Speech perception in predictable and non-predictable contexts.

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ABSTRACT

The ability of language disordered pre-school children to perceive speech masked by noise and to use contextual cues is investigated and compared with the same ability shown by two other groups: a matched group of normally speaking pre-school children and a group of normally speaking adults. The scores on the perceptual tasks are correlated with the pre-school subjects' performance on different language tasks such as syntactic production, comprehension and awareness as well as on verbal short term memory.

INTRODUCTION

In the perception and interpretation of linguistic messages two types of processes are considered: data driven, or bottom-up processes, and concept driven, or top-down processes. The processes work simultaneously, but disturbances in the signal may cause one of the processes to dominate occasionally. This compensatory mechanism was described for reading in an interactive model by Stanovich /1/.
When interpreting speech (listening), compensation for the constantly present but varying noise results in a more or less heavy reliance on top-down strategies. When interpreting writing (reading), heavier reliance on top-down strategies occurs when e.g. misprinting makes word decoding difficult. However, poor readers with poor decoding ability (poor bottom-up strategies) are said not always to compensate by a more efficient use of contextual cues (top-down strategies). Therefore, an interesting question is whether poor readers and children running the risk of

becoming poor readers, i.e. language disordered pre-school children, show the same reluctance or inability to use top-down strategies in spoken language when bottom-up strategies are insufficient.

PURPOSE

This study is part of an investigation on language disordered and normally speaking pre-school children's reading and spelling acquisition (cf Magnusson & Nauclér, /2/). The aim of the study reported here is to examine language disordered pre-school children's ability to use contextual cues when the signal-to-noise ratio in speech is too high to permit data processing alone.
The questions to be answered are the following:
- Are language disordered pre-school children able to understand speech masked by noise to the same extent as normally speaking children of the same age in the absence of contextual cues?
- Do language disordered pre-school children benefit from contextual cues to the same extent as normally speaking children do?
- If not - what specific linguistic deficiencies are mainly preventing their use of contextual cues?

TEST ITEMS

Ten words, masked by white noise, occurred in the final position of 20 sentences designed so as to make the masked words non-predictable in 10 cases and highly predictable in the other 10 cases. The test items were selected from a material that has been developed by Axelsson /3/, based on Kalikow et al. /4/. All the words were familiar to Swedish pre-school children

and differed in length and structure as is shown below:

1- svans (tail)   6- sågen (the saw)
2- säng (bed)   7- vas (vase)
3- ljus (candle)   8- bordet (the table)
4- katten (the cat)   9- saxen (the scissors)
5- fötterna (the feet)   10- tråd (thread)

SUBJECTS

The subjects were 39 language disordered and 39 normally speaking pre-school children and eleven normally speaking Swedish adults.
The two groups of pre-school children were matched on an individual basis as to sex, age, and non-verbal cognitive level. In each group there were 27 boys and 12 girls.
The mean age in the language disordered group was 6 years, 3 months, and in the normally speaking group 6 years, 4 months.
The mean of the non-verbal cognitive level, measured by Raven's coloured matrices, was 16.74 (S.D. 3.8) in the language disordered group, and 16.87 (S.D. 3.6) in the normally speaking group.

PROCEDURE

The 20 test sentences were randomized and tape recorded and presented individually to the children and as a group task to the adults. The task was to identify the masked word, but in most cases the subjects responded by repeating the whole sentence, which made it possible to register whether the context preceeding the masked word had been correctly perceived.

RESULTS

The scores on the two identification tasks , i.e. the identification of predictable or non-predictable masked words were calculated separately for the language disordered group (LD group), the normally speaking group (LN group) and the adult group (AN group). The scores differed both within the groups and between the groups, as can be seen in table 1. In all the

groups the predictable words showed significantly higher scores (M = 8.8, 9.4 and 9.8 resp.) than the non-predictable words (M = 5.4, 5.8 and 6.9 resp.). This indicates that all subjects, regardless of group, take advantage of the contextual cues.

Table 1. Identification of non-predictable and predictable words in the language disordered (LD), linguistically normal (LN), and adult (AN) groups.

	Un-predict. word			Predict. word		
	LD	LN	AN	LD	LN	AN
Mean	5.4	5.8	6.9	8.8	9.4	9.8
S.D.	1.9	1.9	1.8	1.4	1.0	0.4
Var.	3.6	3.7	3.9	1.8	1.0	1.2
Min.	1	1	2	4	6	9
Max.	9	9	9	10	10	10

Comparing the results for the non-predictable words in the three groups it is evident that the LD group scores lower than the LN group and the AN group. Although the difference between the pre-school groups is not significant, it illustrates the negative effect of language disorders on interpreting speech in noise.
The LD group also scores lower than the LN group, which in turn scores lower than the AN group when the task is to identify predictable words. The difference is significant between the LD group and the LN group and between the LD group and the AN group but not between the LN group and the AN group. Thus, the normally speaking subjects, whether children or adults, benefit significantly more from contextual cues than the language disordered subjects do.
Figures 1-3 show the frequency distributions for each of the test items of the two identification tasks in the LD group (fig.1), the
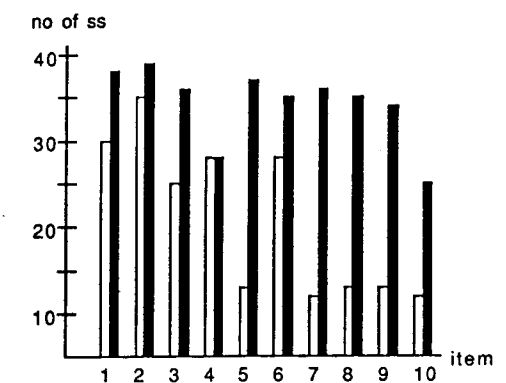
no of ss

Fig.1. Number of subjects in the language disordered group (N=39) who identify non-predictable (white columns) and predictable (black columns) words correctly.
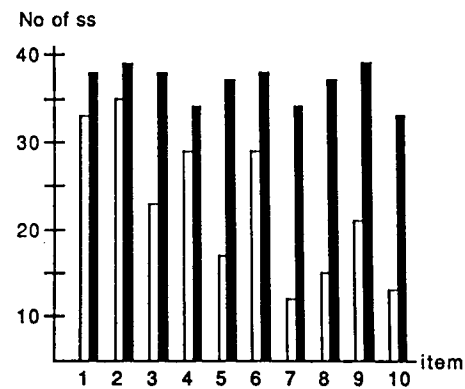
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Fig. 2. Number of subjects in the normal language group (N=39) who identify non-predictable (white columns) and predictable (black columns) words correctly.

LN group (fig. 2), and the AN group (fig. 3). It is apparent from any of the figures 1, 2, or 3, that more subjects identify the test words correctly when contextual cues are provided.
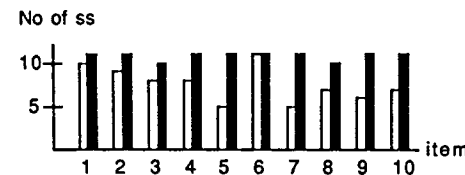
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Fig. 3. Number of subjects in the adult group (N=11) who identify non-predictable (white columns) and predictable (black columns) words correctly.

Some of the words are more difficult to identify without contextual cues than others, as e.g. words no 5 (fötterna) and no 7 (vas), which are hard for all the groups, and words no 8 (bordet) and no 10 (tråd), which are penalising for the two pre-school groups. On the other hand, word no 6 (sågen) is correctly identified by all the adults in the non-predictable task.

Apart from the fact that some of the words are harder to identify than the others in a non-predictable context it is also to be seen in figures 1 and 2 that the influence of the contextual cues on the words to be identified varies in the pre-school groups. On one of the test items, no 4 (katten), the LD group does not benefit from the contextual cues at all, as their scores are the same as in the non-predictable task. Not even the AN group makes full use of the context, as is shown for items no 3 and no 8 in figure 3. However, the majority of the pre-school children, i.e. 25 of the subjects (64%) in the LN group and 16 (41%) in the LD group make full use of the contextual cues. This can be seen in table

Table 2. Number of children identifying predictable and non-predictable words.

| | Number of predictable words | | | | | | | |
Number of non-predictable words	4	5	6	7	8	9	10	
1	1				1			2
2			1	1	1			3
3			1		2		3	6
4				3	1	2	5	11
5					3	3	7	13
6						5	9	14
7				1	2	8	7	18
8							7	7
9						1	3	4
	1		2	5	10	19	41	

2, in which it is also shown that the top scores in the predictable task cannot be inferred from the scores on the non-predictable task. Only very low scores (1 and 2) on the non-predictable task seem to imply poor or incomplete use of contextual cues on the predictable task. There is, nevertheless, a correlation between the performance on the predictable and non-predictable tasks in both the LD group (.60) and the AN group (.60), but not in the LN group (.37).

Since the LD group performs worse than the matched LN group on both the predictable and non-predictable tasks it seems appropriate to look for the cause in the LD group's deficient linguistic competence. However, there are no correlations found between the performance of the two pre-school groups' performance on the predictable or the non-predictable tasks and their scores on linguistic tasks such as syntactic production, comprehension and awareness. As the scores of the LD group and the LN group overlap considerably, the scores of the worst performers (N=8) and the best performers (N=11) were calculated separately. There were no correlations between language tasks and the predictable or the non-predictable identification tasks among the worst performers, but there was a very high correlation between the predictable identification task and two of the syntactic measures (.97 and .91) among the best performers, as well as a moderate correlation with short term memory (.63).

DISCUSSION

The data in the present study allow us to make the following comments on the questions which were posed in the beginning of the paper:
Language disordered pre-school children are not able to understand speech masked by noise to the same extent as normally speaking children of the same age in the absence of contextual cues. This is in accordance with the results obtained by Brady et al. /5/ in a study where good and poor readers listened to speech in noise. The authors were able to conclude that the poor readers' low performance was due not to vocabulary but to a perceptual difficulty, and that "poor readers require more complete stimulus information than good readers in order to apprehend the phonetic shape of spoken words." (p. 21)
Language disordered pre-school children do not benefit from contextual cues to the same extent as normally speaking children do. This does not necessarily imply a general inability to use contextual cues. Rabbit /6/, in a study of adults, found that recall of items presented without noise was impeded if subsequent items were presented in noise. Thus, it might have been the case in our study, that the sentences that preceded the masked words were hard to perceive for some of the subjects and therefore did not facilitate the identification of the test words.
Syntactic ability and short term memory seem to be important factors for the use of contextual cues. The scores obtained by the subjects who performed best on identification of predictable words (i.e. subjects from both the LD and the LN groups) correlat with syntactic ability and short term memory. No such correlation is found for the subjects who performed low on the identification of predictable words. This implies

that the low performing subjects are a heterogenous group as regards syntax and memory. Some of them do not have sufficient syntactic ability and memory to perform the tasks successfully, while others have these abilities but do not use them.

The variation of syntactic ability and memory in the low performing group shows that these factors are not the only determinants for the ability to use contextual cues in identification tasks such as reported in this study.

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