DOCUMENT RESUME

ED 239 425 EC 161 162

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TITLE Deaf Readers Ability to Analyze Morphological Regularities.
PUB DATE Aug 83
NOTE 13p.; Paper presented at the Annual Conference of the American Psychological Association (Anaheim, CA, August 26-30, 1983).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Adults; *Deafness; Decoding (Reading); *Morphology (Languages); Reading Instruction; Reading Processes; Spelling; *Word Recognition

ABSTRACT

Seventeen deaf adults and 17 hearing controls participated in three experiments to determine the use of morphemes by deaf Ss as a unit of analysis in reading English. Ss were asked to circle pairs of words with related meaning, divide a derivationally complex word into its component parts, and choose words that best complete sentences. Among findings were that the deaf Ss generally were not confused by visual similarities and identified word pairs with 90% accuracy; deaf Ss were more likely to commit syllabic errors than hearing Ss and deaf Ss scored significantly above chance on the word completion tasks, with an average of 84% correct. It is suggested that in the absence of sound, morphological information can provide a compensatory approach to word identification and reading comprehension. (CL)

Deaf readers ability to analyze morphological regularities.

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Presented at the American Psychological Association Conference, Anaheim, CA, August 1983.

In a 1970 article, Noam Chomsky argued that English orthography is optimal. It has evolved to capture a perfect balance between an alphabetic/sound representation and a morphological/meaning based representation. The alphabet provides a good approximation to the sound of printed words. Hence, those equipped with an alphabet and with spelling-sound rules can "sound-out" unfamiliar words in an attempt to locate their meanings. Yet the alphabetic representation is not so exclusive (in English) that it camouflages the relationship between families of words that are similar in meaning but different in pronunciation. The oft cited word pair telegraph/telegraphy provides one example of a case in which pronunciation varies without an accompanying spelling change. Thus, readers who know morphological roots and endings could identify unfamiliar words by relating the new word to words already in their vocabularies. It has been estimated that 50% of the content words in adult reading material are morphologically complex. Consequently, attention to the morphological information in the visual print can potentially increase word identification by 100%.

Though both alphabetic and morphological information are available to English readers, only the role of the alphabet or sound based rules has been extensively studied. The relationship between sensitivity to morphemes and reading skill has been largely neglected.

This research is an attempt to learn more about the ways in which morphological information can be detected and used by readers of English. We assume, along with other proponents of a dual process theory of reading, that normal readers can identify printed words either by (1) converting them into sound (the so called Phonetian method) or, (2) by going directly from print to meaning (the so called Chinamen method, see Baron, 1979). Profoundly deaf readers, in contrast, must develop word identification skills without the Phonetian advantage of spelling to sound rules. It thus becomes reasonable to hypothesize that as obligate "Chinamen", successful deaf readers might rely on the visually apparent "morpheme" as a basic unit of analysis. That is, by focusing on profoundly and congenitally deaf individuals who master English reading, we might learn more about the potential information that morphological cues can provide the reader.

Our research project is divided into three separate phases. Today, I am reporting only on the first of these research endeavors. Can deaf individuals use the morpheme as a unit of analysis in reading English? I hope to convince you that deaf individuals are especially attuned to the visual information represented in print. They not only attend to visual redundancies and to regular spelling patterns as suggested by Hanson and earlier by Gibson (1965); but they go beyond this limited visual information to construct word knowledge at the morphological level.

The subjects for these preliminary experiments were 17 second generation congenitally deaf adults, all of whom were native users of American Sign Language (ASL). Their average reading score on the paragraph meaning subtest of the Stanford Achievement Test, Level II was 9th grade. The median reading level for this group is at 11th grade and the range is from 4th through 12th. Thus, deafness was very narrowly defined by the small sample of profoundly congenitally deaf individuals who are both native signers and successful readers.

Seventeen eighth graders who were matched to the deaf readers on the same subtest of the Stanford Achievement test served as the hearing control group. All were of average or above average intelligence. Unlike the deaf subjects, however, all of these students had some training in derivational morphology.

These 34 subjects participated in three paper and pencil tests that are outlined in Tables 1 through 3 on your handout. In the first experiment, the word relations task, subjects were asked to circle pairs of words that are related in meaning. The procedure is modeled after that used by Derwing and Baker (1979) and by Freyd and Baron (1982). Half of the words that are presented to the subject are related both in meaning and in visual appearance. Half of the words are related in visual appearance only. So, for example, subjects might see the derivationally related words SHIP and SHIPMENT along with a control word pair of PIG and PIGMENT. These words were carefully chosen so that correct responses would not be a byproduct of contextual word associations. That is, the word SHIPMENT is no more likely to have been learned in the context of ships than is PIGMENT to have been learned in the context of pigs. Notice also that successful completion of the task requires more than just visual analysis or awareness of orthographic redundancies. The ability to differentiate derivational word pairs from control word pairs requires analysis at the morphological level.

The second experiment, outlined in Table 2, is the word analysis task. Here subjects are asked to divide a derivationally complex word into its component parts. Successful completion of this task requires recognition of common prefixes, suffixes and root words. Though the instructions request morphological analyses, a number of alternative and incorrect word divisions are possible here. For example, one might parse the word DIVISION into the segments of DI and VISION earmarking the embedded word VISION in the more complex word. One might also choose to bypass morphological segmentation in favor of syllabic segmentation. Here the word DIVISION would be incorrectly parsed into the three segments DI VIS ION. Finally, one might fail to abstract the appropriate derivational endings yielding segments like KNOW + INGLY where they demonstrate an ability to separate the root from the suffixes, but fail to differentiate between the suffixes ING and LY. Thus correct responses in this task necessitate a conscious recognition of morphological roots, conventional prefixes and word endings. They also require subjects to understand that each of the divided parts must independantly serve as a unit of meaning: that an analysis yielding DI and VISION must necessarily be wrong.

Finally the third experiment, outlined in Table 3, calls upon the subject's productive rather than reflective knowledge of English morphological structure. In this "word box" test, subjects are presented with a sentence completion task. Given the sentence frame, FRED KNOWS HOW TO ___________ THE REPORT, they are asked to choose which of five nonsense words, SNARKMENT, SNARKIFY, SNARKIST, SNARKABLE or SNARKNESS, best completes the sentence. Successful completion of this task requires that subjects not only know that IFY is a derivational ending, but also that it is used to transform certain adjectives and nouns into verbs. The task cannot be solved by analogy to any single English word because the range of endings appended to each nonsense word exceeds that which is appropriate for any single English derivation.

The results from these experiments are best discussed with respect to three issues. First, how do the deaf subjects perform overall? Second, what types of errors do deaf subjects make? Third, how does the performance of the deaf individuals compare with that of the hearing readers? In all of the analyses, responses were scored only if the subject knew the vocabulary item being probed. Also a number of analyses were performed using the split-half technique: by separating the readers into two reading groups of high verses average or below. This technique is motivated by the results presented in Freyd and Baron (1982) in which the top readers showed a sensitivity to morphological analyses that was not apparent in the average or below average readers.

We begin with the word relations task. Overall, the deaf individuals in our sample were not confused by the visual similarities prevalent in this experiment. When asked to circle pairs related in meaning, they accurately do so in 90% of the cases, performing at a level well above chance ($t = 5.1$ (16), $p < .001$). They can use the morpheme as a unit of analysis in this task. In the error patterns, the deaf individuals, like hearing individuals, are conservative revealing a reluctance to circle word pairs that are actually related in meaning. They do not even default to a visual strategy when they are unsure of a response. Further, analyses of error patterns suggests that these subjects are not even using a sign based strategy. At the completion of this task, all subjects were asked to judge whether the words in each word pair would be signed similarly or differently in their dialect of sign language. Since many of the word pairs judged as similar in English were not similar in sign and since many sign related words were not assessed as related in English, we can safely conclude that sign recoding did not determine responses. The subjects assessed word relatedness on the basis of English morphology alone.

Finally, one might ask how the deaf readers compare with their hearing counterparts. The data were analyzed using an analysis of variance with factors of group (hearing verses deaf) and reading level (high verses average or below). These results are summarized in Table 4 of your handout. There you see that deaf readers are performing at levels commensurate with hearing readers. While there are no main effects for group or level, an interesting trend does emerge in the interaction of these factors ($F(1,30) = 3.75$, $p < .10$). Average and below average hearing readers performed significantly worse than the other three groups: a result that is consistent with Freyd and Baron's (1982) research on hearing individuals. It is interesting the the deaf readers do not show a decrement in performance at the lower reading levels. Here is one situation in which deaf readers appear to do better in abstracting morphological information than matched hearing readers. Without phonological interference, deaf readers seem, uniformly, to achieve high levels of morphological awareness.

The results of the second experiment provide converging evidence on the transparency of the morpheme. Overall, deaf subjects achieved an average of 80% correct on these problems. The error data, again, reveals the most interesting information. Half of the errors committed by the deaf individuals, involved what we term "spelling change" errors. For example, the derivation of UNFORTUNATELY from

FORTUNE requires a deletion of the final E. As you can see in Table 5a, deaf individuals were significantly more sensitive to these spelling change divisions than were hearing people ($t(16) = 2.09$, $p < .06$), two tailed. This sensitivity to spelling is also consistent with the fact that the deaf individuals were two years above the hearing readers in spelling level as evaluated on the spelling subtest of the Stanford Achievement Test. In direct contrast, the average and below average hearing readers were much more likely to commit syllabic boundry errors. A full 75% of the errors made by average or below hearing readers was due to parsing at syllabic boundries. The two way analysis of variance, summarized in Table 5b suggests that these sound considerations are again interfering disproportionately with the average hearing reader's performance ($F(1,30) = 13.75, p < .01$).

Finally, the word box task attests to the deaf reader's ability to productively use morphological word endings. Overall, these individuals scored significantly above chance on this task yielding an average percent correct of 84%. All of the subjects, deaf and hearing, made many more errors on the derivational endings than on the inflectional endings (those endings governed by syntactic agreement, ie. the plural s or progressive ing).

In sum then, the deaf readers (1) are using morphological analysis - or visual analyses that go beyond the recognition of visual regularities, (2) are learning the information implicitly from the reading of English and are not relying on sign generalizations and, (3) seem to have some advantage in these tasks over the average or below average hearing readers who are matched to their level in reading.

So we turn to the question posed by this symposium. How important is the role of sound in reading? We know that sound provides one way of moving from print to meaning. Traditionally, the dual process theories of reading suggest that word identification is accessesed through sound decoding and through whole word association. This research proposes a third route to the lexicon through morphological analysis: a route that is also available through the English orthography. Freyd and Baron (~~1979~~ 1982) have already demonstrated that morphological analysis is important in highly skilled reading. Their research also suggests that average and below average readers are not attuned to this level: often hindered by an overreliance on sound. The preponderance of syllabic boundary errors by the hearing readers in our sample exemplifies this dependence on sound. On the other hand, deaf individuals were adept at locating morphological cues unless the morphological consistencies were obscured by spelling changes. Thus it seems that in the absence of sound, English orthography provides a third access route to the lexicon through morphological analysis. To the extent that subjects can and do use this morphological information in reading it should offer a compensatory strategy for achieving word identification and subsequent reading comprehension. Only future research using on-line reading tasks will determine the full extent to which these word analysis skills impact on the reading process.

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Table 1 Word Relations Task

ship	shipment
pig	pigment
clear	clearance
sent	sentence
burn	burner
corn	corner

Table 2 Word Analysis Task

	Prefix	Base	Suffix	Suffix
division		divid(e) or divis	ion	
knowingly		know	ing	ly
unfortunately	un	fortun(e)	ate	ly

Table 3 Word Box Task

snarkment, snarkify, snarkist, snarkable, snarkness

Fred knows how to ______________ the report.
She bought a ______________ dress.
His ______________ was a success.
The ______________ received an award for his work.

Table 4 Results of the Word Relations Task

Percent of correctly circled morphologically related pairs from the possible related pairs.

		Reading Level: High	Reading Level: Low
Group	Deaf	$\bar{x}$ = 79.00 s = 22.00 n=9	$\bar{x}$ = 83.13 s = 11.20 n=8
	Hearing	$\bar{x}$ = 88.00 s = 10.06 n=9	$\bar{x}$ = 75.25 s = 9.30 n=8

Interaction (F (1,30) = 3.75, $p < .10$)

Table 5 Results of the World Analysis Task

A. Percent of spelling errors from possible spelling errors.

Deaf	Hearing
$\bar{x}$ = 48.59 s = 19.34 n=17	$\bar{x}$ = 34.12 s = 19.79 n=17

(t (16) = 2.09, $p < .06$), two tailed

B. Percent of errors made at syllabic boundaries that were not also morpheme boundaries from total possible errors.

		Reading Level: High	Reading Level: Low
Group	Deaf	$\bar{x}$ = 1.44 s = 4.3 n=9	$\bar{x}$ = 6.25 s = 11 n=8
	Hearing	$\bar{x}$ = 1.44 s = 4.33 n=9	$\bar{x}$ = 11.3 s = 8.1 n=8

F(1,30) = 13.85, $p<.01$

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