

THE ABSTRACTNESS OF LEXICAL REPRESENTATIONS

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ABSTRACT

Linguists often assume that lexical representations in memory contain only phonemic information, that is, the minimal information required to distinguish among lexical items. This study seems to support this assumption. In an auditory same-different task with a short ISI, subjects found words that begin with /tr/ clusters, like *truck*, to be more similar to words like *chuck* that begin with the acoustically similar but phonemically distinct sound /tʃ/ than to words like *tuck* that begin with the phonemically similar but acoustically distinct sound /t/. However, with a longer ISI, subjects consider *truck* to be equally similar to *tuck* as to *chuck*. This implies that over time a more abstract representation of words like *truck* arises that does indeed contain the phoneme /t/.

Linguists often assume that lexical representations in memory contain only phonemic information, that is, the minimal information required to distinguish among lexical items.* Thus, for instance, the vowel in the English word *ban* is assumed to be represented without the nasality that is found in actual speech, because nasalized vowels by themselves are not distinctive in English. The systematic allophonic variation, in this case the nasalization of a vowel before a nasal consonant, is thought to be the result of processes that modify the original lexical representation in memory. In this way memory representations are assumed to be abstract.

One question that arises, given this scenario, concerns the processes that seem to neutralize the difference between two phonemes. This study focussed on the palatalization of /t/ before /r/, which, according to Bailey (1973), occurs in virtually all dialects and registers of American English. Thus in the productions of speakers who palatalize /t/, the initial sound of the word *truck* is acoustically more similar to the initial sound of *chuck* than to that of *tuck*. The idea that lexical representations in memory are phonemic allows, then, for two possibilities, schematized in Figure 1: the (tʃ) sound in words like *truck* may be due to on-line processes that derive this sound from an underlying /t/, as is often assumed, or it may be represented as the phoneme /tʃ/ in memory.

 FIGURE 1

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Suggestive evidence for the latter possibility comes from the spelling of children learning to write. Researchers such as Read (1972) have noted that young children will often write the initial sound in TR clusters the same way they write the phoneme /tʃ/ but distinct from the way they write the phoneme /t/ in other contexts. The list in Figure 2 comes from a six-year-old boy who was told to write words beginning with the same sound as *train*. Note that he has included both words normally spelled with TR as well as words normally spelled with CH. For him these words all begin with the same sound, represented in his spelling by HC.

 FIGURE 2

There are problems with this sort of evidence, however. The assumption that children intend their spelling to reflect only lexically distinctive information and not something more concrete may be false. Moreover, it is known that young children have difficulty parsing consonant clusters into their constituent phonemes. The difficulty in recognizing /t/ in *truck* might simply be related to this more general difficulty. Finally, of course, even if young children do represent words like *truck* with the phoneme /tʃ/, they may reanalyze such words as containing /t/ by the time they reach adulthood.

This study attempts to determine if adults perceive words like *truck* as containing /t/ or /tʃ/. Our fundamental assumption was that if listeners perceive *truck* as containing /t/, they will perceive this word as more similar to *tuck*, which is identical except that the onset

cluster is replaced by the phoneme /t/, than to *chuck*, where the onset cluster is replaced by /tʃ/. By contrast, if they perceive *truck* as containing /tʃ/, *truck* will be perceived as more similar to *chuck* than to *tuck*. We decided to use only real words in the hope that speakers would access memory representations to assist in the comparison.

We used a speeded auditory same-different task. In this task pairs of words are presented auditorily, one after the other, and the subject's task is to decide, as quickly as possible, if the two words are the same or different. Reaction times for the different responses are recorded. Presumably, the more similar the two items being compared appear to be, the longer the subject will take to make a DIFFERENT response. Two experiments using this task were performed.

In our first experiment, we selected four groups of monosyllabic words matched for familiarity and frequency. Each group consisted of four words: a target word beginning with /tr/, such as *truck*; a word identical to the target word except that /tr/ was replaced by /t/, such as *tuck*; a word identical to the target word except that /tr/ was replaced by /tʃ/, such as *chuck*; and finally a word different from the target word in all syllable positions, such as *cave*. Subjects were presented with pairs of the items in each group, so that a given /tr/ word was matched either with its associated /t/ word (the UNDERLYING MATCH condition), with its associated /tʃ/ word (the SURFACE MATCH condition), or with an unrelated word (the CONTROL condition). Pairs were presented in both orders. Identical pairs, such as *tuck-truck*, *tuck-tuck*, *chuck-chuck* and *cave-*

cave were also presented. In addition, forty-eight other words were presented in pairs as distractors, making a total of 384 pairs. All pairs were presented auditorily.

Twenty subjects participated in this experiment. Subjects responded by pushing buttons to indicate whether the two words presented were the same or different. Subjects were instructed to respond as quickly but as accurately as possible. The interstimulus interval (ISI) was 50 milliseconds. Reaction times were measured from the onset of the second word.

Mean reaction times in milliseconds for the CONTROL, UNDERLYING MATCH, and SURFACE MATCH pairs are shown in Figure 3. Mean DIFFERENT reaction time was 580 msec for the CONTROL pairs, as represented by the black bar on this graph, 617 msec for the UNDERLYING MATCH pairs, as represented by the black striped bar in the center, and 690 msec for the SURFACE MATCH pairs, as represented by the white striped bar. On average, subjects were 37 msec slower to respond to the UNDERLYING MATCH pairs than to the CONTROL pairs. In addition, subjects were, on average, 73 milliseconds slower to respond to the SURFACE MATCH pairs than to the UNDERLYING MATCH pairs. That is, subjects gave a different response significantly slower to pairs such as *truck-chuck* than to pairs such as *truck-tuck*, indicating that they found the TR-initial words more similar to /tʃ/-initial words than to /t/-initial words.

FIGURE 3

The question remains, however, at what level of representation subjects are making these comparisons. It is possible, for example, that subjects are merely comparing acoustic representations rather than representations closer to those stored in memory. To test for this possibility, we performed a second experiment.

Stimuli and task remained identical. This time, however, we increased the interstimulus interval from 50 milliseconds to 500 milliseconds. Following the use of this technique in studies such as Goldinger, Luce and Pisoni (1989), we supposed that with a longer ISI the first word would undergo more processing before the subject was presented with the second word than in the shorter ISI condition. Thus if *truck* is in fact ultimately analyzed as beginning with /t/, a longer ISI may give subjects time to access or derive this more abstract representation before having to compare *truck* with the second word. Consequently, perception of the similarity between *truck* and *tuck* should increase, as measured by slower different responses.

The mean reaction times in milliseconds for the CONTROL, UNDERLYING MATCH and SURFACE MATCH pairs for the 21 subjects in the long ISI condition are shown in Figure 4. Mean different reaction time was 619 msec for the CONTROL pairs, 683 msec for the UNDERLYING MATCH pairs, and 681 msec for the SURFACE MATCH pairs. On average, subjects were 64 msec slower to respond to the UNDERLYING MATCH pairs than to the CONTROL pairs. The significant difference between the UNDERLYING and SURFACE conditions has disappeared. This has occurred through an increase in reaction times for the UNDERLYING pairs. The mean reaction time

for the SURFACE pairs does not differ significantly in the long ISI condition from that in the short ISI condition.

FIGURE 4

In other words, it seems that a more abstract representation of *truck* with /t/ does indeed arise sometime between 50 and 500 milliseconds. However, the more concrete representation of *truck* that is perceived as similar to *chuck* does not disappear during this time interval. After 500 milliseconds, *truck* is perceived as being equally similar to the underlying match *tuck* as to the surface match *chuck*. Apparently, at this stage words are represented in at least two ways at the same time, one more abstract than the other.

This study raises a number of important questions that remain for future research. First, what sort of thing is this "surface" representation? Is it a specifically linguistic representation, perhaps even a phonological one, related to the more abstract representation by specific phonological or phonetic rules of some sort? Or is the representation purely acoustic?

Second, does the abstract representation of *truck* arise in the course of the task by being accessed from memory, or is it derived by some process that would work just as well with nonwords?

Third, are the initial sounds of *truck* and *chuck* identical in production? If they are not, this would be further evidence that these sounds are represented differently in memory. In fact, studies of other purported cases of neutralization in adult speech, reviewed in works such as Dinnsen (1985), consistently find that apparently

automatic processes do not truly eliminate distinctions between phonemes. For example, Charles-Luce (1985) and others have shown that the underlying voicing contrast in word-final obstruents in German, purportedly eliminated by a process of final devoicing, is nevertheless maintained under certain phonetic and pragmatic conditions.

Fourth, where does the knowledge that *truck* contains /t/ come from? In determining underlying representations, linguists give particular weight to evidence that comes from morphologically related words. For example, one can argue that the word *theatric* has an underlying /t/ that surfaces as (tʃ) because this /t/ surfaces as its flapped allophone in the morphologically related word *theater*. Notice, however, that for most words containing TR there are no such related words. Thus in most cases there is no evidence from related words that a word containing (tʃ) followed by [r] on the surface actually contains /t/ underlyingly.

If the knowledge that *truck* contains /t/ does not come from related words, where does it come from? Does it merely arise through knowledge of orthography? If the palatalization of /t/ before /r/ does not in fact neutralize it with the phoneme /tʃ/ in production, is it the gradient nature of this process that allows language learners to deduce the underlying presence of /t/? Or is variability in the application of this process across different dialects the essential clue that an underlying /t/ is present in all these dialects? Most importantly, if these other sources are sufficient in this case, then are regular morphological alternations, standardly

assumed by linguists to have a special status with regard to the learning of abstract representations, ever necessary?

Finally, what about children? Will they show also evidence of an abstract representation for *truck* in a task like this, or will their behavior be consistent with the evidence from misspellings? All of these questions remain for future research.

FIGURES

Figure 1.

		"truck"
	UNDERLYING	SURFACE
Hypothesis 1:	/t/ruck	(tʃ)ruck
Hypothesis 2:	/tʃ/ruck	(tʃ)ruck

Figure 2.

Words "beginning with the same sound as TRAIN" for a six-year-old (Read 1972:94)

HCEAN	"train"	HCEK	"check"
HCRP	"trip"	HCIKMANCK	"chipmunk"
HCRAK	"track"	HCICN	"chicken"
HCAFE	"traffic"	HCITO	"cheetah"

Figure 3.

/tr/, ISI = 50 msec

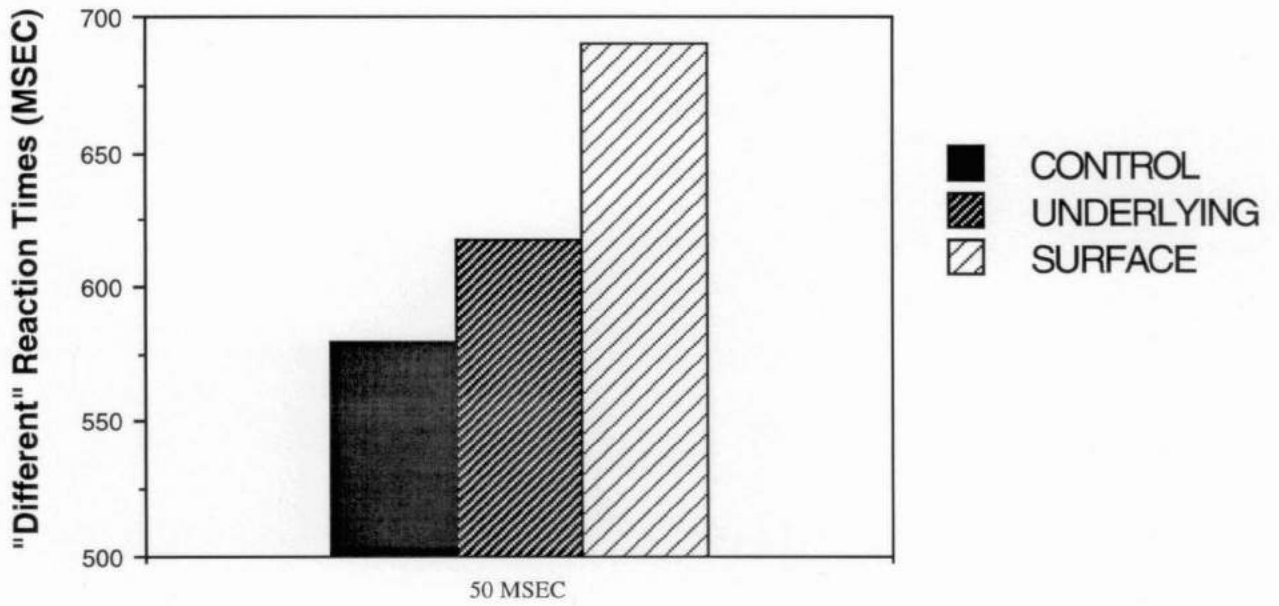
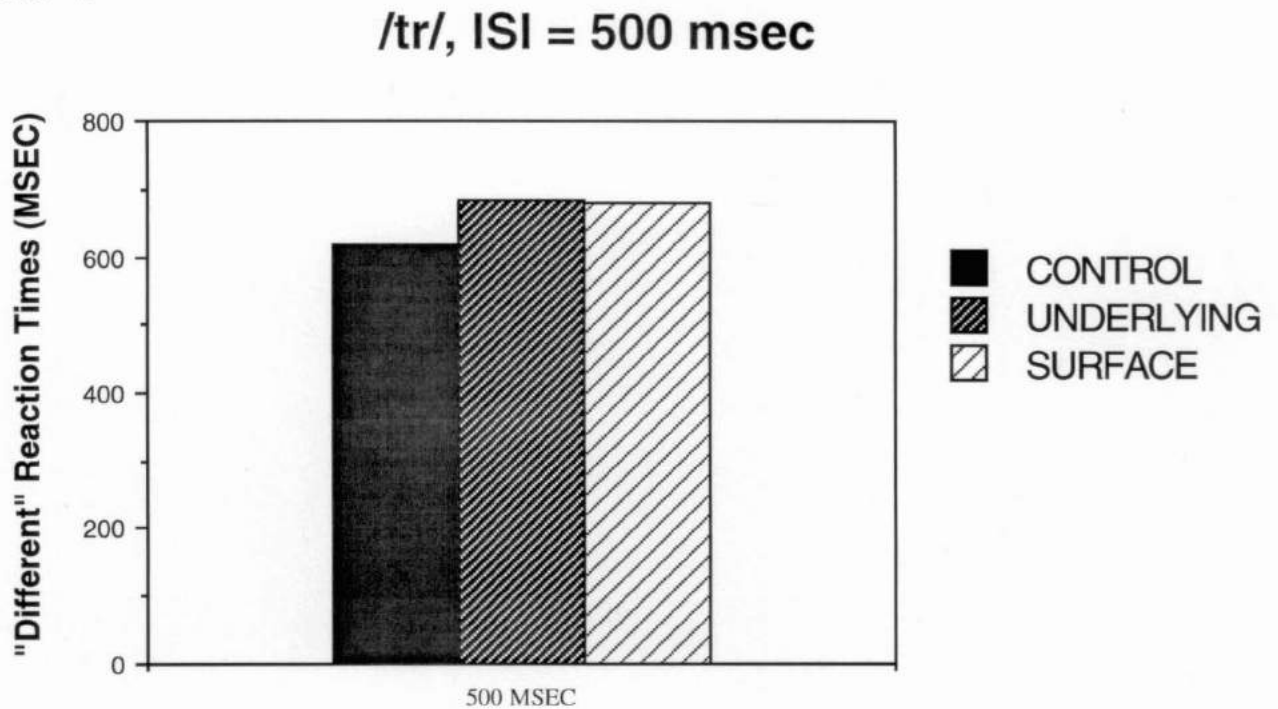


Figure 4.



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