LEARNING TO OVERCOME L1 PHONOLOGICAL BIASES

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ABSTRACT

This paper expands upon the complementary-systems model of speech perception by proposing that exemplar encoding is filtered by native language phonolgy through differential attentional weighting of particular acoustic cues. Phonetic processing in a second language is presumed to rely on an L2 phonological system that is not native-like due to the persistent effects of this attentional filtering. In learning to either re-weight attention or work around this filtering effect, individuals may vary with respect to their ability to exploit the exemplar store in L2 processing, leading to differences in long-term ability to develop native-like L2 phonologies.

Keywords: speech perception, perceptual learning, bilingual, exemplar, second language

1. INTRODUCTION

There is now general consensus that speech perception involves both abstract phonological representations and detailed speech exemplars. The existence of exemplar representations raises the following question regarding the perception of speech in a non-native language (L2): if exemplars encode highly detailed non-phonetic acoustic information, why is it so difficult to overcome the influence of L1 phonology on L2 perception? That is, if acoustic information that is not relevant to L1 phonemic contrasts is encoded in exemplars, why are we not able to readily exploit this information for the purposes of perceiving L2 phonemic contrasts?

2. COMPLEMENTARY-SYSTEMS MODEL OF SPEECH PERCEPTION

Goldinger's paper reviews the evidence supporting both exemplar encoding and abstract phonological representations and presents a neurologically plausible complementary-systems model describing the interaction of these two types of representations in the brain. In this model the speech sound representations in the hippocampus are relatively input-veridical exemplars, while the cortical representations are abstracted and more phonological. According to this model, the answer to the questions above lies in the fact that the acoustic/phonetic input to the hippocampus is not itself fully veridical, but rather is already somewhat filtered by the abstract cortical representations. This filtering occurs via traces that feed back from the neocortex to the hippocampus, reflecting generalized phonological patterns.

Although not a major point of the paper, Goldinger suggests that this filtering effect is mediated by attention. This suggestion echoes episodic memory research more generally [5, 11], in which exemplar representation is presumed to be veridical inasmuch as particular aspects of the exemplar are attended to, with weak or no representation for aspects of the signal that are poorly attended or unattended. This suggests that it is not memory traces per se that feed back from the cortex to the hippocampus, but rather attentional weighting to various acoustic/phonetic cues. In this paper I explore the hypothesis that L1 phonology persists in L2 perception due to difficulties in learning to re-weight attention for encoding of L2-relevant acoustic cues.

3. THE ROLE OF PHONOLOGY IN L2 PERCEPTION

It is clear that prior to acquiring a foreign language perception of any language is heavily filtered by L1 phonology. According to the attentional-weighting hypothesis explored here, this results from many of the L2-relevant acoustic cues being poorly attended. Listeners are, however, able to improve at L2 perception, as research shows that proficient L2 users are better able to attend to L2-relevant cues than L2 novices [3, 6]. One question we must address is whether this improvement in L2 perception is the result of the L2 learner having acquired a second phonological system, or whether they have simply altered their L1 phonological system such that it better accommodates both languages? This amounts to a question commonly posed in the bilingual language processing literature: do bilinguals have one language or two?

Although proficient L2 users show improved L2 perception, their perception is clearly still biased by their L1. Thus, if they have dual phonological systems, the L2 system must be weaker than and/or biased by L1 phonology. If they utilize a single phonological system for perception of both languages, it must be a system that reflects L1 more strongly than L2.

The first answer (dual phonological systems) seems most likely to be correct, at least for late bilinguals, as differentiated neural representations have been found for phonetic processing of L1 versus L2 [4]. For the sake of discussion, let us assume that bilinguals have separate phonological systems for their two languages. Their L1 phonology is based on a lifetime of experience with L1, and thus closely approximates that of other native speakers. Their L2 phonology, however, will initially be heavily biased by the phonetic and phonological properties of L1, as L1 phonology is the initial state for L2 perception. In theory, experience with exemplars from L2 and sensitivity to the distribution of L2 phonetic cues [2, 7] will result in an L2 phonology also approximating that of native speakers. However, since input to the exemplar store is mediated by phonological knowledge, the development of a native-like L2 phonology is impeded by the persistent influence of an L1 bias. This L1 bias may be partially aided by frequency effects, since for many bilinguals L1 representations are activated far more frequently than L2.

If bilinguals possess separate phonetic processing systems for their two languages, how are they able to control which phonetic processing system is active? This may be possible via a central mechanism in situations where the listener knows which language they are listening to (e.g., listening in a particular "language mode"). However, the bilingual is certain to also encounter situations where the language heard is either unpredictable or unexpected (e.g., code-switching). In this case, the speech itself is likely to contain particular phonetic cues to which language is being spoken, and perhaps the hippocampus, primary auditory cortex, or cortical regions that are more sensitive to sub-phonemic cues [9] are then able to trigger activation of L1 vs. L2 attentional weights.

4. THE EFFECT OF STRESS ON L2 PERCEPTION

In L2 phonetic processing there is a tendency for L1 phonology to have a larger than usual effect in situations of duress, such as listening to speech in noise [15], increasing task demands or attentional load [8], and word-finding or sentence-parsing difficulties [13]. This may reflect a falling-back from the L2 to the L1 phonological system under stressful conditions. Or it may be the case that under ideal conditions (e.g., quiet environment, low attentional load) the learner's L2 phonological system appears more native-like than it actually is due to a more efficient use of the exemplar store. That is, a Spanish listener may perform well on a Catalan vowel discrimination task due to heavier-than-usual reliance on exemplar memory or greater-than-usual resource allocation to the task of speech processing; but the added difficulty of recognizing speech in noise may reduce available resources, and thus a larger filtering effect from phonological memory would be evident. This filtering would reflect their *L2* phonology, but an L2 phonology that is not native-like and thus bears a strong resemblance to L1 phonology. If attentional weighting serves to highlight the most crucial information for meaning retrieval, then in low stress conditions when more attentional resources are available, weakly-weighted cues may also be encoded.

If this second explanation is correct, then the same effect is predicted be evident in L1 processing as well. That is, when listening to L1, listeners should be less able to perceive non-categorical phonetic information in noise or with heavy memory or attentional load. This prediction is confirmed by findings that listeners are less sensitive to fine-grained acoustic detail in demanding conditions [14, 17].

5. INDIVIDUAL DIFFERENCES

Anecdotal evidence suggests that there are large individual differences in the degree to which L1 phonology affects L2 processing, even after L2 proficiency level and experience are partialed out. That is, some listeners are more able to overcome their L1 bias when listening to L2 than others. Understanding what underlies these individual differences may help to better explain the sources of the effect of L1 on L2 perception.

The developmental literature suggests that infants who continue to discriminate foreign contrasts until past the age when many infants have lost this sensitivity are in turn slower to develop a native vocabulary [16]. This may reflect individual differences in the development of L1-appropriate attentional cue-weighting. The failure to develop a phonological filter for exemplar encoding would seem to result in more veridical phonetic input to the hippocampus. However, it is also likely to require greater processing resources, as the less critical acoustic/phonetic cues are not filtered out. This would in turn explain the delayed vocabulary development, since infants would need to expend more energy to encode heard speech.

If there are differences in the rate of acquisition for L1 attentional weights, perhaps there are also long-term differences between individual listeners in the degree of attentional weighting. That is, perhaps some people have weaker L1 filters than others. If so, these people would encode more veridical episodic representations for speech, but they would in turn be less efficient in phonological processing. Conversely, other people would have less veridical exemplars but be more efficient processors.

If this is true, it predicts that the less efficient processors should be able to develop more native-like accents in L2, as they would have greater access to more veridical exemplars. Assuming that the same holds for L1 processing, these same people should also be more likely to experience the "Madonna effect".

6. CONCLUSION

Goldinger's complementary-systems model of speech perception provides an elegant account of the complex interaction between surface-veridical speech exemplars and the abstract representations reflecting a language's phonological regularities. I have argued that this model can account for the L1 effects on L2 perception by positing a separate phonological processing system for L2 that is initially highly biased by L1 phonology (gradually becoming less so with continued exposure to L2). I suggest that much of the L1 effect on L2 arises from difficulties acquiring the appropriate attentional weights that highlight linguistically relevant acoustic dimensions in L2. Finally, individuals are likely to vary with respect to their ability to exploit the exemplar store in L2 processing, which in turn may lead to differences in long-term ability to develop native-like L2 phonologies.

Of course, acquiring new attentional weights for acoustic cues need not be the only means by which L2 speakers improve perception abilities in their second language. As argued by Cutler and Weber, the point of difficulty may be lexical; that is, the relevant acoustic information may indeed be encoded in the exemplar store, but the individual may lack the ability to exploit the cue for the purposes of lexical processing. For example, we know that indexical properties of speech are encoded in exemplars, yet listeners find it difficult to learn phonological regularities (such as phonotactic restrictions) that are voice-specific [12]. Perhaps these findings reflect a problem, not of *encoding* acoustic information, but of *retrieval* during lexical processing tasks [5]. However, regardless of the specific location of difficulty (whether in encoding or retrieval), extralinguistic cues like orthography may well provide an additional boost for acquiring an L2-appropriate phonology.

One remaining issue is the fact that phonology appears to affect even low-level auditory perception [1, 10, 18]. This suggests that there is some feedback from the attentional control mechanism to basic sensory cortex. This is potentially problematic for L2 perception as it results in a reduction of potentially L2-relevant phonetic information being available for episodic encoding. This phenomenon is not currently well understood, but the fact that listeners are indeed able to improve at L2 perception indicates that this basic sensory filtering is either incomplete or can be overridden by attentional control.

Much remains to be resolved in future research. We currently lack a good account of how language experience alters primary auditory cortex. Furthermore, models of perception need to be further refined to explain just how veridical exemplars are, and what specific factors affect listeners' access to those representations. These models should take into account evidence that different cortical regions may make different use of subphonemic information [9], and account for the role of phonology in this process.

7. ACKNOWLEDGEMENT

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