Journal of Memory and Language 87 (2016) 71–83

Contents lists available at ScienceDirect

Journal of Memory and Language

journal homepage: www.elsevier.com/locate/jml

Spoken word identification involves accessing position invariant phoneme representations

Jeffrey S. Bowers *, Nina Kazanina, Nora Andermane

School of Experimental Psychology, University of Bristol, United Kingdom

ARTICLE INFO

Article history:
Received 23 October 2014
revision received 2 November 2015

Keywords:
Phoneme
Position specificity
Spoken word identification
Lexical access code

ABSTRACT

In two adaptation experiments we investigated the role of phonemes in speech perception. Participants repeatedly categorized an ambiguous test word that started with a blended /f/-/s/ fricative (*?ail* can be perceived as /fail/ or /sail/) or a blended /d/-/b/ stop (*?ump* can be perceived as /bump/ or /dump/) after exposure to a set of adaptor words. The adaptors all included unambiguous /f/ or /s/ fricatives, or alternatively, /d/ or /b/ stops. In Experiment 1 we manipulated the position of the adaptor phonemes so that they occurred at the start of the word (e.g., *farm*), at the start of the second syllable (e.g., *tofu*), or the end of the word (e.g., *leaf*). We found that adaptation effects occurred across positions: Participants were less likely to categorize the ambiguous test stimulus as if it contained the adapted phoneme. For example, after exposure to the adaptors *leaf*, *golf*... etc., participants were more likely to categorize the ambiguous test word *?ail* as 'sail'. In Experiment 2 we also varied the voice of the speaker: Words with unambiguous final phoneme adaptors were spoken by a female while the ambiguous initial test phonemes were spoken by a male. Again robust adaptation effects occurred. Critically, in both experiments, similar adaptation effects were obtained for the fricatives and stops despite the fact that the acoustics of stops vary more as a function of position. We take these findings to support the claim that position independent phonemes play a role in spoken word identification.

© 2015 Published by Elsevier Inc.

Introduction

Traditional linguistic theory postulates a small set of phonemes that can be sequenced in various ways in order to represent thousands of words in a language (Chomsky & Halle, 1968; Trubetzkoy, 1969). Phonemes are the smallest linguistic unit that can distinguish word meanings and usually are of a size of a single consonant or vowel, e.g., the consonants /b/ and /p/ are phonemes in English because they differentiate the words "bark" and "park". Phonemes are critically distinguished from speech sounds (i.e. phones) in their level of abstractness. Phones are acoustically defined units that are often context-dependent, i.e. in a given language a certain phone may be bound to a specific syllable position, or require a certain stress pattern, or occur within the context of specific surrounding sounds. By contrast, phonemes are abstract entities that encompass several phones. For example, the phoneme /t/ is an abstract representational unit that in English is realized as an aspirated [t^h] syllable-initially as in *top*, as an unaspirated [t] following /s/ as in *star* or as an unreleased [t˺] in the syllable-final position as in *cat*. In other words, [t^h], [t] and [t˺] are different phones which in English represent a unique phoneme /t/.

A key theoretical reason for uniting distinct phones under the same phoneme category is that, despite their acoustic and articulatory differences, they operate as a single unit across a range of synchronic and historical

* Corresponding author at: School of Psychology, University of Bristol, 12a Priory Road, Clifton, Bristol BS8 1TU, United Kingdom.

E-mail address: j.bowers@bristol.ac.uk (J.S. Bowers).

http://dx.doi.org/10.1016/j.jml.2015.11.002
0749-596X/© 2015 Published by Elsevier Inc.

language processes. Take the case of morphological derivation. Morphological derivation often leads to changes in the stress position that in turn result in differences in the quality of the vowel in the root morpheme. For example, the stressed vowel [ɒ] in *solid* [ˈsɒlɪd] changes to an unstressed [ə] in *solidity* [səˈlɪdɪti].[1] If phones were used to represent words, then there would be no *solid* in *solidity*. However, the existence of abstract phonemes ensures that *solidity* contains *solid* as the root morpheme. The same point can be illustrated in pairs *compete* [kʰəmˈpʰiːt̚] – *competition* [ˌkʰɒmpəˈtʰɪʃən], *photograph* [ˈfəʊtəgrɑːf] – *photographer* [fəˈtʰɒgrəfəʳ] and indeed, is ubiquitous across the lexicon.

Another common effect of morphological derivation involves resyllabification of the final consonant of the root morpheme accompanied by a change in the acoustic identity of the consonant. For example, /t/ is realized as an unreleased [t̚] at the end of *float*, but as an aspirated [tʰ] in *floatation*. This process is ubiquitous, e.g. *rate* [ˈreɪt̚] – *rated* [ˈreɪ.tʰɪd], *type* [ˈtʰaɪp̚] – *typing* [ˈtʰaɪ.pɪŋ]. So once again phoneme representations are indispensable to preserve the compositionality of morphologically complex words.

In sum, the lexicon is much more regular – and perhaps easier to learn – if lexical representations are formulated in terms of phonemes rather than context-specific or position-specific phones. This may also explain why we employ a common written letter 't' for the spelling of *top* and *cat* rather than one letter for [tʰ] and another for [t̚].

Although phonemes are widely assumed in linguistic theory, the psychological evidence in support of phonemes, at least in the domain of speech perception, is scant. This has given rise to various models that abandon phonemes as a functional unit in speech perception. For example, on one view, words are stored and directly accessed by position-specific phones (or positional variants of phonemes in Pierrehumbert's 2003 terminology). Pierrehumbert's (2003) rationale for positional units (defined in terms of syllable or word position) stems from the observation that acoustic signature is more stable for position-specific phones compared to position-independent phonemes. These position-specific phones in turn map onto lexical representations.

Similarly, a number of computational models of spoken word identification (e.g., Luce, Goldinger, Auer, & Vitevitch, 2000; McClelland & Elman, 1986) bind segments to time in long-term memory in order to code for the order of segments. For example, in the TRACE model, different 'd' segments (d-at-time-1 and d-at-time-3) are used to activate *dog* and *god* representations, respectively. These time-bound segments can be seen as analogous to Pierrehumbert's position-specific phones (in that the segments do not abstract across position) although the input units in these models are often labeled phonemes.

The common rejection of position invariant phonemes in psychological theories and models of word perception is a fundamental claim, and we explore this issue here. First we review the current empirical evidence regarding phonemes in the domains of speech production and perception, and then describe two experiments that provide strong evidence that phonemes do indeed play a role in word perception.

Empirical evidence for phonemes in speech production

In the domain of speech production the evidence for phonemes, i.e., segment-sized position-invariant units, is reasonably strong. One of the best pieces of evidence for segment-sized units comes from speech errors that involve swapping segments in corresponding syllable positions (e.g., swaps between onset consonants, such as "heft lemisphere" in lieu of "left hemisphere"). These swaps require positing segment size units (Fromkin, 1974). Evidence that the segment size units are coded independent of syllable position comes from swaps in non-corresponding syllable positions. For example, Vousden, Brown, and Harley (2000) found that more than 20% of relevant phonological errors involved changes across syllable positions (e.g., *film* mispronounced as *flim*).

Priming studies point to a similar conclusion. For example, when participants are asked to name an object and its color, naming is facilitated by phoneme overlap between the color and object name both when overlapping segments occur in the same position (e.g. *green goat* vs. *red goat*) and when they occur in different syllable positions (e.g., *green flag* vs. *red flag*; Damian & Dumay, 2009). These findings lend support to the view that phonemes in speech production are coded independently of syllable position and are bound to syllable frames during production (e.g., Shattuck-Hufnagel, 1986).

Empirical evidence against phonemes in speech perception

Although phonemes are widely assumed in theories of speech production, it does not necessarily follow that phonemes are involved in speech perception as well. Indeed, Hickok (2014) recently developed a model of speech processing that holds phonemes as functional units in speech production but not perception. Consistent with this hypothesis, a number of psycholinguistic findings are taken to challenge the psychological reality of phonemes as units of perception, and this has led to a number of theories and models of speech perception that explicitly reject phonemes (e.g., Goldinger, 1998; Luce et al., 2000; Oden & Massaro, 1978; Pierrehumbert, 2003). We review this data next.

Perhaps the most common experimental method used to challenge phonemes is perceptual learning. In these experiments participants learn to identify a degraded or distorted speech sound in one context, and the question is whether the learning generalizes to other contexts. It is assumed that generalization should extend to all allophonic forms of a given phoneme if indeed phonemes play a role in speech perception. By contrast, if generalization is restricted, it is taken as evidence against phonemes.

First consider a perceptual learning study in Dutch by Mitterer, Scharenborg, and McQueen (2013) in which no

[1] Throughout the paper British English transcription will be used.

Download English Version:

https://daneshyari.com/en/article/7296975

Download Persian Version:

https://daneshyari.com/article/7296975

Daneshyari.com