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Phonetic analysis of speech and memory codes in beginning readers

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Two experimental tasks, a speech segmentation and a short-term memory task, were presented to children who began to learn to read following either the "phonic" or the "whole-word" method. The segmentation task required the child to reverse two segments (either two phones or two syllables) in an utterance. The phonic group performed significantly better than the whole-word group in the "phonic reversal" task, but no difference appeared in the "syllable reversal" task. This indicated (1) that most children by the age of 6 years are ready to discover that speech consists of a sequence of phones and (2) that the moment at which they do it is influenced by the way they are taught to read. In the memory task, the children recalled series of visually presented items whose names either rhymed or did not. The difference in performance for the rhyming and nonrhyming series was significant in both groups. It was no greater for the phonic than for the whole-word group and was uncorrelated with the "phonic reversal" task. These results are discussed in connection with the distinction between ways of lexical access and ways of representing verbal information in short-term memory.

Although children are competent speakers and hearers of language when they begin to learn to read, that competence does not guarantee their success at reading. In order to read, the child must master a new code that gives access to linguistic knowledge from vision rather than from sound. The new code apparently presents considerable difficulties to a substantial number of children, and some fail to cope with it at all. Since the alphabet represents speech at the level of the phoneme, to read in an alphabetic system requires the ability to explicitly analyze speech into phones, at least during the initial stages of the learning-to-read process, as well as for reading new words.[1] Several authors (see, for instance, Liberman, 1971, 1973; Liberman, Shankweiler, Fischer, & Carter, 1974; Rozin, Poritsky, & Sotsky, 1971) have claimed, quite convincingly, that one of the most important causes of difficulty in learning to read may be the inability to segment speech into phones. Indeed, some underlying capacity is necessary for the ability to develop, and no training, per se, can be a sufficient condition. But it seems, on the basis of illiterate adults' performance in segmentation tasks (Morais, Cary, Alegria, & Bertelson, 1979), that the ability does not appear spontaneously, so it can be hypothesized that it generally emerges in the learning-to-read situation itself. The most important question is thus how the child becomes aware of the phonetic structure of speech during the learning-to-read process. The development of awareness of phonetic segments would presumably be dependent on the nature of instruction methods. It may be anticipated that since the phonic method seeks to teach the child the correspondence between letters and phonemes, it will lead to better scores in segmentation tasks, at least during the first months of reading instruction, than a "look-and-say" or "whole-word" method. This prediction was tested in the present experiment.

Reading a text entails holding some representation of shorter segments in short-term memory in order to be able to extract the meaning of longer ones. The efficiency of reading will depend on the characteristics of that representation or code, such as its duration, its resistance to interference, and its facility and precision in accessing meaning. Conrad (1972) argued that what he called a "phonological code" (i.e., a verbal translation of the text or internal speech) rather than a visual analogue is a more adequate code for reading. But Conrad also claimed that the phonological code was not employed to store visually presented information before the age of 6 years, so that children younger than 6 years would not be ready to start to learn to read. His claim is based on data that show no difference between children's recall of lists of rhyming and nonrhyming items before the age of 6 years (Conrad, 1971), but significantly better recall for nonrhyming items in 6-year-old and older children. Conrad's claim is probably too strong, since Alegria and Pignot (1979) subsequently showed that this rhyme effect is, in fact, present in 4-year-old children. Whatever its developmental course, some relationship between the rhyming effect and reading has been substantiated by Liberman, Shankweiler, Liberman, Fowler, and Fischer (1977). Testing second-graders, they found that both the memory score and the rhyme effect were greater in good readers than in poor

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ones. We have yet little insight into the nature of the relationship between learning to read and rhyme sensitivity as it appears in memory tasks. This is why, in order to obtain a more comprehensive picture of actual relationships, the present work also had the aim of determining whether or not the ability to represent verbal items in memory in a way that gives rise to rhyme sensitivity is entirely independent of the ability to segment speech into phones explicitly, and whether or not it is related to reading efficiency in first-graders.

The subjects in our experiments were Belgian French-speaking first-graders. One group of subjects were taught to read according to a phonic approach, and the other group, according to a whole-word approach. All children were confronted with two tasks. One required the child to deal consciously with units of speech: It consisted of segmenting an utterance into either phones or syllables and then putting them together again in the reverse order. The other was Conrad's (1971) test of picture recall, adapted for French by Alegria and Pignot (1979).

METHOD

Subjects

Sixty-four first-grade children were tested in December, the 4th month of the school year. All children were first-graders for the first time. All were French-speaking Belgians and attended regular schools in Brussels. Half attended a school in which reading was taught through a phonic method; the other half attended another school in which reading in the first grade was taught through a whole-word method. Both schools were located in a suburb of the town, and most of the pupils were of middle to high socioeconomic status. In most schools in which both methods are used, children who are expected to learn to read easily are oriented toward whole-word classes; the others are oriented toward phonic classes. This kind of bias could not affect the present study, since our schools were specialized in one method or the other, so children in the first grade were not selected. Subjects of the phonic group were aged 6 years 0 months (6-0) to 6-11 (mean = 6-6); those of the whole-word group were aged 5-11 to 7-11 (mean = 6-6). Half of the subjects in the phonic group and 53% in the whole-word group were male. Each child was tested individually in two tasks: a segmentation task and a memory task. In addition, reading level was evaluated for each child by his/her own schoolteacher according to a 5-point scale (1 = very poor; 5 = very good). These subjective evaluations, made in December, were highly correlated with the marks obtained in classical achievement evaluation tests at the end of the school year ($r = .78$ and $.81$ for the phonic and whole-word groups, respectively; $p < .01$ in both cases).

The Segmentation Task

Material. Three series of 12 items (one for training and two experimental) were constructed. In Series 1, each item was a pair of words. In Series 2, each item was either a disyllabic word or a pronounceable disyllabic nonword. In Series 3, it was either a monosyllabic word or a pronounceable monosyllabic nonword. The entire set of items is listed in Table 1.

Procedure. At the start of the test, the experimenter said the first item of the training series (Series 1) and asked the subject to "reverse" the utterance, that is, to reproduce it "with the second word first, and only then the first word." If the subject did not respond correctly, the experimenter provided the correct answer. For each item of Series 1, there were as many trials as

Table 1
Segmentation Task: List of Items

Series 1		Series 2		Series 3	
écureuil	sympathique	radis	[radi]	seau	[so]
carotte	cassée	petit	[pəti]	rat	[ra]
fourchette	tordue	rosé	[roze]	air	[ɛr]
hirondelle	rapide	phare	[fa:r]	riz	[ri]
crayon	rouge	balle	[balə]	mot	[mo]
pomme	mûre	coca	[kɔka]	aïe	[aj]
lune	claire	pesou	[pəsu]	ar	[ar]
poule	mouillée	cheta	[ʃəta]	ap	[ap]
chat	noir	lepé	[ləpe]	am	[am]
clown	gai	para	[para]	ti	[ti]
chou	blanc	fuli	[fyli]	pu	[py]
mur	haut	bofa	[bofa]	ol	[ɔl]

necessary to ensure that the subject understood the rule. Then, the items of Series 2 were presented, followed by the items of Series 3. It must be noticed that the last four items of Series 1 are monosyllabic words and so provide a smooth transition for Series 2. In Series 2 and 3, each item was presented only once and no correction was provided. The task for Series 2 was to accomplish a syllabic reversal on each item, that is, to reproduce the disyllabic word or nonword with the second syllable first and the first syllable in the end (to say, for instance, [dira] for [radi]). The task for Series 3 was to reverse the order of phones in the utterance ("phonic reversal" condition): for instance, to say [os] for [so].

The Memory Task

The materials and procedure were the same as those in Alegria and Pignot (1979, Experiment 1). A short description will be given here.

Material. Three series of eight black-and-white drawings were used. In one of the series (R), the names of the drawings rhymed: drapeau (flag), château (castle), chapeau (hat), chameau (camel), bateau (boat), rateau (rake), gâteau (cake), and marteau (hammer). In the others (NR), the names did not rhyme: livre (book), scie (saw), cheval (horse), poisson (fish), nounours (bear), église (church), fusil (rifle), and moto (motorcycle) for NR_1; avion (plane), tambour (drum), pipe (pipe), canard (duck), vache (cow), maison (house), pelle (shovel), and vélo (bicycle) for NR_2.

Procedure. The experimenter initially showed three cards from the same series successively, each for 2 sec, while saying the name of the object represented in the card. Each card was placed in a row, face down in front of the subject, and as soon as the last card was placed, the experimenter put on the table a strip of cardboard representing the eight cards of the series. The child was asked to push each of the three cards he had just seen, without turning it up, in order to bring it in front of the corresponding card on the strip. The experimenter then turned over the cards to show the subject any mistakes he had made. This training phase, consisting of 6-10 trials, allowed the subject to become familiar with the task and, at the same time, permitted the experimenter to determine the number of cards to be used during the experimental trials in order to give a performance level of 60%-70%. During the training, half of the subjects in each group were given the NR_1 series and half were given the NR_2 series. The experimental trials, with the same structure as the training trials, began immediately afterward. They consisted of 10 trials with the NR series that had not been used during the training phase (Condition NR) and 10 trials with the R series (Condition R). Half of the subjects in each group worked in the NR-R order, and half worked in the reverse order. The presentation order for the memory and segmentation tasks was counterbalanced in the same way.

RESULTS

The Segmentation Task

The mean percentages of correct responses in the two segmentation conditions ("syllabic" and "phonic" reversal) for each group of subjects (phonic and whole word) are presented in Table 2. A three-way analysis of variance (hierarchical model) showed significant effects of group [$F(1,62) = 24.5$, $p < .005$] and condition [$F(1,62) = 106.1$, $p < .005$] and a significant Group by Condition interaction [$F(1,62) = 27.5$, $p < .005$]. The phonic group performed better than the whole-word group, the "syllabic reversal" condition yielded better scores than the "phonic reversal" condition, and the inferiority of the phonic reversal condition was greater for the whole-word group than for the phonic group. In addition, t tests showed a significant superiority of the phonic group for the phonic reversal condition [$t(62) = 7.4$, $p < .0005$] but no significant difference between groups for the syllabic reversal condition [$t(62) = 1.40$, $p > .10$].

The distribution of subjects according to their level of performance is shown in Figure 1. Seventy-eight percent of the whole-word subjects gave less than three correct responses over the 12 trials (i.e., less than 25% correct responses), whereas this happened for only 9% of the phonic subjects; only 3% of the whole-word subjects gave more than six correct responses (i.e., more than 50% correct responses), but 59% of the phonic subjects achieved this.

About 44% of the errors on the phonic reversal in each group consisted of incomplete segmentation (e.g., [os]→[sos] and [ri]→[iri]) or lack of fusion (e.g., [os]→[o] and [ri]→[i]).

Performance in the phonic reversal condition was significantly correlated with evaluation of the reading level by the schoolteacher in the phonic group ($r = .65$, $p < .001$), but not in the whole-word group ($r = .11$, $p > .10$).

Performance in the syllabic reversal condition was significantly correlated with reading in both groups ($r = .60$, $p < .0005$, and $r = .36$, $p < .025$, for phonic and whole-word groups, respectively).

The Memory Task

The mean percentages of correct responses obtained

Table 2
Segmentation Task: Mean Percentages of Correct Responses (and Standard Deviations) in the Syllabic and Phonic Reversal Conditions as a Function of Reading Instruction Method

Group	Syllabic Reversal		Phonic Reversal	
	Mean	SD	Mean	SD
Whole Word	67.5	22.3	15.4	20.2
Phone	75.3	21.7	58.3	32.0

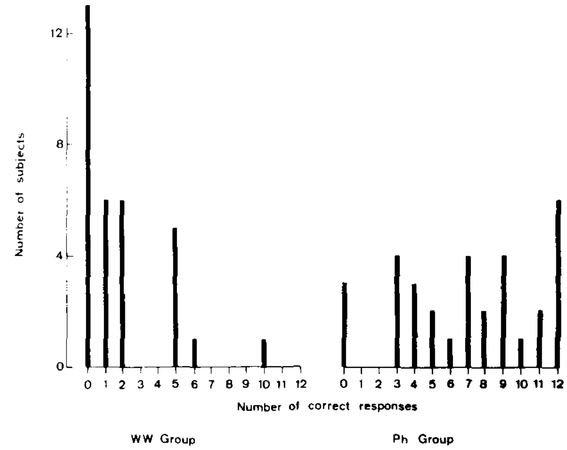

Figure 1. Number of subjects at different levels of performance (12 corresponds to 100% correct responses) in the WW and Ph groups.

by each group in the rhyming and nonrhyming conditions of the memory task are presented in Table 3. A three-way analysis of variance (hierarchical model) showed significant effects of group [$F(1,58) = 5.46$, $p < .025$] and condition [$F(1,58) = 45.5$, $p < .005$], but no significant Group by Condition interaction [$F(1,58) = 1.77$]. The phonic group scored higher than the whole-word group, and a rhyme effect was observed in both groups. This effect, although apparently greater in the whole-word group, did not reach significance.

Table 3 also shows the mean rhyme effect in the whole-word and phonic groups for the best readers (score = 5), the intermediate readers (score = 4), and the poor ones (score $\leqslant 3$). Although the rhyme effect seems to be greater in the whole-word than in the phonic group, especially for the best readers, the Group (phonic, whole word) by Condition (NR, R) by Reading Level (best, intermediate, worst) interaction was not significant [$F(2,58) = 1.12$, $p > .10$]. However, the best readers in the phonic group displayed almost no rhyme effect and a significantly smaller one than that of the best readers in the whole-word group when compared by a t test [$t(19) = 2.08$, $p = .026$].

The number of items found in the training phase to produce 60%-70% correct responses was, on average, similar in the phonic and in the whole-word groups (3.7 and 3.8, respectively). That number seemed to be related to the reading level; that is, it was higher for best (4.2 and 3.8) and intermediate (3.7 and 4.1) readers than for poor readers (3.4 and 3.4) [$F(2,29) = 7.59$, $p < .005$, and $F(2,29) = 4.48$, $p < .025$, in the phonic and whole-word groups, respectively].

Since the majority of subjects in each group worked with four items, the correlation between rhyme effect (i.e., the difference between scores in the NR and R conditions) and mnemonic performance (the score in the NR condition) was estimated for those subjects.

Table 3
Memory Task: Mean Percentage of Correct Responses in Rhyming (R) and Nonrhyming (NR) Conditions and the Rhyme Effect (NR − R) as a Function of Reading Instruction Method

		Items		R		NR		NR − R	
	n	Mean	SE	Mean	SE	Mean	SE	Mean	SE
				Whole-Word Group					
Total	32	3.8		49.3	2.35	65.0	2.21	15.7	3.04
Best Readers	11	3.8	.13	52.9	3.96	72.7	3.57	19.8	4.88
Intermediate Readers	14	4.1	.13	47.3	2.81	57.9	3.25	10.6	4.46
Worst Readers	7	3.4	.22	47.7	7.82	67.1	3.11	19.3	8.34
				Phonic Group					
Total	32	3.7		58.1	2.69	68.6	2.23	10.5	2.61
Best Readers	10	4.2	.14	62.3	5.24	66.3	4.42	4.0	5.48
Intermediate Readers	6	3.7	.23	60.3	5.03	68.7	5.64	8.3	7.45
Worst Readers	16	3.4	.13	54.6	4.07	69.9	3.21	15.4	2.90

Note—The total results have been divided as a function of the reading performance of the subjects. "Items" = the mean number of items presented for recall on each trial. $SE = s/\sqrt{n-1}$.

It was highly significant in the whole-word group ($r = .77$, $n = 23$, $p < .001$) but only approached significance in the phonic group ($r = .39$, $n = 19$, $p < .1$). The difference between the two r values approached significance with a two-tailed test ($r = .069$).

Finally, the rhyme effect was significantly correlated with neither performance in the phonic reversal condition nor performance in the syllabic reversal condition in either group ($r = .18$ and $.10$, respectively, for the whole-word group; $r = -.18$ and $-.21$, respectively, for the phonic group).

DISCUSSION

First-grade children who had been taught to read for 4 months were asked to carry out a task that required them to deal explicitly with units of speech such as syllables and phones. A high level of performance was observed for syllables, thus indicating some insight into the sublexical structure of words. On the other hand, syllables were easier to manipulate than phones, as shown earlier by Liberman et al. (1974). In addition, it was found that the method of instruction affected awareness of phones, not awareness of syllables. No significant difference in performance was observed for operations on syllables between children taught to read according to a whole-word method and those taught to read according to a phonic method. However, the latter were strikingly better than the former for operations on phones.

The mean percentage of correct responses in the phone task and the distribution of subjects according to their performance that were observed for "whole-word" and "phonic" children fit quite well those obtained by Morais et al. (1979) with illiterate adults and adults who learned to read beyond the usual age, respectively: The whole-word group behaved in a way similar to that previously observed with illiterate people. By the age of 6 years (and perhaps before), children are ready to discover that speech is a sequence of phones, but they do not do it spontaneously as a normal outcome of intellectual maturation. Our results from illiterates suggested that learning to read offers for most people the only opportunity to gain insight into the phonologic structure of speech. The present results show that the development of phonologic awareness depends on the way people are taught to read, and they support the hypothesis of a reciprocal relation between reading instruction and awareness of phones (Liberman, Liberman, Mattingly, & Shankweiler, 1980). Whole-word children, as well as illiterate adults, have the potential capacity to deal explicitly with phones, but they have never faced a problem requiring them to do so. Those children are in a situation similar to that of people taught to read in an ideographic system. This is the reason that phonic segmentation was poor in the whole-word group and unrelated to reading performance. In the phonic group, on the contrary, phonic segmentation was better and correlated highly with reading level.

We might ask, on the basis of the positive correlation between performance for syllables and for phones, whether both tasks involve essentially the same cognitive capacity and whether simple exercise of this capacity is enough to attain awareness of the phonetic segments. The idea of a progressive transition from high-level to low-level segments by regular steps inspired some teaching programs. For instance, Rozin and Gleitman (1977) tried to bring the child from ideas to words, then to syllables, and, finally, to phones. However, they admit that the final step, the one from syllables to phones, presents a degree of difficulty by far greater than the previous ones. So, it seems that some specific capacity not involved in syllable manipulation must develop in order to deal with phones.

Whatever the initial instruction method, the majority of children will eventually be able to deal explicitly with phonologic segments. Reading more than several tens of words implies such an ability, and the fact that almost half of the whole-word subjects showed an attempt at segmentation suggests that these children might already be halfway. But our experiment has shown that children will reach an explicit knowledge of phonological segments much quicker if they are confronted with the alphabetic principle than if they are merely required to discriminate overall shapes. We do not want to imply here that speed in acquiring phonetic awareness is a desirable educational goal, we only want to point out that how the child is taught to read influences that awareness. We would also like to draw attention to those rare children in our sample who either did not attain awareness despite phonic instruction or did attain it very quickly despite the whole-word approach to reading. They may be of appreciable theoretical and practical interest.

Let us come now to the results obtained in the memory task. Both groups showed a rhyme effect, which was no greater for the phonic group than for the whole-word group and was uncorrelated with performance in the phone task. This outcome shows that the code used for representing verbal information in short-term memory and responsible for rhyme sensitivity is not affected by phonologic awareness. It has already been demonstrated (Erikson, Mattingly, & Turvey, 1977; Tzeng, Hung, & Wang, 1977) that reading in a logographic system does not prevent the subjects from making most of their recall errors on phonetically confusing items. This means that the way in which the lexicon is accessed need not be phonetic for the way in which the word is held in memory to be, in some sense, "phonological." The assumption of independence of these two issues (lexical access and postlexical representation)[2] is strengthened by the present results, since they indicate that learning to read on the basis of grapheme-to-phoneme conversion rules does not encourage a more "phonological" memory coding. The "phonological" representation responsible for rhyme sensitivity is not in terms of a sequence of phones arranged consciously in appropriate order by the subject. It might consist, instead, of a continuous articulatory pattern associated with each unit in the lexicon and available independently of the way this unit is accessed: "Château" and "chameau" are articulatorily more alike than are "cheval" and "poisson," and so, more confusing.

In this context, the fact that the rhyme effect tended to be greater in the whole-word group than in the phonic group seems puzzling at first. This difference (which reached statistical significance when the best readers from both groups were compared) is a transient one. We have tested kindergarteners and fourth-graders in both schools, with the same material and procedure. For kindergarteners, the rhyme effect was 6.2 and 6.8 in phonic and whole-word schools, whereas for fourth-graders, it was 18.6 and 18.8, respectively (see Alegria & Pignot's, 1979, Experiment 1 for the whole-word group data). We suggest that the difference observed here may be the result of a useful strategy adopted by some of the children of the phonic group concurrently with the usual (and probably automatic) nonanalytical way of representing verbal items in short-term memory. Confronted with a recurring set of eight rhyming names, the subjects might offset the disturbing effect of rhyme by focusing on the parts of the words that allow them to differentiate the items and trying to remember those parts (e.g., "b" or "ba" for "bateau," "g" or "ga" for "gâteau") as additional aids for recall. The possibility that "phonic" children, already aware of the existence of phones and daily trained to pay attention to parts of words, do use to some extent such a strategy is quite plausible, especially if they are the best readers in the group. This strategy should lead not only to a smaller rhyme effect, but also to a greater mnemonic performance, and both of these were found.

Finally, we must acknowledge that several studies by the Haskins group (Liberman et al., 1977; Mann, Liberman, & Shankweiler, 1980; Mark, Shankweiler, Liberman, & Fowler, 1977) have found a greater effect of rhyme in good readers than in poor readers. However, in the present experiment, no such difference was observed. The fact that Liberman and her collaborators tested second-grade children whereas we tested first-graders might be crucial for understanding this discrepancy. Second-graders read much longer segments of text than first-graders do, so that short-term memory ability may influence reading performance considerably. On the other hand, second-graders probably do not rely so heavily on letter-sound correspondence as do first-graders. They are more concerned with linking together larger segments in order to extract the whole meaning. Continuous articulatory-like representations might then be particularly useful for reading efficiency. If we assume, in addition, that the rhyme effect stems from the use of such representations, we might account for the rhyme effect's being independent of reading level in first-graders and greater in good second-grade readers than in poor ones. We plan to test this tentative explanation.

REFERENCES

Alegria, J., & Pignot, E. Genetic aspects of verbal mediation in memory. *Child Development*, 1979, **50**, 235-238.

Conrad, R. The chronology of the development of covert speech in children. *Developmental Psychology*, 1971, **5**, 398-405.

Conrad, R. Speech and reading. In J. F. Kavanagh & I. G. Mattingly (Eds.), *Language by ear and by eye*. Cambridge, Mass: M.I.T. Press, 1972.

Erickson, D., Mattingly, I. G., & Turvey, M. T. Phonetic activity in reading: An experiment with Kanji. *Language and Speech*, 1977, **20**, 384-403.

Liberman, I. Y. Basic research in speech and lateralization of language: Some implications for the reading disability. *Bulletin of the Orton Society*, 1971, **21**, 71-87.

Liberman, I. Y. Segmentation of the spoken word and reading acquisition. *Bulletin of the Orton Society*, 1973, **23**, 65-77.

Liberman, I. Y., Liberman, A. M., Mattingly, I. G., & Shankweiler, D. Orthography and the beginning reader. In J. F. Kavanagh & R. L. Venezky (Eds.), *Orthography, reading, and dyslexia.* Baltimore, Md: University Park Press, 1980.

Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. Reading and the awareness of linguistic segments. *Journal of Experimental Child Psychology,* 1974, **18**, 201-212.

Liberman, I. Y., Shankweiler, D., Liberman, A. M., Fowler, C., & Fischer, F. W. Phonetic segmentation and reading in the beginning reader. In A. S. Reber & D. L. Scarborough (Eds.), *Toward a psychology of reading.* New York: Wiley, 1977.

Mann, V. A., Liberman, I. Y., & Shankweiler, D. Children's memory for sentences and word strings in relation to reading ability. *Memory & Cognition,* 1980, **8**, 329-335.

Mark, L. S., Shankweiler, D., Liberman, I. Y., & Fowler, C. A. Phonetic reading and reading difficulty in beginning readers. *Memory & Cognition,* 1977, **5**, 623-629.

Morais, J., Cary, L., Alegria, J., & Bertelson, P. Does awareness of speech as a sequence of phones arise spontaneously? *Cognition,* 1979, **7**, 323-331.

Rozin, P., & Gleitman, L. R. The structure and acquisition of reading II: The reading process and the acquisition of the alphabetic principle. In A. S. Reber & D. L. Scarborough (Eds.), *Towards a psychology of reading.* New York: Wiley, 1977.

Rozin, P., Poritsky, S., & Sotsky, R. American children with reading problems can easily learn to read English represented by Chinese characters. *Science,* 1971, **71**, 1264-1267.

Tzeng, O. J. L., Hung, D. L., & Wang, W. S. Y. Speech recoding in reading Chinese characters. *Journal of Experimental Psychology: Human Learning and Memory,* 1977, **3**, 621-630.

NOTES

1. We use here the term "phone" instead of "phoneme" because phoneme is, in the generative-transformational perspective, an abstract representation that depends on morphemic information, and the present experimental task simply required our subjects to manipulate different uttered sounds without regard for meaning.

2. We are indebted to an anonymous reviewer who called our attention to this distinction.

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