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Research Article

Discrimination of uncategorised non-native vowel contrasts is modulated by perceived overlap with native phonological categories

Mona M. Faris [a,*], Catherine T. Best [a], Michael D. Tyler [b]

[a] MARCS Institute for Brain, Behaviour, and Development, University of Western Sydney, Locked Bag 1797, Penrith, NSW 2751, Australia
[b] School of Social Sciences and Psychology, Bankstown Campus, University of Western Sydney, Locked Bag 1797, Penrith, NSW 2751, Australia

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ABSTRACT

Non-native vowels perceived as speech-like but not identified with a particular native (L1) vowel are assimilated as uncategorised, and have received very little empirical attention. According to the Perceptual Assimilation Model (PAM: Best, 1995), contrasts where one or both phones are uncategorised are Uncategorised-Categorised and Uncategorised-Uncategorised, respectively. We reasoned that discrimination accuracy for these assimilations should be influenced by perceived phonological overlap (i.e., overlap in the categorisations to L1 vowels), and predicted excellent discrimination for non-overlapping contrasts, followed by partially overlapping, and completely overlapping contrasts. To test those predictions, Australian English speakers discriminated between Danish monophthongal and diphthongal vowel contrasts that formed Uncategorised-Categorised and Uncategorised-Uncategorised assimilations, varying in the presence of overlap, in addition to Two-Category and Single-Category contrasts. The discrimination accuracy results supported our predictions. These findings have implications for PAM, and broader relevance to second-language learning models, as they allow for more precise discrimination predictions to be made based on assimilation type.

1. Introduction

Research on adult cross-language speech perception suggests overwhelmingly that attunement to the native language (L1) influences non-native vowel perception (Escudero & Williams, 2011; Strange et al., 1998; Tyler, Best, Faber, & Levitt, 2014). Adults often experience difficulty in discriminating between certain pairs of non-native phonemes that are phonologically distinctive for native speakers of that language (i.e., they are contrasts), yet they are able to discriminate between other pairs of non-native contrasts reasonably well (see Best, McRoberts, & Goodell, 2001). The discrimination of contrasting non-native consonants that are each identified with a single L1 category has been the primary focus of cross-language speech perception research (e.g., Best et al., 2001; Polka, 1991; Strange & Dittmann, 1984). Relatively little is known, however, about how well pairs of vowels are discriminated when one or both of them is not perceived as similar to any single L1 vowel. The purpose of the present study was to provide a systematic examination of discrimination performance on contrasting non-native vowels that are not perceived as similar to any one particular L1 category.

One of the most widely accepted theories of cross-language speech perception that accounts for the variability in the discrimination of non-native phones is the Perceptual Assimilation Model (PAM: Best, 1994, 1995). PAM makes predictions of discrimination by naïve listeners based on how they perceptually assimilate non-native phones to their L1. Individual non-native phones may be assimilated to the L1 phonological system in one of three ways: (a) categorised: a non-native phone may be assimilated to an L1 phoneme and be perceived as an excellent, moderate, or poor exemplar of that category, (b) uncategorised: a non-native phone may not be perceived as similar to any one particular L1 phonological category, and so falls in an untuned region in between categories, or (c) non-assimilable: a non-native phone is not perceived as speech and so falls outside the listener's L1 phonological space. Phones are deemed categorised if assimilated to a single L1 phoneme above a particular categorisation threshold

* Corresponding author.
E-mail addresses: m.faris@westernsydney.edu.au (M.M. Faris), c.best@westernsydney.edu.au (C.T. Best), m.tyler@westernsydney.edu.au (M.D. Tyler).

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(e.g., 50%, 70%), otherwise they are deemed uncategorised (Antoniou, Best, & Tyler, 2013; Bundgaard-Nielsen, Best, & Tyler, 2011b; Tyler et al., 2014).

PAM makes discrimination predictions based on the various ways pairs of contrasting phones are assimilated. When the two contrasting phones are categorised as different L1 phonemes (a *Two-Category assimilation, TC*), discrimination accuracy should be excellent because the non-native contrast happens to correspond to an L1 phonological contrast. When one phone is categorised and the other is uncategorised (an *Uncategorised-Categorised assimilation, UC*), discrimination should be very good because the contrast consists of an L1 phonological distinction between one non-native phone that is perceived as a native phonological category and another that is not perceived as any L1 phonological category. Thus, discrimination for TC and UC assimilations is predicted to be very good to excellent. Conversely, if both phones are categorised to the same L1 phoneme, then perceivers are unable to use information about L1 phonological contrast to discriminate the non-native phones, but they may be able to detect differences in phonetic goodness-of-fit of each non-native phone to the same L1 phonological category. If one phone is perceived as a more acceptable version of the same L1 phoneme than the other (a *Category-Goodness assimilation, CG*), discrimination accuracy will range from good to very good, but if both phones are perceived as equally good or equally poor versions of the same L1 phoneme (a *Single-Category assimilation, SC*), discrimination accuracy will be poor. TC assimilations are predicted to be the easiest to discriminate, followed by both UC and CG, with SC predicted to be the most difficult to discriminate.

Discrimination accuracy for contrasts involving categorised phones (i.e., TC, CG, SC, UC) has been examined in adults mostly using consonants and have provided support for the PAM predictions of discrimination (e.g., Best & Strange, 1992; Best et al., 2001; Halle, Best, & Levitt, 1999; Polka, 1991), but there have been fewer studies using vowel stimuli (e.g., Bundgaard-Nielsen, Best, & Tyler, 2011a; Polka, 1995). In Tyler et al. (2014), the perception of French (/bo/-/bõ/, /dø/-/dœ/, /sy/-/sø/), Norwegian (/ki/-/kʉ/, /ki/-/ky/), and Thai (/bɯ/-/bɤ/) vowel contrasts was assessed in native speakers of American English. Most of the vowels were assimilated as uncategorised when a 70% assimilation criterion was used. TC and UC assimilations combined were discriminated more accurately than CG, followed by SC assimilations. Despite the variability in vowel perception, the PAM predictions held true for monophthongal vowels. It is yet to be determined whether, and to what extent, the PAM predictions also apply for diphthongal vowels.

When both phones are uncategorised (an *Uncategorised-Uncategorised* assimilation*; UU*), according to PAM (Best, 1995; Best & Tyler, 2007) there is no clear L1 phonological contrast for perceivers to detect. It is also not clear how goodness-of-fit information might influence discrimination when neither phone is perceived as a clear instance of any L1 phonological category. In the absence of perceived L1 contrastive phonological information, the perceiver may detect *phonetic* differences between the non-native phones, in which case discrimination is predicted to range from poor to moderate/very good, depending on the phonetic similarity of the two phones to each other. However, it is possible that the perceiver may detect phonological similarity of each of two non-native phones to *more than one* L1 phonological category. If each non-native phone were phonologically similar to different sets of L1 phonemes, then this may also facilitate discrimination of UU contrasts on a phonological basis.

While there has been no systematic examination of discrimination accuracy for assimilations involving uncategorised phones, a recent study by Faris, Best, and Tyler (2016) demonstrated that there are at least three different ways in which individual non-native vowels may be assimilated as uncategorised. In a perceptual assimilation task, native Egyptian Arabic speakers identified all of the Australian English (AusE) monophthongs and diphthongs in terms of all possible L1 monophthongs, diphthongs, and allophonic variants of the monophthongs and diphthongs. The only AusE vowels that were categorised above the (lenient) 50% cut-off categorisation criterion were /ɐː/, /e/, and /ɔ/ to the Egyptian Arabic /aː/, /i/, and /u/, respectively, while the remaining AusE vowels were uncategorised. For the uncategorised vowels, some were perceived as similar to a single L1 vowel phoneme at above chance rates, but responses to that vowel were below the 50% categorisation threshold (a *focalised* assimilation). There were also instances whereby two or more L1 vowels were selected above chance (a *clustered* assimilation), and other cases where no one label was selected above chance (a *dispersed* assimilation). Dispersed assimilations suggest that the listener does not detect any phonological similarities between a non-native vowel and any of the L1 vowel phonemes. For both focalised and clustered responses, modest phonological similarities are detected between a non-native vowel and one or more L1 vowel phonemes, respectively. A revision of PAM's original definition of uncategorised assimilations is needed to account for the different ways that uncategorised non-native vowels may be perceived to be phonologically similar to one, or more, or no L1 vowels, respectively, focalised, clustered, or dispersed assimilations.

Considered as contrasting pairs, a new set of discrimination predictions arise for uncategorised phones. As mentioned, the three uncategorised assimilation types are determined using a perceptual assimilation task, which assesses sensitivity to phonological information. Since phones assimilated as focalised and clustered are perceived as phonologically similar to one or more L1 phonemes, respectively, there is the potential for perceiving L1 phonological distinctions in a UU assimilation unless the two uncategorised phones are perceived as similar to the same set of L1 phonemes. That is, if there is *perceived phonological overlap* in the sub-threshold categorisations to L1 vowels, discrimination accuracy for both UU and UC assimilations may be poorer as compared to when there is no perceived phonological overlap. For vowels assimilated as dispersed, there will be very little to no systematic interference from the L1 phonology because they are not perceived as similar to any L1 phonological category reliably enough. Instead, dispersed phones may be perceived in terms of low-level phonetic features. Therefore, discrimination accuracy for contrasts involving two dispersed vowels should depend only on the degree of phonetic similarity between the non-native vowels, and discrimination accuracy may range from poor to excellent. Discrimination accuracy for contrasts involving at least one