14 Reading Without Vowels: Lexical Access in Hebrew

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ABSTRACT

Hebrew has two forms of spelling, pointed and unpointed. In the unpointed form, letters carry mostly consonantal information, whereas vowels are generally not directly given; in the pointed form, certain signs are added that convey vowel information. Three experiments are described in which Hebrew words that have only one pronunciation when unpointed were used. Half were transformed into nonwords by changing one letter. In Experiment 1 these letter strings were presented, either pointed or unpointed, for lexical decision. They were preceded by word primes. The following predictions were tested, based on the assumption that lexical access is phonologically mediated: (a) lexical decisions should be faster for pointed strings, (b) the effect of pointing should increase with string length, and (c) the effect of pointing should be reduced by a related context. The results lent support for none of the above predictions, suggesting that lexical access is by and large direct.

Experiments 2 and 3 used a pronunciation task, with Experiment 2 including only words and Experiment 3 including both words and nonwords. Pronunciation latencies for words revealed main effects for Experiment 2 vs. Experiment 3 for pointing and for context but no interactions. The results are seen to support a parallel-conjunctive model of reading, according to which the pronunciation of a word is derived both lexically and nonlexically in parallel, but both processes must be

Koriat, A. (1984). Reading without vowels: Lexical access in Hebrew. In H. Bouma, & D. G. Bouwhuis (Eds.), Attention and Performance X: Control of language processes (pp. 227-242). Lawrence Erlbaum Associates.

completed and their results compared before the commands for articulation are issued. Additional results pertaining to the effects of string length are presented, and their implications are discussed.

INTRODUCTION

One of the basic questions in reading research is whether access to the lexical entry of a printed word is mediated by its phonological representation. According to one position, a visually presented word is first converted into a phonological code before its meaning can be retrieved (Rubenstein, Lewis, & Rubenstein, 1971). A second position is that semantic information may be retrieved directly from the graphemic representation of a word (Smith, 1971). A third position is that both modes of access are available and may be used either interchangeably or simultaneously. Evidence pertinent to these positions has been reviewed elsewhere (McCusker, Hillinger, & Bias, 1981) and will not be dwelt on in the present paper.

The present study involves Hebrew. Hebrew orthography has two forms of spelling, unpointed and pointed. In the more traditional, unpointed form, letters carry mostly consonantal information, whereas most vowels are generally not directly expressed by any letters or signs. Hebrew unpointed spelling is therefore considerably ambiguous with respect to grapheme-to-phoneme translation and contains a large number of homographs. In view of this ambiguity, vowel signs, referred to *as pointing,* were invented, which are placed above, below, and inside the letters (see Navon & Shimron, 1981). When pointing is superimposed on the traditional spelling, pointed spelling results. Pointing supplies not only vowel information but also some consonantal information. Without pointing, for example, the letter *Shin* may convey either /s/ or /sh/. Likewise, both /v/ and /b/ may be expressed by a single letter, and so may /p/ and /f/. Pointing, then, removes a considerable amount of the phonemic ambiguity.

Unpointed spelling may nevertheless contain some vowel information. Thus in some words the letter *Vav* may express the phonemes /o/ or /u/, and the letter *Yod* may convey the phonemes /i/ or /e/. Yet both *Vav* and *Yod* can also convey consonantal information (the phonemes /v/ and /y/, respectively). This, in addition to the possibility of their expressing more than one vowel phoneme each, still leaves a great deal of ambiguity.

Pointed spelling is only used nowadays for prayer books, poetry, children's literature, and books for teaching Hebrew. School children begin by learning to read pointed spelling but gradually move on to unpointed spelling. In common adult use, some of the ambiguity involved in unpointed spelling has been reduced by extending the use of the letters

unpointed	pointed	corresponding consonants	pronunciation
תל	תֵּל	TL	tel
כנף	כָּנָף	KNF	kanaf
ברזל	בַּרְזֶל	BRZL	barzel
מרפסת	מִרְפֶּסֶת	MRPST	mirpeset
התלבש	הִתְלַבֵּשׁ	HTLBS	hitlabeʃ

FIG. 14.1 Examples of Hebrew unpointed and pointed words, their roughly corresponding Latin letters, and their pronunciations.

Vav and *Yod* by inserting them as vowel markers even where strict grammar rules would disallow their usage.

Figure 14.1 presents examples of pointed and unpointed words and their pronunciations. It also presents the Latin letters equivalent to the Hebrew consonants (from left to right). It should be recalled that Hebrew is read from right to left.

In comparing Hebrew to English, we might say that in its unpointed form Hebrew is considerably more ambiguous than English as far as the derivation of a phonological code is concerned. The superimposition of pointing, however, removes most of the phonological ambiguity and makes pointed Hebrew less ambiguous phonologically than English. This peculiar feature of Hebrew allows the methodological advantage that the extent of phonological ambiguity may be experimentally manipulated with regard to the same set of letter strings by using the pointed or unpointed spellings.

EXPERIMENT 1

In the first experiment, Hebrew letter strings varying in length were presented for lexical decision, each preceded by a prime word. The target strings were either pointed or unpointed, and when they were words they were preceded by either a related or an unrelated prime. All words, it should be stressed, had the same pronunciation whether pointed or not, so that pointing was essentially redundant.

If phonological encoding is necessary for lexical access, then (1) lexical decisions should be faster for pointed than for unpointed letter strings; (2) lexical decision time should increase as a function of array length; (3) the advantage of pointed over unpointed spelling should increase with increasing string length; and (4) context effects should be greater for unpointed than for pointed strings.

The first prediction rests on the assumption that the derivation of a phonological code must require one or more operations with unpointed strings than with pointed strings. The second and third predictions assume that this derivation involves a serial process whereby different readings of the letter string are examined in sequence. Thus, the longer the letter string, the more readings are possible and the stronger the advantage of pointing. The fourth prediction assumes that a related context resolves phonological ambiguities, and therefore the presence of a related context may compensate for the absence of pointing.

Method

Apparatus. The stimuli were presented in a three-field Gerbrands Harvard-type tachistoscope model T-3B-1. Only two fields were used. Viewing distance was 76cm. The luminance of the field was about ll.0cd/m^2

Stimulus Materials. Ninety-six Hebrew words were compiled from Balgur (1968), which lists Hebrew word frequencies in primary school material. These represented four levels of string length, with 24 words in each cell. String length varied from two to five *consonant* letters. Thus, the word "deckle," for example, is a three-letter word, since its consonant string is written as "dkl."

All 96 words satisfied the following conditions: First, when unpointed, they allowed for only one correct reading. This means that pointing did not resolve any lexical ambiguity. Second, none of the words included the letters *Vav* or *Yod,* which are often used to convey vowel information. Third, none of the words included a mute letter. Twelve words in each cell were transformed into nonwords by replacing one of the letters by another letter (not including *Yod* or *Vav).* In their pointed form, the nonwords had the same pointing as the original base words. The practice list included 12 word-nonword pairs, 6 related word-word pairs, and 6 unrelated word-word pairs, randomly ordered. All stimuli were made with Letraset Tal Vardi Bold Letters (sheet no. 516930). Each letter string appeared on the center of a card. The pointing was added by HR 420 Letraset symbols.

Design and Procedure. A pointing x context design was used with pointing as a between-subject and context as a within-subject factor. Half of the target words of each length were preceded by their related primes for half of the subjects and by unrelated primes for the other half in a counterbalanced arrangement. In the pointed condition, all target words were pointed; in the unpointed condition, they were not. All primes were pointed for all conditions. Subjects were instructed to classify the strings as words or nonwords as quickly as they could and to pay attention to the preceding prime.-In the pointed condition they were informed that all words were correctly pointed and that none of the nonwords would make a word if pointing were changed or eliminated.

Each trial was initiated by a beep followed after 100 msec by a presentation of the prime for 500 msec. No overt response was required to the prime. After a 100-msec interval, the letter string was presented for 1000 msec. Subjects classified the letter string by pressing one key (labeled "word") with the right index finger or another key (labeled "nonword") with the left index finger. Response time was measured to the nearest millisecond with a maximum of 2.5 sec allowed.

Subjects. Forty students participated for course credit, all of whom used Hebrew as their first language. Twenty subjects were assigned to the pointed and 20 to the unpointed condition.

Results

We shall first examine the results pertaining to mean latencies for correct responses to words. A pointing x context x length ANOVA was carried out twice, collapsing first over subjects and then over items. Clark's (1973) F_{min} statistic was then calculated. Pointed spelling had a 7-msec advantage over unpointed spelling, yielding $F_S<1$, $F_i(1, 44) = 3.98$, $p<.10$ and $F_{min}<1$. The effect of context was significant [$F_{min}(1, 82) = 14.09$, $p < .001$], but the context x pointing interaction was not ($F_{min} < 1$). The net effect of context was 43 msec for unpointed words and 37 msec for pointed words. Neither the effect of word length ($F_{min}<1$) nor the length x pointing interaction ($F_{min}<1$) were significant. There was, however, a slight tendency for 5-letter words to require longer response times than shorter words (Fig. 14.4, p. 238), and for these words there was a 22-msec advantage for pointed over unpointed spelling.

The error data yielded somewhat stronger evidence for phonemic recoding. Mean error rate was 5.3% for unpointed and 2.9% for pointed words, but the difference was significant only in the item-based ANOVA [$F_i(1, 44) = 6.82$, $p< .05$]. Also, a related context reduced error rate by 4.4% for unpointed and by 1.1% for pointed words, but this interaction was significant only in the subject-based ANOVA [$F_s(1,38) = 4.17$, $p < .05$]. Error rates for words of lengths two to five were 3.9, 4.4, 2.7, and 5.5%, respectively, with five-letter words yielding the largest advantage for pointed (3.1%) over unpointed (8.0%) spelling.

The nonword correct responses revealed a 14-msec advantage for pointed spelling (Fig. 14.3), which approached significance in the item-based ANOVA [$F_{,}(l, 44) = 3.69$, $p < .10$]. Response times varied nonmonotonically as a function of string length (Fig. 14.4), and there was no indication that the effect of pointing increases with string length ($F_{min} < 1$ for the interaction). Percent errors also indicated an advantage for pointed (4.5%) over unpointed (8.2%) spelling, a difference that was significant in both ANOVAs but yielded $F_{min}(l, 78) = 3.85$ (not significant).

Discussion

The latency results on the whole lend little support for the phonemic recoding hypothesis. There was no main effect of pointing, nor was there an interaction between pointing and context. Furthermore, word length had little effect on lexical decision latency, and the effect of pointing did not increase with increasing string length.

These results imply that phonemic recoding does not play any role in lexical access, or that lexical access proceeds in both a visual and a phonological route in parallel but that the former is always faster. As far as the effects of string length are concerned, Frederiksen and Kroll (1976) have already noted that their absence for words in a lexical decision task supports the view of direct, visually based lexical access. In the present experiment, the fact that no such effects were found for unpointed orthography, with words ranging in length from two to five consonantal letters, is particularly instructive. This finding would be detrimental to a phonemic recoding view only if it is assumed that the conversion of a letter string into a phonological code involves serial, piecemeal translation, rather than looking up the word as a whole in the phonological lexicon. The latter possibility was rejected by Coltheart (1978) for English but might nevertheless hold for Hebrew.

EXPERIMENTS 2 AND 3

Experiments 2 and 3 examined naming latency. Existing studies disagree with respect to the role of lexical access in reading aloud. One position asserts that if a phonological representation must be derived before lexical access, this representation may also serve as the basis for forming the motor commands necessary for articulation. A second position maintains that phonological representation is not only necessary for lexical access but, rather, may itself depend upon lexical access. Baron and Strawson (1976) postulated two mechanisms for pronouncing printed words, an orthographic mechanism in which the phonological code is directly derived from the printed word and a lexical mechanism that first uses the visual record to access the lexicon and then obtains the pronunciation of the word from the lexicon.

Experiments 2 and 3 were designed to investigate the process underlying pronunciation. The procedure and stimuli for Experiment 3 were identical with those used in Experiment 1, except that the task was pronunciation. Experiment 2 differed in that it included words only (whereas Experiment 3 included words and nonwords, mixed).

If, for the set of words employed in these experiments, lexical access is indeed direct, what is the process by which a phonological code is derived? Three types of models are schematically sketched in Fig. 14.2. The first, "lexical" model assumes that once a lexical entry has been accessed directly from a printed word, it allows the derivation of a phonological code. Only when an entry cannot be located—as with nonwords—does the reader resort to a derivation of phonology directly from the printed word. The second, "disjunctive" model assumes that two processes begin with the. visual record, and that pronunciation is determined by one of them. One version of this model is the horse-race model, according to which the generation of a phonological code may begin before access to a lexical entry has been achieved and may therefore be affected by stimulus variables other than those affecting lexical access. In the third, "conjunc-

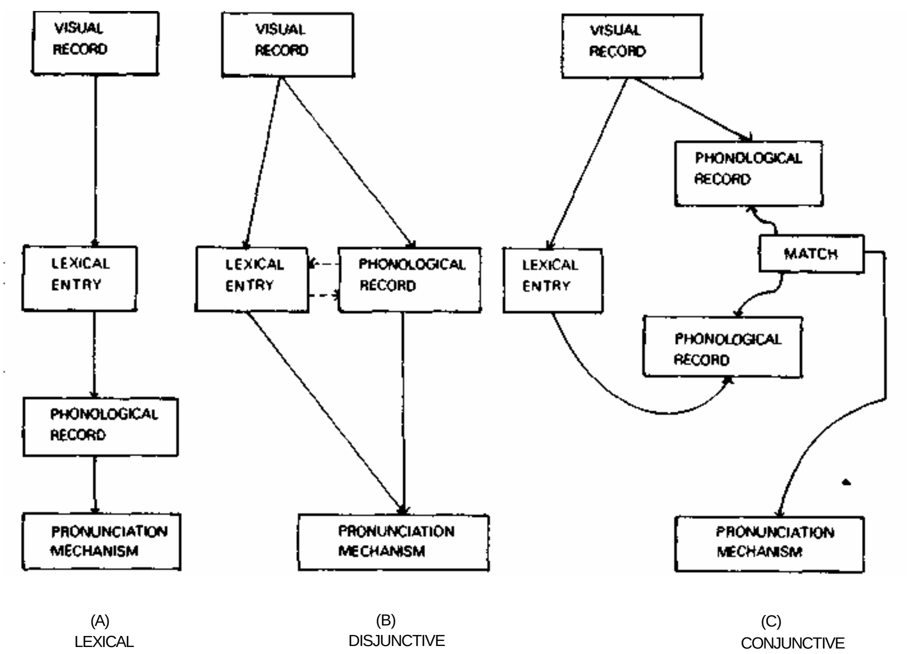

FIG. 14.2 Three models of reading aloud.

tive" model, the commands for articulation are issued only once both processes have been completed and their outcomes compared. In this model, a lexically derived phonemic code must first be checked against the visual record before articulation can take place (see Patterson & Marcel, 1977).

If the first model is correct, the results for the pronunciation of words should parallel those found for the lexical decision task, namely, no effects for pointing. The second model allows for a pointing effect; this should be found whenever direct derivation of a phonemic code from the visual record is achieved before a lexically mediated derivation. The size of this effect, however, should be reduced by the presence of a related context. Since such context facilitates lexical access, it may help the lexically mediated process win the race, and, as the results of Experiment 1 suggest, it should reduce or eliminate the effects of pointing. The conjunctive model, on the other hand, predicts that pointing and context should have additive effects. Since pronunciation is determined by whichever process ends last, pointing and the presence of a related context should each reduce pronunciation latency independently of the other.

Method

Procedure. The apparatus and stimulus materials of Experiment 3 were exactly the same as those used in Experiment 1, except that here a naming response was required. Reaction times were measured from target-word onset until the subject spoke into a voice-activated microphone. Experiment 2 was similar in all respects to Experiment 3, except that only words were employed.

Subjects were instructed to pay attention to the prime and to read the target stimuli aloud as fast as they could without making errors. They were informed that each word had only one correct pronunciation. In the unpointed condition of Experiment 3, subjects were instructed to read the nonwords using whatever vowels they chose, as long as they did not deviate from the consonantal structure. The words had to be read correctly. The responses of the subjects were taperecorded.

Subjects. Subjects were all students at the University of Haifa. Twenty-four subjects participated in Experiment 2, and 24 in Experiment 3. In both experiments, half of the subjects received pointed and half unpointed strings. All subjects used Hebrew as their first language,

Results

Responses that were incorrect or involved deliberations or self-corrections were excluded from the analyses (1.6% in Experiment 2 and 0.9% for the word stimuli of Experiment 3). A four-way experiment x pointing x context x length ANOVA indicated that the effects of the first three factors were all significant and almost perfectly additive. The inclusion of nonwords among the stimuli retarded pronunciation time by 103 msec (105 for unpointed and 100 for pointed) [$F_s(1, 44) = 19.48$, $p < .001$; $F_i(1, 44) = 323.7$, $p<.001$]. Pointing reduced pronunciation time by 56 msec [$F_s(1, 44) = 5.83$, $p<.05$; $F_i(1, 44) = 85.02$, $p<.001$; and $F_{min}(1, 50) = 5.46$, $p<.05$]. The effect amounted to 58 msec for unprimed and 55msec for primed words. The effect of a related context amounted to 21 msec and was significant only in the subject-based analysis [$F_s(1, 44) = 15.37$, $p<.001$].

The effects of length were highly significant [$F_s(3, 132) = 82.82$, $p<.001$; $F_i(3, 44) = 23.59$, $p<.001$]. Both analyses yielded significant experiment x length interactions [$F_s(3, 132) = 5.77$, $p<.01$; $F_i(3, 44) = 7.95$, $p<.001$]. The increase in latency from two-letter to five-letter words (Fig. 14.4) was 108msec for Experiment 2 and 169msec for Experiment 3. The subject-based ANOVA also yielded small but significant effects for the context x length and the experiment x context x length interactions.

As for nonwords in Experiment 3, 11% of the responses were classified as incorrect. Error rate was the same for pointed and for unpointed nonwords but varied greatly with string length. Thus, for nonwords of two to five letters, respectively, it was 2.2, 7.9, 10.7, and 25.8%.

A two-way pointing x length ANOVA on latency of correct responses indicated $F_s(1, 22) = 7.47$, $p<.05$, and $F_i(1, 44) = 112.81$, $p<.001$ for pointing. Presence of pointing aided pronunciation by 115msec (Fig. 14.3). The effects of length (Fig. 14.4) were $F_s(3, 66) = 55.57$, $p< .001$, and $F_i(3, 44) = 34.13$, $p<.001$. The item-based ANOVA yielded $F_i(3, 44) = 2.89$, $p< .05$ for the interaction. The increase in response latency from two- to five-letter nonwords was 299 msec for unpointed and 242 msec for pointed strings.

Discussion

The results of Experiments 2 and 3 indicate that although pointing has little effect on lexical decision, it seems to aid pronunciation. A similar effect of pointing on pronunciation latency was also reported by Navon and Shimron (1981). This result argues against the first model of Fig. 14.5, which assumes that pronunciation is always derived postlexically. Rather, it appears that even if a lexical route to phonology exists, an option for an orthographic route must also be postulated.

Let us examine these results in the light of four possible models, representing variations on the disjunctive and conjunctive models sketched in Fig. 14.2. All assume that under the conditions of the present experiments, lexical access is visually based, and that the pointed and unpointed variants of a printed word activate the same address in the lexicon.

How can pointing affect pronunciation? The first, "divergent" model assumes two disparate routes starting from a printed word, one leading to its meaning and the other to its pronunciation. This means that the pathway leading from the lexicon to phonology (Fig. 14.2) does not exist. This model can easily be rejected. First, it cannot explain the pronunciation of unpointed words, and, second, it is incompatible with the finding that even for pointed letter strings pronunciation latency in Experiment 3 was 74msec faster for unprimed words than for nonwords.

The second, "sequential" model assumes two routes to phonology, with the nonlexical route resorted to only when the lexical route fails. The advantage of words over nonwords in pronunciation time is consistent with this model and may indicate that words are pronounced postlexically, whereas nonwords require the additional operations of switching to and activating the phonological mechanism. Inconsistent with this model is the pointing effect found for words, suggesting that the pronunciation of words is not exclusively postlexical. Also the advantage of words over nonwords in pronunciation latency (Experiment 3) was essentially the same as that for lexical decision (Experiment 1), 111msec and 113msec, respectively, whereas the sequential model would predict a larger advantage for pronunciation than for lexical decision.

The third, "disjunctive-parallel" model assumes a race between the lexical and nonlexical processes. According to this model, unpointed words require longer response times because their pronunciation can be derived through the lexical mechanism only, whereas for pointed words either mechanism can be employed. If this model is correct, then which of the two mechanisms is faster? If the nonlexical mechanisms were always faster, we would obtain no advantage for words over nonwords. On the other hand, if the lexical mechanism were always faster, we would not find a pointing effect for words. Thus, it would appear that the distribution of times required for lexically mediated access overlaps with the distribution of times for phonological access. In some cases the phonological mechanism completes its operation first, on others the lexical mechanism does.

It was proposed that the critical test for comparing this disjunctive-parallel model to the conjunctive-parallel model outlined in Fig. 14.2 lay in the interactive effects of pointing and context. If the major effect of a related context is to activate the lexical entry corresponding to a target word, this would facilitate the print-to-lexicon process and, according to the disjunctive model, increase the likelihood that the lexical process would win the race. If pointing has little effect on speed of lexical access (Experiment 1), then a related context should help pronunciation but should also reduce the effect of pointing. Since there was no sign of a pointing by context interaction, the results would appear consistent with the conjunctive model. Still, it is important to note that the additivity of the pointing and context effects would be compatible with a disjunctive model as well, if it can be assumed that context affects the reading process at stages that are common to both the lexical and the nonlexical routes to phonology (i.e., very early stages or very late ones).

GENERAL DISCUSSION

Figures 14.3 and 14.4 summarize the main findings. The most significant trends in our results are as follows:

1. Pointing has almost no effect on lexical decision time, suggesting that access to the lexicon is not phonologically mediated. Pointing,

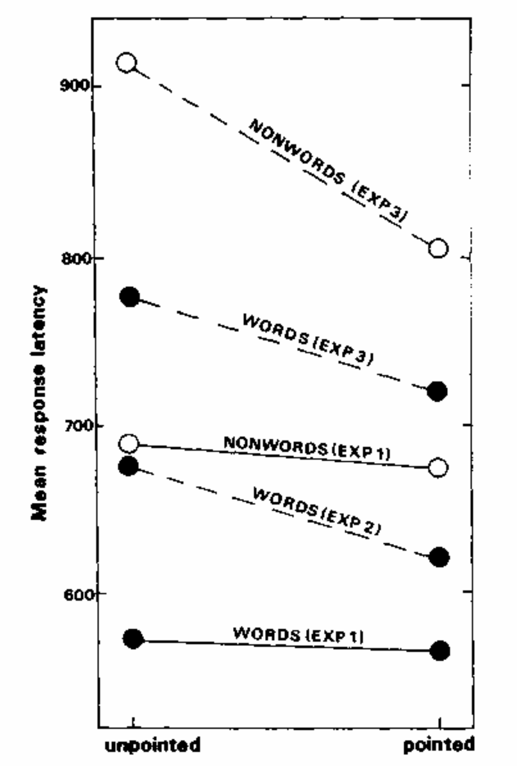

FIG. 14.3 Mean response latencies for lexical decision (Experiment 1) and pronunciation (Experiments 2 and 3) as a function of presence or absence of pointing.

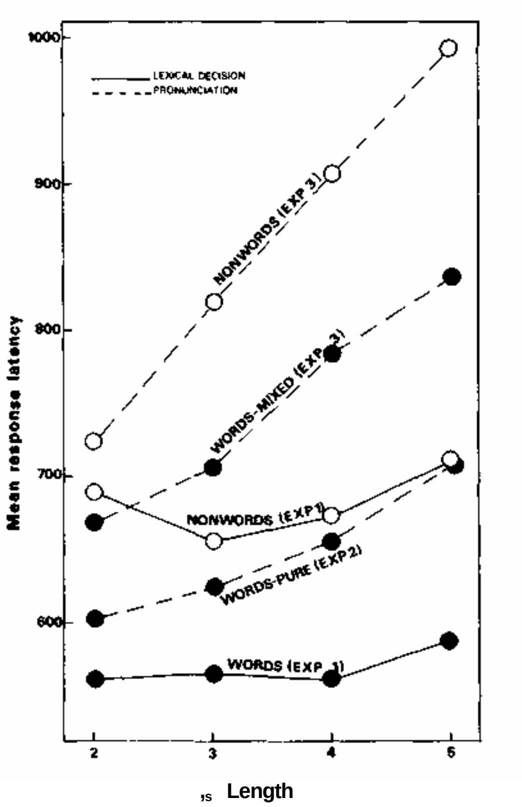

FIG. 14.4 Mean response latencies for lexical decision (Experiment 1) and pronunciation (Experiments 2 and 3) as a function of string length.

however, seems to have some effect on error rate and on response times to nonwords, suggesting the possibility of a slower, phonologically mediated route to the lexicon.

2. In contrast, pronunciation reveals a clear effect of pointing for words as well as for nonwords, suggesting that the pronunciation of words is derived phonologically as well as postlexically. Thus, although the direct route to the lexicon may be faster than the phonologically mediated route, as far as reading aloud is concerned, prelexically derived phonology may be obtained earlier than lexically derived phonology.

3. There is a sizeable difference between words and nonwords in both lexical decision and pronunciation latencies. The difference in lexical decision may indicate that nonwords require a more exhaustive search before a response can be made. As for pronunciation latency, it appears that the slow response to nonwords may indicate that these can

only be read phonologically, whereas words can be read both through their lexical values and via phonological translation.

4. No pronounced effect of string length on lexical decision is found either for words of for nonwords. String length, on the other hand, has a very strong effect on pronunciation latency. The extent of this effect, from two-letter to five-letter strings, is largest for nonwords (271 msec), somewhat smaller for words mixed with nonwords (169msec), and smaller still for words presented alone (108msec).

The somewhat stronger length effect for words in the mixed condition than in the pure condition is consistent with the assumption that in the mixed condition there is greater reliance on the nonlexical route. The effect of pointing, however, was not different under the two conditions, nor was there a tendency for the expected pointing by length interaction in the data of Experiment 3. Further research is needed to clarify this discrepancy.

For English, Frederiksen and Kroll (1976) found that pronunciation latency increased with string length by about 28msec per letter. This figure is very close to what we found for word targets in the pure condition. In contrast, however, they found the size of this effect to be the same for words and for nonwords, whether these were mixed or blocked. Their interpretation, that the string length effect is attributable to the process of phonological receding, was challenged by Coltheart (1978). He argued that if this is correct, the slope of the function relating pronunciation time to string length should be steeper for nonwords than for words, and steeper for words that were mixed with nonwords than for words presented alone. This, however, is exactly what was found in the present study.

5. The unexpected result, however, is that although both string length and pointing yielded significant main effects for pronunciation latency, there was no interaction between them for words. This finding may have two important implications. First, it seems that pointing and word length affect different stages of the reading process. One tempting hypothesis is that pointing affects the time it takes to derive a phonological representation, whereas word length affects the time needed for generating commands for articulation.

The second implication concerns the process by which a phonological representation is derived from a printed word. If pointing affects speed of phonological encoding, the finding that the size of the pointing effect is uniform over different word lengths seems to indicate that prelexical, phonological encoding is not carried out serially, letter by letter, but, rather, all at once, on the basis of the whole structure of the word. We may assume the existence of a phonological lexicon in which pronunciations of all known words in the language are represented (Marcel, 1980). Pronunciation is derived by locating the entry that corresponds to the presented orthographic form. Access to this phonological lexicon seems to be faster when the word is pointed.

6. In comparing the effects on pronunciation latency for words and nonwords, three differences emerge. First, nonwords reveal a larger benefit from pointing than words, 115 vs. 56msec. Second, as noted above, nonwords reveal a stronger effect of string length than words. Third, only for nonwords is there a pointing by length interaction. As we move from two-letter to five-letter strings, the effect of pointing is 73, 98, 159, and 129msec, respectively.

The pointing by length interaction found for nonwords but not for words suggests that all the differences between words and nonwords noted above are due to one single component of the reading processes, possibly the component affected by pointing (rather than that affected by length), and they reflect differences in the manner by which a phonological code is derived for words and for nonwords. Thus, for words, the effect of string length mostly reflects the speed of generating articulatory commands. For nonwords, on the other hand, this effect has two components: the articulatory component, which exists for words as well, and an additional component, which results from the process by which a phonological code is derived for a printed nonword. If a word's phonology is obtained from the phonological lexicon, nonwords, which have no direct representation in this lexicon, must involve the use of spelling-to-sound conversion rules through a process that is partly serial. This results in the additional effect of string length for nonwords, an effect that is more pronounced for unpointed than for pointed strings. This would explain why nonwords benefit more than words from the presence of pointing and why the extent of this benefit increases with string length.

The interpretation offered above assumes that the phonological lexicon is used to derive the pronunciations of words only, whereas nonwords require an analytic rule-based conversion. It has been proposed that the lexicon (in English) does play some part in the derivation of pronunciations for nonwords as well (Glushko, 1979; Marcel, 1980). There are indications in the present study that this might also be true for Hebrew. Thus, an analysis of the pronunciations of unpointed nonwords suggests that these pronunciations are carried out "through" words bearing some similarity to the printed nonwords. It seems as if an effort is made to pronounce the nonword in a manner that would make its pointing similar to that of words in the language. The pertinent data will not be presented here. Suffice it to indicate that on the average 44% of all unpointed nonwords were pronounced according to the pointing pattern of the base words from which they were derived. When nonwords were broken up according to string length, the percentages were 45, 42, 28, and 63% for two-letter to five-letter nonwords, resectively. This suggests that the pronunciation of unpointed nonwords is sensitive to the totality of the orthographic string as well as to the content of the phonological lexicon. Altogether, our results would appear consistent with Glushko's activation and synthesis model, assuming that the phonology of words relies on the visual pattern as a whole, whereas that of nonwords rests on units that are smaller than the whole word.

Finally, it is not clear to what extent the results of the present study are generalizable to other languages or specific to Hebrew. Two of the main conclusions of the present research might be peculiar to Hebrew: the conclusion that lexical access in Hebrew is direct, and the suggestion that the phonology of a word is retrieved from the lexicon as a whole. Both of these may derive from the peculiar nature of Hebrew. First, the very existence of unpointed spelling may encourage reliance on an orthographic rather than a phonological mode of lexical access and the use of the entire word as a whole for deriving its phonology. Second, many of the Hebrew words are derived from common-root morphemes that usually consist of consonants. These consonants are generally retained over the various derivatives, but their voweling changes. This feature makes derivationally related words more similar orthographically (particularly when unpointed) than phonologically. It is quite likely that some semantic information about an unpointed word is gained prior to the retrieval of the corresponding unique lexical entry. It is also likely that, for many Hebrew words (although not those included in the present study), a lexical decision may be performed on the basis of less information than that required for lexical access. This characteristic of Hebrew may encourage a superficial processing of words during reading and a stronger reliance on context for solving lexical ambiguities.

ACKNOWLEDGMENTS

This research was supported by a grant from the Israeli Academy of Science. I am very indebted to Dr Yaakov Kareev of the School of Education, Hebrew University, who collaborated with me in the initial stages of planning this study. I am grateful to my colleagues David Navon and Joel Norman for their valuable comments.

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