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Using Spelling-Sound Correspondences Without Trying to Learn Them

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Adult subjects learned spoken responses to nonsense words written in an artificial alphabet. Correspondences between letters and phonemes were hidden by the use of right-to-left correspondences. Even though subjects did not notice the existence of correspondences, they were able to decode new nonsense words in the same alphabet. In a second experiment, nonsense words written with hidden correspondences were read more quickly than nonsense words without correspondences. A third experiment suggested that this effect was due to the fact that similar words had similar responses. In general, the results suggest that correspondences can be used without the use of special strategies for learning correspondences, but when this occurs, people use examples rather than knowledge of the correspondences themselves.

No matter how a child learns to read, much of his experience typically consists of reading aloud. Producing vocal responses to printed words undoubtedly promotes learning of associations between printed and spoken words. The question addressed in this paper is whether anything else is learned as a consequence of this learning. In particular, does the learning of associations between printed and spoken words enable a beginning reader to decode words he has never seen before in print?

The practical importance of our question is this: if a child somehow gets to the point at which he can read aloud, does he need further training in finding and using spelling-sound correspondences? Or, alternatively, will practice at reading aloud inevitably lead to learning to use correspondences that do exist (Venezky, 1970)? For example, if a child learns to read by the whole-word method, it might be inevitable that he will ultimately learn to use the correspondences with further practice at reading, even reading of fairly simple materials (on the assumption that these materials contain most of the correspondences he will need to know). If such learning occurs, reliance on practice alone might be a useful alternative method for teaching children who seem unable to learn to use correspondences from direct instruction. Of course, it is also possible that such learning from practice works for some children but not others.

It is useful to distinguish among four different ways in which a person might come to use spelling-sound correspondences as a result of experience at learning associations between printed and spoken words. I shall call these ways *implicit abstraction, explicit abstraction, generalization,* and *analogy.*

In *implicit abstraction* the learner comes to represent the actual rules of correspondence, possibly in the form of associations between letters and phonemes or between groups of letters and groups of phonemes. Such learning occurs in the absence of special strategies of any sort; the learning is assumed to be the result of the operation of basic learning mechanisms. Some theories of learning would seem to imply that such learning would occur.

In particular, some versions of stimulus-response theory might hold that learning is inevitable when a response is intentionally produced in the presence of an attended stimulus. When a person produces a spoken word in response to a printed word, all the conditions are present for learning an association between a part of the printed word and a part of the spoken word. The part of the spoken word is indeed an intentionally produced response. And the part of the printed word is apparently attended to. By this mechanism, associations would be formed between every letter in a word and every phoneme in the response. For example, if the stimulus were *bit* and the response /bit/, associations would be formed between the *b* and the /b/, the *b* and the /i/, the *b* and the /t/, the *i* and the /b/, etc. Only some of these associations would be those we are interested in having a child learn. However, if a child learned a large set of words, it seems likely that some of these associations would be strengthened by repetition and others would not. For example, if the next word a child learned were *bam,* the association between the *b* and the /b/ would be strengthened, but the association between the *b* and the /i/ would not.

This learning is called implicit because it is not the result of any explicit effort to learn what is ultimately learned. Technically, implicit learning is a kind of incidental learning; a person is given the task of learning (or practicing) associations between printed and spoken words, and, as a result, he incidentally learns associations between letters and sounds. The study of implicit learning has received a large boost from the recent work of Reber (e.g., 1976; see also Brooks, 1977, for another view). Reber examined the learning of the rules of artificial grammars governing sequences of letters, measuring learning by the ability to classify new sequences according to whether or not they conform to the grammar. In one experiment, subjects instructed simply to memorize grammatical sequences learned more of the grammar than did other subjects instructed to try to discover the rules of the grammar while they were memorizing. Reber (personal communication) has suggested that there might be special mechanisms for implicit learning and that these mechanisms might be used not only in such things as learning a first language but also in learning spelling-sound correspondences from practice at reading. Reber does not identify these mechanisms with those of stimulus-response learning of part-part associations, but for present purposes, such learning seems roughly equivalent to true implicit learning.

In *explicit abstraction,* the learner uses special strategies for discovering rules at the time that the examples of the rules (correspondences) are presented. This is probably what most of us would do if we were asked to memorize the pronunciations of a number of Greek words (assuming we don't know Greek). While we were memorizing the words, we would also be generating and testing hypotheses about the sounds of individual letters such as rho and gamma. As adult readers, this would be particularly easy because we already have a way of representing phonemes abstractly, that is, a way of naming phonemes. As we discover the sounds of the Greek letters, we can formulate rules of the form, "The thing that looks like a P sounds like an R." It is not at all clear that young children have a way of representing phonemes before they learn to read, so we cannot assume that this explicit mechanism is open to them.

Previous work on the learning of whole words in artificial alphabets is consistent with the view that explicit abstraction is the only mechanism available for learning letter-sound correspondences. Bishop (1964) taught a group of college students associations between printed and spoken nonsense words using Turkish letters. Bishop then tested subjects on their ability to use correspondences by asking each subject to pronounce new words according to the same correspondences. Eight of the twenty subjects did not consciously discover any correspondences, and these subjects performed at chance levels on the transfer test. The remaining twelve subjects were able to pronounce some of the transfer-test items, and these subjects were also able to report explicit spelling-sound correspondences they had discovered.

Jeffrey and Samuels (1967) did a similar experiment with six-year-old children, using artificial letters as stimuli and consonant-vowel English words as responses. Without additional training in "phonic blending," none of the children was able to decode any new words on the basis of correspondences present in the original set. The experiments to be reported here show that transfer of correspondences *can* occur in the absence of explicit abstraction. Our experiments thus stand in apparently direct contradiction to the earlier studies, and we are forced to face the question of why transfer without explicit abstraction occurs in some situations but not others.

One consequence of the existence of letter-sound correspondences is that words that look similar will have pronunciations that sound similar (Brooks, in press; Baron, 1977). In most cases, three-letter words with two letters in common (e.g., pat—pan) will have pronunciations with two phonemes in common; words that have no letters in common will have pronunciations with no phonemes in common, etc. Such a state of affairs could easily facilitate transfer of learning on the basis of well-known mechanisms of stimulus and response *generalization* gradients (Osgood, 1949). In general, it has been found that there is a great deal of positive transfer between learning one stimulus-response association and learning another when the two stimuli are similar and the two responses are similar. This finding is presumably the result of basic learning mechanisms rather than the result of application of any special strategies; the same principle ought to apply to pigeons as well as children.

Such a mechanism might even operate to allow some decoding of new words presented for the first time (Brooks, in press). For example, suppose a child knew the words *bat, rat,* and *ran,* and we give him the new word *ban.* Because of the similarity between *ban* and each of the three original words, the responses to these words will be activated by stimulus generalization. Possibly one of the known responses will then be produced (as often happens with young children presented with such a novel word). However, another possibility is that none of the three original responses will be produced, because these responses will inhibit one another through competition. In this case, we might imagine that some sort of "response averaging" mechanism would take over. A new response would be constructed by taking pieces from the old responses and putting them together (as occurs in Spoonerisms and other tips of the slongue). Such a response would have a good chance of being correct—or at least of being close enough so that the actual word could be recognized with the help of context in a real reading situation. Note that this mechanism of stimulus generalization is like implicit abstraction in that both are a necessary consequence of learning. These mechanisms differ, however, in what needs to be present in memory for transfer to occur. For implicit abstraction, rules themselves must be in memory, for stimulus generalization, only examples.

The final possible mechanism for decoding novel words on the basis of experience with old ones is *analogy* (Baron, 1977). For example, a person seeing BOROUGH for the first time might think of THOROUGH. Analogy is like generalization except that the use of responses to old stimuli is not automatic. Instead, it is assumed that the subject actively tries to recall words that are similar to a new word he is trying to learn or to decode, and then uses additional strategies to modify the pronunciations of these old words to derive the pronunciation of the new word. Note that there are two points at which special strategies are used: first, the recall of similar words; and second, the modification of the pronunciations of these words to derive the pronunciation of the new word.[1]

These four mechanisms for transfer—explicit abstraction, implicit abstraction, generalization, and analogy—may be distinguished in two ways, according to what is learned and according to whether strategies are used. For implicit and explicit abstraction, the rules (correspondences) themselves are learned from exposure to words that follow the rules. Theoretically, it would be possible to forget all the examples and still remember the rules themselves (as seems to occur, for example, in some cases of artificial-grammar learning; see Smith, 1966). For the mechanisms of generalization and analogy, transfer is based on the memory of examples alone. There need be no representation of the correspondences themselves in order for these mechanisms to operate. As for the other distinction, implicit abstraction and generalization do not require any special strategies for learning or transferring rules. They rely on basic mechanisms that are presumably present in all people and that do not have to be learned. On the other hand, explicit abstraction requires the use of hypothesis-testing and representational strategies at the time the examples are presented, while analogy requires the use of retrieval strategies and strategies for modifying pronunciations at the time the transfer-test items are presented.[2]

The present experiments are designed to find out whether other mechanisms besides explicit abstraction, such as analogy or generalization, are available to college students for transferring correspondences on the basis of experience with examples following those correspondences. Depending on what those other mechanisms turn out to be, such studies may shed light on the original question of whether children can learn to use correspondences from practice at reading whole words. In general, these experiments use the artificial-alphabet technique first used by Bishop (1964) to address these questions. However, we make an effort to hide the existence of correspondences from the subjects, so that explicit abstraction will not be used.

Experiment I

In the first experiment twelve college students learned to read a set of nonsense words printed in an artificial alphabet. The subjects were told that there were no correspondences between letters and sounds and that the best strategy was simply to try to memorize associations between whole stimuli and whole responses. In fact, the subjects were deceived. Six of the twelve stimuli had right-to-left correspondences, with the rightmost artificial letter corresponding to the first phoneme, etc. The other six stimuli were derived from a similar set of stimulus-response pairs, but the assignment of responses to stimuli was rearranged so that there were no consistent letter-sound correspondences.

Method. The stimuli and responses used are shown in Table I. In the table the stimuli from the two sets are shown separately, but in the experiment, all twelve stimuli used for a given subject were mixed together randomly (by shuffling the cards on which the stimuli were printed before each trial). This made the correspondences in the correspondence set even less obvious than would otherwise have been the case. In addition, the letters used in the two sets were chosen in pairs; each letter in the correspondence set had a corresponding letter in the no-correspondence set to which it was similar. This was to discourage the subject from looking for regular correspondences by comparing responses to similar stimuli. The stimulus most similar to a given stimulus was in fact from the other set. Assignment of stimuli to sets was balanced across subjects.

Each subject learned the responses to the twelve stimuli, printed on cards, by a self-paced anticipation procedure in which the subject was free to answer or not, as he chose. The correct answer was spoken by the experimenter if the subject did not give it. This procedure continued for 25 trials (runs through the list). Only one subject succeeded in learning all twelve responses. After completing the 25 learning trials, subjects were asked to try to decode transfer words (see Table I). These stimuli were presented in a random order. After the first presentation of the transfer words, the subjects were told that some of the stimuli had had correspondences. The subjects were then shown the transfer words again and asked to try to decode them. Finally, the subjects were told that the correspondences were right-to-left and were asked to try to decode the transfer items a third time. After this, the subjects were interviewed in detail about the way they learned the responses to the original stimuli, about whether they noticed any correspondences, etc.

Results. The main result was that the subjects made fewer errors on the items in the correspondence set than on the items in the no-correspondence set during the learning trials. For the correspondence set, 67% of the responses were correct, for the no-correspondence set, 56%, $p<.01$. The interviews after the experiment revealed that two of the subjects suspected that there might be correspondences (although they could not discover any); one subject actually discovered the correspondences in the middle position (which would, after all, be present even if the subject were looking for left-to-right correspondences), and two other subjects knew how to read Hebrew (which has right-to-left correspondences). When these five subjects were eliminated from the analysis, there was still a significant difference (52.3% vs. 45.6%, $p<.01$) between the conditions across the remaining seven subjects. In sum, the presence of correspondences facilitated the learning of those items containing correspondences even though the subjects were unaware of the existence of the correspondences and thus (presumably) did not employ specific strategies for learning the correspondences.

Eight subjects were used for the analysis of the transfer items.

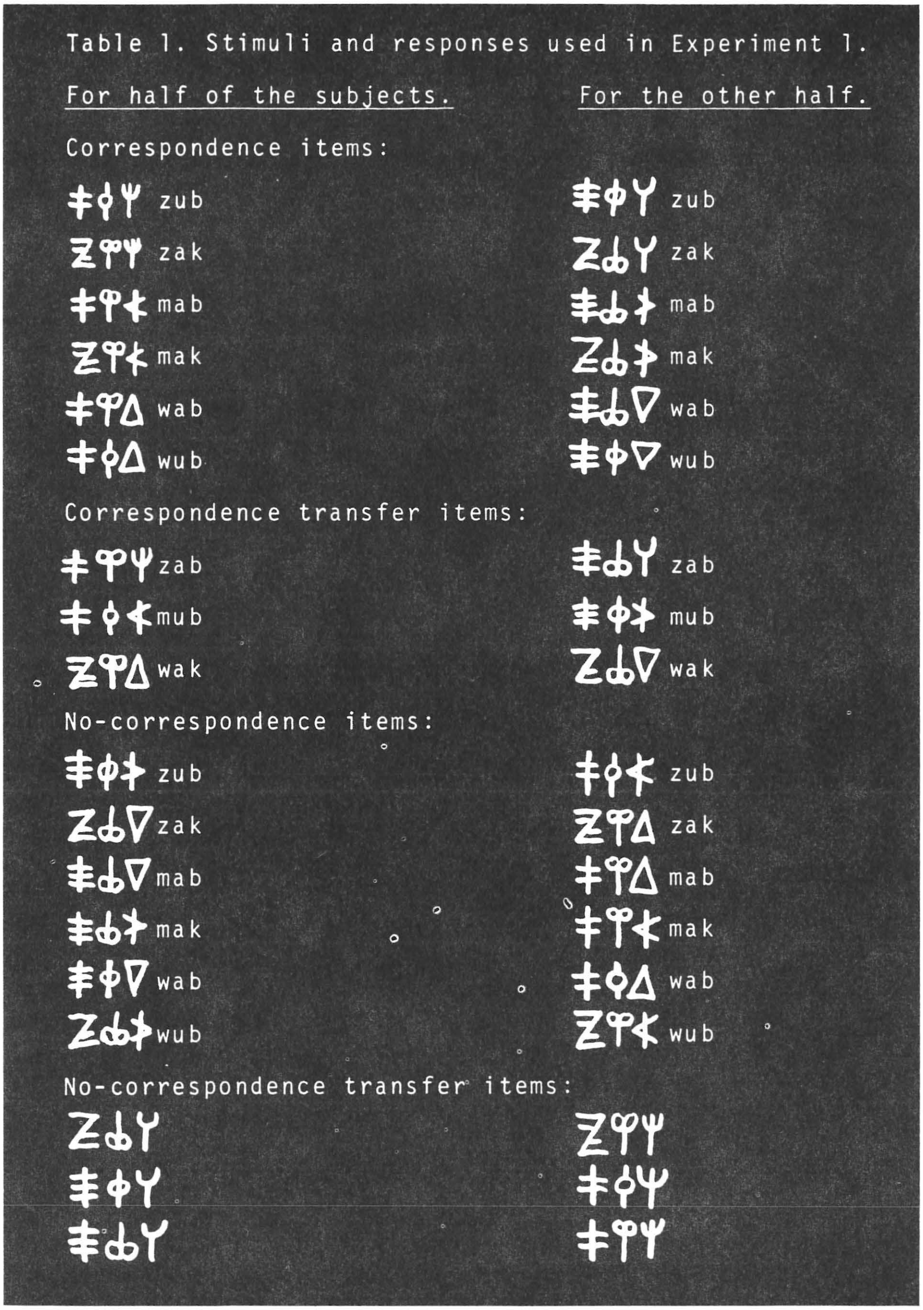

Table 1. Stimuli and responses used in Experiment 1.

For half of the subjects.	For the other half.
Correspondence items:	
zub	zub
zak	zak
mab	mab
mak	mak
wab	wab
wub	wub
Correspondence transfer items:	
zab	zab
mub	mub
wak	wak
No-correspondence items:	
zub	zub
zak	zak
mab	mab
mak	mak
wab	wab
wub	wub
No-correspondence transfer items:	

The three subjects who noticed correspondences or looked for them during learning were excluded. The other excluded subject was the only one who spelled out his responses instead of pronouncing them, and only 31% of the letters he used were letters used in the spellings of actual responses, in contrast to 81% for the next lowest subject. To find out whether transfer occurred, only the correspondence trials were analysed. The number of phonemes in the correct position was determined for each test trial. The means for the three trials, respectively, were 4.75, 4.75, and 4.38, out of a possible 9.00 on each trial. To find out whether these scores could be due to some sort of guessing, it was necessary to calculate the scores expected by chance. To do this, we assumed (conservatively) that if the subject had guessed, he would have produced the same three responses as he did produce, but would have assigned them randomly to the three stimulus items. These expected scores were calculated for each trial for each subject. Their means were 3.91, 4.22, and 4.10 for three trials, respectively. The difference between the actual scores and the expected scores was not quite significant for any of the three trials alone, but it was significant across subjects by a *t* test for all three trials combined ($p<.03$) and for the first two trials combined ($p<.025$). In sum, the results support the claim that transfer to new items does occur even when the rules transferred were not thought to exist at the time of learning. Further, the subject need not know that the rules go from right to left for such transfer to occur; this is shown by the significant result for the first two test trials.[3]

From the results of this experiment, there seems to be little doubt that subjects can transfer spelling-sound correspondences even though the subjects are unaware of these correspondences at the time of learning associations between printed and spoken words. It thus seems—in spite of the earlier results of Bishop (1964), described above—that other mechanisms besides explicit abstraction are available for transferring correspondences on the basis of experience with whole words.

Clearly, the results can be explained by some implicit-abstraction mechanism (except for the one subject who did not appear to transfer). It is also worth noting that the conditions were present here for either generalization or analogy to operate as well. For example, all of the results could be accounted for by the analogy mechanism. In the correspondence condition, stimuli that have two letters in common always have two phonemes in common. During learning, a subject might be unable to recall the response to some stimulus but might be able to recall the response to a similar stimulus. He may then use the response to the second stimulus as a cue to remember the response to the first; a response sharing two phonemes might be sufficient to remind the subject of the correct response to the stimulus at hand. Likewise, during transfer, the test items might remind the subjects of stimuli presented during training. In fact, each of the three test stimuli had two letters in common with each of two stimuli presented during training. If the subject could recall these training stimuli and their respective responses, he could correctly infer two of the phonemes of the correct response to the test item simply by producing the phonemes common to the two responses he could recall. If he were clever, he might even infer that the remaining phoneme must be different from either of the two training items, and he could be correct on all three phonemes in the test item. No subject appeared to be this clever. Completely correct answers were given on only 12.5% of test trials.

Experiment II

Experiment II does not attempt to find out which of the various mechanisms is available, although its results may bear on this issue. Rather, it attempts to show that spelling-sound correspondences can be useful in fluent responding to printed words as well as in learning the responses to these words for the first time. Also, it shows that correspondences can facilitate memory even in a situation in which all learning is incidental, even the learning of the associations between printed and spoken words.

Method. In this experiment, the subject was given what he thought was only a reaction-time task. He was given an index card with a set of four stimuli and four corresponding responses; he was also given a column of 24 stimuli. Each stimulus on the list of 24 was one of the stimuli on the card. His task was to look at each stimulus on the list of 24, look at the card to find the stimulus and its associated response, produce the response as quickly as possible, and move on to the next stimulus on the list until all 24 stimuli had been responded to. He was not encouraged to memorize the four responses. The two measures of interest were the time required to go through the list and the memory of the responses to the stimuli presented at the end of the experiment.

Some of the stimuli and responses used in this experiment are shown in Table II. Each of the index cards contained a set of stimuli and responses. Half of the subjects used sets A, C1, B, and D2; the other half used sets A, C2, B, and D1. When set A is used in combination with set C1, there are consistent rules relating letters and phonemes. This is also true for set B in combination with set D1. However, when sets A and C2, or sets B and D2, are used together, there are no consistent correspondences. Each letter can correspond to two phonemes instead of one. It is important to note that the correspondences could not be noticed within the members of a single set. The correspondences were consistent only across sets. Thus, the subject had no need to learn the correspondences simply to deal with the card in his hand. It is also worthy of note that half of the correspondences were consistent only when viewed from left to right, and half only when viewed from right

Table 2. Stimuli and responses for Experiment 2, by list.

	List A		B
Γ∇	bah	≃∞	faa
ΣΛ	meh	≡∿	vih
Φ<	gaw	∂Ψ	zuh
T→	koo	§Ω	tay

	C1	C2		D1	D2
ΓΛ	beh	kaw	≃∿	fih	tuh
Σ∇	mah	goo	≡∞	vaa	zay
Φ→	kaw	beh	∂Ω	tuh	fih
T<	goo	mah	§Ψ	zay	vaa

to left. The basic design of this experiment is thus analogous to that of the first experiment, except that learning is incidental.

Twenty college-age subjects were tested, 10 with A and C1 as the correspondence condition, 10 with B and D1. For half of the subjects in each group of 10, the assignments of stimuli to the right-to-left versus left-to-right conditions were switched (by switching the first response on the B1 and D1 card with the second, and the third response with the fourth). Thus, the assignment of stimuli to the correspondence versus no-correspondence conditions, and to the forward versus backward conditions within the correspondence condition, was completely balanced across subjects.

The subjects went through 16 lists (24 items each, four different lists run through four times) with each index card. The order of presentation of conditions insured that sets in the correspondence condition would occur in different blocks of trials. This would minimize the chances of the subjects noticing the correspondences. The subject first alternated between the C and D cards, starting with the C card (i.e., C1 or C2), for a total of eight runs with each card. Then the same was done with the A and B cards. Then the whole procedure was repeated before the memory test. In the memory test, the stimulus items were presented in a list in the fixed order, A, B, C, D. Since there was complete counterbalancing, the order of testing cannot account for any results.

Results. In the memory test, for incidental learning of the responses, the responses in the left-to-right correspondence condition were recalled correctly (in entirety) 37.5% of the time, the right-to-left correspondence items were recalled 35% of the time, and the control no-correspondence items were recalled 22.5% of the time, $p<.05$. This indicates that the consistent correspondences did promote incidental learning. Of interest is the lack of difference (nowhere close to statistical significance) between the left-to-right and right-to-left conditions. This suggests that the effect of the correspondences was not a result of explicit abstraction of the correspondences. Surely, explicit abstraction mechanisms would have been more likely to discover left-to-right rules than the reverse.

The difference between correspondence and no-correspondence conditions was apparent in the times for going through the lists as well as for the memory scores. This effect was tested for sets A and B only, since the C and D conditions were presented first, before the effects of correspondences could be manifest. The mean time for each item in the list was 1.16 sec for the correspondence condition and 1.22 sec for the no-correspondence condition, $p<.05$. The availability of consistent letter-sound correspondences thus improved speed of responding as well as incidental learning of the responses.

Experiment III

So far, the experiments have indicated fairly strongly that spelling-sound correspondences may be transferred without the use of explicit abstraction. The first experiment showed transfer of correspondences of which the subjects were unaware. In the second experiment, the transfer measured was actually transfer of learning (or performance) between sets using the same correspondences, rather than transfer of rules to new instances. However, it is necessary to distinguish among the three remaining mechanisms.[4] One critical test concerns the effect of similarity relations between stimuli and between responses. Recall that both the analogy and generalization mechanisms rely primarily on the fact that similar stimuli have similar responses, whether or not spelling-sound correspondences are preserved. Experiment III is an attempt to make use of this property of these two mechanisms to find out whether true implicit learning—the only mechanism that does not rely on similarity relations—occurs. This experiment is as much like Experiment II as possible, except that both correspondence and no-correspondence conditions are identical in the extent to which similar stimuli are associated with similar responses. In particular, every pair of stimuli with a letter in common now has a corresponding pair of responses with exactly one phoneme in common.

Method. The method is identical to that of Experiment II, except for the responses assigned to the stimuli. Some of these responses are shown in Table III. The remaining sets are identical except that the first and second responses to the C1 and D1 sets are switched, as are the third and fourth responses, as in Experiment II.

Table 3. Stimuli and responses for Experiment 3, by list.

	List A		B
Γ∇	zee	≃∞	foo
ΣΛ	taw	≡∿	kay
Φ<	zee	∂Ψ	foo
ϒ→	taw	§Ω	kay

	C1	C2		D1	D2
ΓΛ	zaw	zaw	≃∿	koo	koo
Σ∇	tee	zaw	≡∞	fay	koo
Φ→	tee	tee	∂Ω	fay	fay
ϒ<	zaw	tee	§Ψ	koo	fay

One way of looking at the design is to examine what the subject would learn if he tried to learn correspondences from left to right or from right to left. Consider sets A and C1. For the first two items in each set, a right-to-left correspondence would work perfectly across the two sets, and for the second two items, a left-to-right rule would work. For this reason, set A was considered to be in the correspondence condition when it occurred along with set C1. Now consider sets A and C2, a combination of conditions received by other subjects. Here, consistent correspondence would not work. There is no way of keeping consistent left-to-right or right-to-left correspondences in lists A and C2 combined. The sets A and C2, when used together, thus make up the control condition. If subjects are learning letter-sound correspondence, they should do better on A and C1 together than on A and C2.

Another feature of this design was that transfer of letter-sound correspondences between lists could be used to read some letters but not others. For example, there is no way the subject who has lists A and C2 can derive the response EE to the first item in A, while there are potentially two ways in which he might derive Z, (1) if he takes the correspondences to go from left to right, (2) if from right to left. If the subject does really learn letter-sound correspondences, then we might expect him to do particularly poorly on these particular correspondences for which no other correspondence could possibly exist. If the subject relies on overall similarity relations, however, there is no reason to expect such a difference.

Results. The data were quite clear. There was absolutely no effect of anything. The mean time per item here was 1.25 sec for the

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1 We can imagine intermediate cases between analogy and generalization, in which one of these strategies is used but not another. For example, the retrieval of memories of similar words might be the result of basic mechanisms but the modification of the responses to these words might require special strategies.

2 A further complication is the possibility that a person can present items to himself, whether by recalling examples he has learned or by making up transfer items. However, we can treat these self-generated items as equivalent to externally-presented stimuli for purposes of our classification scheme.

3 Typically, subjects give either old responses (mab, zak) or responses with the same phonemes (zam, wuk). Sometimes, new phonemes were inserted. Subjects could have achieved higher scores than they did by matching probabilities of phonemes in positions, but the procedure for estimating scores expected by guessing would also be influenced by such matching, so we can conclude that it did not account for the results. Finally, it may be of interest that the positive results were due almost entirely to correct performance on the vowel (77% obtained vs. 56% predicted, $p<.015$). Performance on the first phoneme in the response was only slightly above chance, while performance on the last phoneme was slightly below chance.

4 We might think that the analogy mechanism would operate too slowly to be useful in Experiment II. But we have no right to make such an assumption. How slowly is too slowly?

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(Baron and Strawson, 1976; Baron, submitted). Such differences might arise in at least two different ways. It might be that people who are good at using correspondences are those who are good at finding analogies in their memories. If so, practice at this skill might be useful. Or, on the other hand, it may be that the retrieval of similar words is automatic (through generalization), once the stimulus word is perceived in the right way. In this case, teaching people to "parse" a word correctly may help them generalize along appropriate dimensions. The third difficulty is that the transfer effects we found are small. If these effects are indicative of what we might expect outside the laboratory (although there is no reason to assume they are), explicit instruction might be faster.

The fourth argument against relying too heavily on the present results is that these results might tell us about mechanisms available to college students only; these mechanisms for transferring by analogy or generalization might not be available to young children (as the results of Jeffrey and Samuels, 1967, suggest). Children might be different for two reasons. First, they might be less prone to apply intentional strategies such as those involved in using analogies. Second, children might perceive printed or spoken words differently. If, for example, a child perceives spoken words more as wholes and less as strings of separate phonemes, (Treiman and Baron, submitted), the mechanisms of generalization and analogy, both of which require preservation of some phonemes and replacement of others, may not work as well.

correspondence condition and 1.21 sec for the control condition. This effect is slightly opposite to what we predicted. For these mean times, the difference in magnitude of transfer between the Experiments II and III was significant, p<.025. For memory, the mean scores were 28.9% for the correspondence condition and 27.5% for the control condition. This difference of 1.3% is to be compared to the difference of 13.8% in the last experiment, although the difference between experiments did not quite reach statistical significance. When only sets A and B were examined, memory was correct 37.5% of the time for the correspondence condition and 42.5% for the control condition, again, an effect slightly opposite to our prediction.

Finally, we can compare the individual phonemes for which the subject had two sources of transfer (such as "Z" in the first item in set A, for subjects who used list C2) with the letters for which he had no sources (such as "EE" in this same item). The Z could be inferred either from an association between the Z in ZAW and the first letter of the first item of list C2 or the second letter of the second item. There is no association from which EE could be inferred. For the letters with two sources of transfer, the subjects produced the correct phoneme 55.0% of the time, and for the letters with no sources, 52.5%. These figures are almost identical. Again, there is absolutely no evidence for transfer based on associations between letters and phonemes.

Discussion

We must acknowledge that these results may be restricted to these somewhat artificial situations. In addition, Experiments II and III might not be quite as comparable as we intended; there were, for example, even fewer responses to be learned in Experiment III than in Experiment II, and this may have affected the processes used. Still, the overall results of these experiments do point to analogy and generalization as the most likely mechanisms for transferring spelling-sound correspondences in the absence of knowledge of the existence of the correspondences. When similarity relations are controlled, as in Experiment III, no incidental learning based on transfer of the spelling-sound correspondences is found.

If it is true that analogy and generalization are important in using spelling-sound correspondences, we might want to consider the implications of this fact for teaching children to decode new words. One might think from the present findings that there is little to be done. It might appear that since rules may be abstracted from learning to read whole words, this is all that is required. However, there are four arguments against this. First, many studies have (Chall, 1967) shown that the whole-word method is often inferior to other methods in the classroom, and by our argument, it ought to be superior in all cases. Second, there do appear to be individual differences in the extent to which people can use spelling-sound correspondences