tertiary category. When the numbers for all three levels (primariy to tertiary) were considered DEC was found in 66% of the children, TFM in 47%, ORG in 18%, 13% in INT-1 and 4% in INT-2.

We wonder if there is significance to the higher than expected percentage of girls in the ORG and OTHER groups. We will study this in subsequent samples.

RULES FOR DETERMINING PRIMARY CATEGORY

A DECODING primary category if:

1. Major and Minor Signs are primarily decoding
2. More Major Signs are decoding than other categories
3. Consistent pattern of decoding Minor Signs in the absence of stronger signs for any of the other categories (i.e., no Major Signs or more consistent Minor Sign pattern)

B TOLERANCE-FADING MEMORY (TFM) primary category if:

1. Major and Minor Signs are primarily TFM
2. More Major Signs than for any other category
3. Consistent patttern of TFM Minor Signs in the absence of stronger signs for any of the other categories (i.e., no Major Signs or more consistent Minor Sign pattern)

C INTEGRATION primary category if:

1. Type A pattern (the Major Sign for integration)
2. Sharp LC peak with 2 Minor Signs if there are no Major Signs for other categories
3. Sharp LC peak with 1 Minor Sign if there are no stronger signs for any of the other categories (i.e., no Major Signs or consistent pattern of Minor Signs)

D ORGANIZATION primary category if:

1. Significant reversals on SSW and/or PS test and Major Signs for no other categories
2. Many (significant) reversals on SSW and/or PS test in the absence of stronger signs for other categories (e.g., a Major Sign with 3 Minor Signs)
3. Significant reversals on SSW and/or PS test in the absence of other significant SSW findings (conditions or response bias) and abnormal scores on the other 2 central tests

E OTHER (Non-Specific Abnormalities) primary category if:

1. No Major Signs, but at least 4 Minor Signs with no more than 2 supporting any one category

F NORMAL primary category if:

1. Normal performance on each of the 3 tests (i.e., a few Minor Signs can be seen, e.g., delays)
2. Mild speech-in-noise score(s), but no Major Signs, except as many as 3 Minor Signs permitted other than an extreme delay

TABLE 3. This shows the performance criteria used for this study to determine the primary AP category. The "Major Signs" refer to those test findings, that are listed in Table 1, which give strong support to a category. "Minor Signs" are those indicators, which are found in Table 1, that are somewhat weaker or may be ambiguous in determining an AP category. When the test results do not permit differentiation based on these criteria, then the number and severity of the signs should be considered in order to derive a primary category.

GROUP	SP. AVG RE	SP. AVG LE	WDS RE	WDS LE	% OM HX	LANGUAGE RECEPTIVE	LANGUAGE EXPRESSIVE
DEC	6	5	93	92	50	-0.5	-0.4
TFM	6	6	94	94	46	-0.3	0.0
INT	7	6	94	92	64	-0.6	-0.6
ORG	6	7	93	93	75	0.0	-0.5
OTH	6	5	93	94	50	-0.1	-0.2

Table 5. Speech average (.5 - 2kHz), WDS, reported cases with significant histories of otitis media and receptive and expressive language deficits (negative values) for each of the 4 primary categories and the "Other" group.

INFORMATION ABOUT THOSE IN THE PRIMARY CATEGORIES

At the outset it should be remembered that the categories are not homogeneous. Half of the group had such significant findings that they were given secondary and some tertiary status. Therefore, we cannot expect clear-cut distinctions between groups.

Table 5 shows the average hearing in the speech range (500, 1k, 2k Hz), the WDS, the reported history of otitis media and the language performance for the children in each category. The otitis media information was based on the parent questionnaire, while the 2 language scores were obtained from the teacher questionnaire. The negative language values reflect the average number of years below normal of the teacher ratings. These mean deficits look rather small for children who are often referred to as "language-learning disabled". Perhaps some of the questionnaire inaccuracies that were mentioned previously apply here. Also, recall that most of the children were quite young (typically in 2nd or 3rd grade) and therefore limited in how many years below normal they could be.

No obvious differences were noted for either puretone thresholds or for discrimination scores among the 5 groups. However, the ORG group (which is based on significant SSW and/or PS reversals) had the largest percentage with a history of otitis media. Ordinarily, this might not be considered too highly because of the small sample size (n = 4), however, in adults it is the conductive hearing loss group that generally demonstrates a high percentage of cases with reversals (40%) with a fairly large mean number of reversals (8) for those who have reversals (SSW Workshop Manual, 1987). Interestingly, 3 out of the 4 subjects in the group with many reversals is the one with histories of O.M. This will be checked out further as we collect additional data.

We have long considered the INT-1 group to have the greatest learning deficit of the AP cases. We found for the small sample of INT-2 cases more learning difficulty than expected. It is not surprising then that the INT group had the poorest language ratings in both reception and expression.

DEC cases have been thought to have the next most severe language-learning difficulties and we did find them to be second only to the INT group. Although the difference was small, the receptive language score was poorer than that for expression. It was reasonable to find the ORG group to be depressed in the expressive area. After all, the reversal strip is completely within the anterior cerebral region associated with Order Effect H/L and not far off from the other anterior zones.

The Other group was rated best in language overall. They were also best on the central tests and therefore might simply represent a borderline group (or perhaps the girls tended to have better language than the groups with more boys). The major surprise was the TFM group. They did well expressively, but somewhat behind receptively. To be continued 8-92.