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ABSTRACT

In this investigation, the differences in psycholinguistic processing of written and spoken language and the psycholinguistic deficiencies of poor readers were studied by giving meaningful, anomalous, and random word strings to 18 good readers and 18 poor readers who were reading at the fourth grade level. It was found that in both spoken and written conditions, the order of recall was meaningful, then anomalous, and finally random words, suggesting that syntactic and semantic demands of spoken and written sentences were similar. Poor readers were inferior to good readers on written presentations. The groups were similar on spoken presentations. The reading comprehension deficiency could not be attributed to inadequate psycholinguistic processing, memory, or automaticity in decoding. Incomplete decoding during silent reading by poor readers was supported as an explanation. (Author/JM)

PSYCHOLINGUISTIC PROCESSING IN READING AND LISTENING AMONG GOOD AND POOR READERS

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Differences in psycholinguistic processing of written and spoken language, and psycholinguistic deficiencies of poor readers were studied by giving meaningful, anomalous and random word strings to 18 good and 18 poor readers. In both spoken and written conditions the order of recall was meaningful > anomalous > random ($p < .001$), suggesting that syntactic and semantic demands of spoken and written sentences were similar. Poor readers were inferior to good readers on written presentations ($p < .05$). The groups were similar on spoken presentations. The reading comprehension deficiency could not be attributed to inadequate psycholinguistic processing, memory or automaticity in decoding. Incomplete decoding during silent reading by poor readers was supported as an explanation.

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In early formulations by linguists, reading was viewed as a fairly simple derivative of listening. In 1962, Fries said that "learning to read is not a process of learning new or other language signals than those the child has already learned. The language signals are all the same (p. xv)." Continuing this theme in 1970, John Carroll asserted that "The child must learn that printed words are signals for spoken words and that they have meaning analogous to those of spoken words. While decoding a printed message into its spoken equivalent, the child must be able to apprehend the meaning of the total message in the same way that he would apprehend the meaning of the corresponding spoken message (p. 299)." A number of current models of reading are founded on the assumption that speech and print are two inroads to the same language processor (Sticht, Beck & Hauck, 1974; Carver, 1973; Athey, 1971).

One alternative to this viewpoint is voiced by Frank Smith (1971), who notes that "written language may quite reasonably be regarded as a manifestation of language quite independent from the spoken form (p. 45)." He points to such characteristics of speech as incomplete sentences, gestures, unique purposes, and lack of scanability as qualities that discriminate it from printed language. Gibson (1972)

generally agrees with Smith, but ventures further that "I think there are clues to syntax on the printed page that are comparable perhaps, but by no means identical with those in heard speech (p. 15)." From this remark we may be directed to look for differences in syntactic processing between reading and listening at the sentence level, since syntax is a characteristic of sentences but not paragraphs. All these authors have forwarded assumptions or predictions. None has forwarded direct tests of hypotheses about reading and listening. The present study provides an empirical comparison of psycholinguistic processing of written and spoken language which should assist in determining the similarity of the two processes.

It has been claimed that poor readers manifest deficiencies of psycholinguistic processing. For example, poor readers have shorter eye voice spans than good readers, which indicates less processing of phrases and clauses as units during reading (Levin and Turner, 1968). In addition, oral reading by poor readers has a word-by-word quality (Clay & Imlach, 1971), and is relatively unaffected by knowledge of background information relevant to the passage (Steiner, Wiener & Cromer, 1971).

Several attempts to attribute this global psycholinguistic deficiency to a deficit in syntactic processing have been made. Denner (1970) reported that poor readers were inferior in sequencing written logographs according to syntactic rules. But the specificity of this deficit is in question since the poor readers had lower IQs than the controls. In a study of syntactic processing during listening,

Weinstein & Rabinovitch (1971) found that poor readers were inferior in using syntactic information in learning to repeat spoken sentences. However, poor comprehension is probably not solely attributable to syntactic processing deficiencies. While poor readers were inferior in using syntactic cues to select words in a written multiple-choice cloze (maze) task, they were also inferior in using semantic cues in the same task (Guthrie, 1973). The present study examined whether: 1) comprehension deficiencies of poor readers are present for both spoken and written language 2) the deficits are more pronounced for semantic or syntactic processing of sentences, 3) a lack of automaticity in decoding can account for poor reading comprehension and 4) incomplete decoding accounts for performance of poor readers.

Method

Subjects:

There were 52 children. From an elementary school, 30 fourth grade children reading at grade level were selected. Most of them resided near the school and were primarily middle-class. The mean age was 9.50 years (sd = .53), and the mean grade level on the Gates-MacGinitie (G-M) comprehension test was 4.88 (sd = 1.03). From a school for learning disabled children, 22 subjects reading at the fourth-grade level were included. The subjects were chosen by the reading specialist on the basis of reading level. Most of the children were from upper middle-class families, since the school obtains much of its funding from tuition. The mean age was 12.08 years (sd = 1.11), and the mean G-M comprehension on grade level score was 4.47 (sd = 1.16). The

means and standard deviations of the good and poor readers on the Peabody Picture Vocabulary Test (PPVT) were 114.10 (12.26) and 101.96 (10.18) respectively. These means were significantly different ($t = 3.89$, $df = 50$, $p < .01$). To equate the two groups on IQ, 12 good and 4 poor readers were eliminated from the statistical analysis. Finally there were 18 good and 18 poor readers with means and standard deviations on the PPVT of 106.17 (5.95) and 104.50 (9.49) respectively which were not significantly different. The G-M reading comprehension means of the good and poor groups were 4.57 (.67) and 4.56 (1.14) which were not significantly different.

Stimulus Materials

Word strings were generated from the Dale-Chall list of 3,000 easy words. This was intended to insure that the fourth-grade level readers in the study could identify the sounds and meanings of each word. Three types of strings included: Meaningful, Anomalous, and Random. The Meaningful strings were grammatical English sentences that shared the same basic structure of Adj-Plu.Noun-Prep-Adj-Plu.Noun-Verb-Adj-Plu.Noun. One of these sentences was: "Quick workers with red pants paint bright houses." Anomalous strings contained the same syntactical structure as the Meaningful strings but violated the semantic constraints of English. For example, "Loud dinners beside green stories help growing smells" was included. Random strings violated both rules for syntax and normal semantic constraints. Each Random string was generated by randomly ordering the words in an Anomalous string. One constraint was that no two adjacent words in an Anomalous string could be in the same order as its corresponding Random string. All strings contained 8 words. Twenty-four sentences of each of the three types

(meaningful, anomalous, random) were constructed. Three sets of eight meaningful sentences were created. Anomalous and random sentences were developed from the meaningful sentences within each set. All sentences were typed on 5 x 7 cards for the reading condition and spoken by E in the listening condition.

Design

The experimental design consisted of 2(groups-good and poor readers) x 3(sentence types-Meaningful-Anomalous-Random) x 2(modalities-reading and listening). All Ss in both groups received six conditions: reading-meaningful, reading-anomalous, reading-random, listening-meaningful, listening-anomalous, listening-random. Each condition contained eight sentences. All aspects of each condition were counterbalanced in the same manner for good and poor readers. The modalities were presented in alternation (R L R L R L) with half of each group receiving reading first and half receiving listening first. Equal numbers of Ss received each possible order of word string types: meaningful, anomalous, random. There were six possible orders. Finally three lists of 64 words were used to construct sentences for each of the reading and listening conditions. Within reading and listening separately, no S was given the same list twice; no words were repeated within a modality except a few prepositions. A list could be repeated across the reading and listening conditions, but the same list did not occur in adjacent treatments.

A paradigm used by McNeil (1970), Weener (1971) and Frasure & Entwisle (1973) to compare semantic and syntactic development was employed. Three types of sentences were used which contained different categories of linguistic information. Meaningful sentences contain normal syntax and normal semantic meanings. Anomalous sentences contain normal syntax

but do not carry any conventional meanings. Finally, random word strings contain neither normal syntax nor meaning as a sentence. Comparison of the recall of meaningful and anomalous sentences permits the examination of the processing of semantic information. Comparison of the recall of anomalous sentences and random word strings allows one to determine the degree of processing of syntactic information.

Procedure

All children were administered a Peabody Picture Vocabulary Test and the comprehension subtest of the Gates-MacGinitie, Survey D, Form 1. Each child was given the experimental tasks individually in a separate room in both of the schools involved. In order to acquaint the subjects with the experimental task, all subjects were given practice lists consisting of two Meaningful, two Anomalous, and two Random strings in each of the two conditions. Each sentence was repeated until the child recalled 6 of 8 words or more correctly.

In the listening condition, one of two female experimenters read the word strings aloud to each subject with as little intonation as possible at a constant rate of one word/sec.

In the reading condition, the subject read each of the strings typed on the 5 x 7 cards. The subject was told to read silently, and the E covered the words after the subject read them by means of another 5 x 7 card. By watching the Ss eyes, E determined what word S was reading and when he had finished. Reading was subject-paced and presentation time was not held constant since giving sufficient time for all poor readers might have allowed opportunities for review for good readers. The subject was not allowed to go back and reread a word.

The child was instructed to repeat as many words as he could remember, in any order, after he had heard or read all 8 words in a single string. The child was allowed as much time as he needed to respond. Sentences were not repeated by E and feedback was not given.

The scoring was done on mimeographed lists of the words prepared in advance. The E wrote down the order of the words recalled and any intrusions and/or errors the subject made. There were two sessions of approximately thirty minutes each.

Two weeks after the second session with the disabled readers, an experimenter returned to the school for a decoding check. All the disabled readers were asked to pronounce all the words they had received in the experiment; their mean was 98 percent correct. While the good readers were not tested, they were assumed to perform at the same high level of proficiency.

Results and Discussion

The dependent variable was number of words recalled correctly regardless of order. The first analysis conducted on these data was a 2(groups) x 2(modalities) x 3(sentence types) repeated measures analysis of variance. The sentences were treated as a random effects variable in agreement with the Clark (1973) viewpoint. Consequently, procedures for successively pooling error and interaction terms outlined by Winer (1971) were used (p. 374-384). To examine whether the recall of spoken and written sentences requires different psycholinguistic operations, the interaction between modality and sentence type was examined. It was not significant ($F = 1.91$, $df = 2/68$, $p > .10$). This shows that different sentence types had the same relative difficulties irrespective of whether they were presented in written or spoken

form. More specifically, a significant main effect for sentence types ($F = 195.52$, $df = 2/74$, $p < .001$) was analyzed with Newman-Keuls tests revealing that meaningful sentences were easier than anomalous ($p < .01$) which were easier than random ($p < .01$). The importance of this outcome is that the three sentence types contained different categories of linguistic information, i.e. meaningful sentences have syntactic and semantic information; anomalous sentences have only syntactic information and random word strings have neither type of information (in very large proportions). Since meaningful sentences were easier than anomalous which were easier than random strings for both reading and listening the processing of semantic and syntactic information in the two modalities appears to be similar. Table 1 shows means and standard deviations. The total possible for each cell is 64.

To seek to determine the sources of reading comprehension problems of poor readers the question was first asked, are reading comprehension deficiencies attributable to general language comprehension deficiencies? This question may be addressed by inspection of the group x modality interaction which was significant ($F = 6.71$, $df = 1/74$, $p < .025$). As the table illustrates, poor readers were significantly lower than good readers on reading ($p < .01$), but the groups were not significantly different on listening. Viewed another way, poor readers were significantly worse in reading than listening ($p < .05$) whereas good readers were equally proficient in the two modalities.

Since poor readers appear to be lower in reading than listening comprehension some explanation of their low reading which is independent of general language capability seems needed. First we hypothesized that poor readers might manifest inefficient processing of one type of linguistic information, e.g., syntactic, during reading while showing normal

syntactic processing during listening. However, the three-way interaction between group, modality and sentence types which was required to confirm this hypothesis is not significant ($F = 1.73$, $df = 2/72$, $p > .10$). To conduct a second test of this hypothesis, we counted the number of subjects, verbs and objects as a group and the number of other words that each subject recalled in each of the meaningful sentences. On these data a 2(groups) x 2(modalities) x 2(recall categories-svo vs. other) repeated measures analysis of variance was conducted. Again the three-way interaction which was required to confirm the hypothesis was not significant ($F = 1.67$, $df = 1/34$, $p > .10$). The measure of psycholinguistic processing was sensitive since subjects, verbs and objects were recalled more frequently than other words ($F = 109.84$, $df = 1/34$, $p < .001$). In addition, this factor did not interact significantly with either group or modality which provides a replication of previous results in this study which involved a different measure of psycholinguistic processing, i.e. meaningful vs. anomalous vs. random word strings. Therefore, we have no evidence that poor reading comprehension is a consequence of a deficiency of processing any one individual category of linguistic information in reading. Both semantic and syntactic information are processed less efficiently in reading than in listening by poor readers.

Next we hypothesized that poor readers may not have acquired decoding skills to a level of automaticity and that poor decoding interfered with comprehension (LaBerge & Samuels, 1974). There are alternative means of operationalizing automaticity for experimental study. In one interpretation (Perfetti,1975) automaticity of decoding implies speed

of decoding. If decoding is not automatic, and slow, a relatively heavy load is placed on working memory during decoding. Consequently, information presented early in a reading task will be more likely to be forgotten by slow decoders than fast decoders while information presented later in the sequence will be recalled equally by the groups. To test this suggestion, data for the meaningful and random sentences for both groups and both modalities were partitioned by the eight serial positions in the word strings and sentences. The hypothesis predicts that the poor readers will be lower than good readers in the early position, but not the later positions of the serial position data for reading and that the serial position data for listening will be similar for the two groups. The needed three-way (group x modality x position) interaction decoding inhibits comprehension by producing loss of memory for words presented early in a written sequence.

A second interpretation of the automaticity hypothesis which seems closer to the intent of its authors is that slow, laborious decoding consumes a large proportion of available attention and reduces the amount of attention that is devoted to meaningful processing. This hypothesis suggests the prediction that poor readers will perform lower than good readers on all positions in meaningful sentences, but the two groups will be similar on random word strings; and this will occur for reading but not listening tasks. However, the group x modality x sentence type interaction was not significant, bringing the hypothesis into question. It should be noted that a number of position effects were found. There was a significant main effect ($F = 20.53$, df 7/238, $p < .001$). Position interacted with modality ($F = 2.14$, df 7/238, $p < .04$)

showing that scores in listening were higher than reading in the later positions (6, 7, 8) but not in the earlier positions (1-5). This is understandable in terms of the facilitation of recall by the acoustic storage of recently presented spoken stimuli which is weaker for written stimuli. Finally, position interacted with sentence type ($F = 15.37$, df 7/238, $p < .001$) due to the fact that positions 2, 6 and 8 were occupied by subjects, verbs and objects in meaningful sentences which increased recall for these positions whereas there were no subjects, verbs or objects in the random word strings.

Since poor readers were not inferior in psycholinguistic processing nor automaticity of decoding, we proposed that they were not decoding adequately, i.e. completely and consistently, during reading. If so, words would not be entered into short-term memory and could not be processed psycholinguistically, resulting in lower performance on all three types of written word strings. This "incomplete decoding" hypothesis was tested by analyzing intrusion errors according to whether they were attributable to inadequate decoding, inadequate short-term memory, or other forms of intrusion. Since there is evidence that the initial letter is more important than other letters in visual word recognition (Marchbanks & Levin, 1965) children who do not decode completely are likely to perform correctly on the first letter and err on other letters. Since there is also evidence that the final letters are most salient in auditory word recognition (Kuenne & Williams, 1973), it is likely that children who cannot retain words in short-term memory will preserve the final letters and err on the initial letters. It was predicted that poor readers would be more likely than good readers to make mistakes that reflect incomplete decoding in which initial letters

are correct and other letters are incorrect. It was also predicted that good and poor readers would make the same number of errors that reflect inadequate short-term memory in which final letters are correct and other letters are wrong.

For the analysis of intrusion errors, four categories were constructed based on the similarity between the error and the original stimulus word: 1) first letters same, last letters same; 2) first letters same, last letters different; 3) first letters different, last letters same; 4) first letters different, last letters different. For each word string, each intrusion error was matched to the stimulus word that was most similar to it. The intrusion error was then classed into one of the four categories. Interrater reliability of categorizing the errors was .90 on a random sample of the data. All intrusion errors for all Ss in the reading-random word string condition were used. For each child the errors in each category were totalled, providing a score for each child on each error type. The means and standard deviations are presented in Table 2. A 2(groups) X 4(error types) repeated measures analysis of variance was conducted that yielded a significant interaction ($F = 4.03$, $df = 3/102$, $p < .01$). Post hoc tests with the Newman-Kuels procedures confirmed the prediction. Poor readers made significantly more errors than good readers in category 2 ($p < .01$), but the two groups were not significantly different in category 3 or in the other two error types. The number of errors attributed to inadequate decoding was higher for poor than good readers, but errors attributed to other factors were the same for thw two groups. Therefore, it appears that poor readers did not completely decode many of the words in the written conditions

with the consequence that recall among poor readers for all types of written word strings was lower than the recall among good readers.

Discussion

The supposed parallel in processing of written and spoken forms of language was documented in this study. It was found that semantic and syntactic characteristics of sentence and/or word strings facilitated verbal recall to an equal degree for reading and listening tasks. That is, the advantage of meaningful sentences over anomalous sentences over random word strings was similar in magnitude and level for visual and auditory modalities. Since word meanings and sentence structure retained their basic linguistic properties regardless of the medium in which they were represented, it appears that the acquisition of reading comprehension is dependent not only on a global language capability, but on a precise set of relationships between semantic and syntactic functions in oral language processing. The parallel between reading and listening is confirmed only at the single sentence level in the present study. As Craik & Lockhart (1972) illustrate, recall of verbal materials depends on the depth and elaboration of the processing that are possible in the task. Since the recall of a multi-sentence unit (paragraph) permits deeper and more elaborate operations than a single sentence unit, it is possible that differences between psycholinguistic operations in reading and listening will be found at the paragraph level.

Our findings also suggest that the failure of some children to comprehend written language cannot totally be attributed to a failure to comprehend spoken language. Poor readers were significantly lower

than good readers on reading comprehension although they were equal to good readers on listening comprehension. It should be noted that the poor readers were older than the good readers. It is likely that for good and poor readers of the same age, the good readers would be superior on the listening task. However, since the absolute level of the reading comprehension was lower than listening for poor readers in this study, a lack of spoken language processing capability could not have been the only source of reading comprehension deficiency.

It should be noted that while the good and poor readers were matched on the standardized reading test, they differed significantly on the experimental reading task. The two reading tasks differed substantially, since the standardized tests could be scanned and reviewed, searched for specific answers to the questions on the test, and could be integrated with prior knowledge. These processes were minimized in the experimental tasks. Poor readers may have performed relatively worse on the single sentences than the standardized test paragraphs because they have learned to engage in search and integration operations to compensate for their difficulties in decoding and in processing large proportions of the information in large proportions of the sentences.

Several sources of reading comprehension deficiency were examined. In the first place the reading comprehension deficiency was not attributable to a failure of poor readers to utilize semantic and syntactic cues. For poor readers in the reading task the recall of meaningful sentences was significantly higher than the recall of random word strings. Thus the semantic and syntactic cues facilitated processing and recall. This interpretation is confirmed by the report of Steiner,

Weiner & Cromer (1971) in which poor readers, as well as good readers, made more oral reading errors in a paragraph than in a word list. Psycholinguistic cues, which were present in the paragraph and absent in the word list, influenced word identification, and consequently were processed, by both groups. The popular interpretation of this study, originally voiced by its authors, that poor readers read "as if the words were unrelated items unaffected by syntactical or contextual relationships" (p. 511), appears to require modification.

The poor readers were lower than good readers in recall of all written sentence types: meaningful, anomalous and random. This result cannot be attributed to a general memory deficit since the poor readers were relatively proficient, i.e., equal to good readers on recall of all types of sentences that were spoken. It could be suggested that the short-term memory (STM) of poor readers for written material was deficient such that the words entering STM early in a trial could not be retained although the later words were retained. However, the data did not warrant this conclusion. Words at all eight positions in the meaningful sentences were recalled less accurately by poor than good readers.

A probable explanation for the relatively low recall of poor readers on written presentation is incomplete decoding. During silent reading, poor readers may not decode as many words as good readers into sound form that are easily processed in short-term memory. The preponderance of intrusion errors for poor readers reflected inadequate decoding rather than poor short-term memory or semantic associates.

This failure to decode some of the words or syllables may occur despite the presence of the capability to decode since, according to Perfetti and Hogoboam (1975), the operation of decoding requires an inordinate degree of time and attention among poor readers. This position leads to the prediction that accurate word identification skill does not necessarily produce good comprehension in poor readers. The prediction is confirmed by Oaken, Wiener and Cromer (1971), who reported that poor readers did not comprehend paragraphs for which they learned to identify all the words any better than paragraphs for which they had no word identification training. Reading comprehension of good readers, on the other hand, was improved by an increase of word identification capability. The frequency with which poor readers, during silent reading, decode written words into forms that can be easily processed in STM and entered into language processors appears to be lower than the frequency for good readers. Consequently, reading comprehension deficiency is at least partially attributable to a failure to fully identify a sufficient number of the words during the course of reading.

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TABLE 1

MEANS AND STANDARD DEVIATIONS ON

3 TYPES OF WORD STRINGS IN TWO MODALITIES

FOR GOOD AND POOR READERS

		Reading			Listening		
		Word String Types			Word String Types		
		M	A	R	M	A	R
Good	$\bar{x}$	47.11	32.17	28.94	46.39	33.72	31.89
	sd	10.13	5.09	5.46	7.31	7.12	4.44
Poor	$\bar{x}$	42.33	31.11	25.83	45.89	35.61	32.17
	sd	12.86	9.84	7.61	10.73	10.49	7.77

TABLE 2

INTRUSION ERRORS

	ERROR CATEGORY							
	1 same-same		2 same-different		3 different-same		4 different-different	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Good	1.2	(1.4)	4.1	(2.6)	1.2	(1.3)	3.3	(3.9)
Poor	1.2	(1.4)	7.1	(3.2)	1.2	(1.4)	3.4	(3.6)