Several studies have reported how the production of phonemes differs between native speakers and non-native speakers of a language or dialect (Best et al., 2015; Bion, Escudero, & Morrison, 2008; Burgos, Cucchiarini, van Hout, & Strik, 2014; Cebrian, 2007; Cutler, Smits, & Cooper, 2005; Dufour, 2007; Evanini & Huan, 2012; Fabra & Romero, 2012; Flege, 1987; Flege & Bohn, 1992; Flege, Munro, & Skelton, 1992; Hanulíková & Weber, 2012; Jia, Strange, Wu, Collado, & Guan, 2006; Levy & Law, 2010; Lombardi, 2003; Rau, Chang & Tarone, 2009; Rogers & Dalby, 2005; Tsukada, Birdsong, Bialystok, Mack, Sung, & Flege, 2005; Zhang & Xiao, 2014). These studies use corpora of recorded accented speech and usually evaluate phoneme productions in one of three ways (sometimes in combination): 1) trained phoneticians transcribe the recorded phonemes; 2) groups of naïve native speakers judge the phonemes, indicating what sounds they hear; or 3) acoustic analyses are conducted on the recordings. Here we briefly review studies that relied on listeners’ judgments (either phoneticians or naïve listeners) because our focus is on listeners’ perception of accented speech; patterns observed in acoustic analyses are not always consistent with perceptual results (see Bohn & Flege, 1992).

Non-native speakers have particular difficulty with phoneme contrasts that do not exist in their first language. A classic example is the English /l/-/ɹ/ contrast that distinguishes words like “lock” and “rock”. This contrast does not exist in Japanese (Flege, Takami & Mann, 1996; Goto, 1971). As a result, native Japanese speakers may engage in what Flege described as “equivalence classification” when producing English words that contain these phonemes (e.g., Flege, 1987, 1995). Equivalence classification occurs when non-native speakers assimilate two phonemes in their second language to the same first language phoneme. That is, because the English /l/-/ɹ/ contrast does not exist in their first language, Japanese speakers of English may have trouble with their perception and production, usually assimilating both sounds to the Japanese /ɹ/ (phonetically, Japanese /ɹ/ is closer to the English /l/ than the English /ɹ/; Best & Strange, 1992). Aoyama et al. (2004) found that around 20 to 25% of the time, Japanese speakers produced what English listeners perceived as the wrong phoneme. Productions that fall unambiguously into an unintended phoneme category have been called “*bad maps*” (Sumner, 2011).

Comparable results have been found for other language pairs. For example, Mandarin speakers’ productions of the English /θ/-/s/ and /ð/-/z/ contrasts are often misperceived by native English speakers (Hanulíková & Weber, 2010; Picard, 2002; Rau, Chang & Tarone, 2009; Rogers & Dalby, 2005; Teasdale, 1997; Zhang & Xiao, 2014). Rogers and Dalby (2005) reported that native English speakers misperceived Mandarin speakers’ /θ/ productions as /s/ about 30% of the time, while /ð/ was misperceived as /z/ about 20% of the time. Similarly, the contrast between English vowels /ɛ**/** and /ae/ can be difficult for native German speakers. When native English listeners were asked to categorize the words “bat” and “bet” recorded by inexperienced and experienced native German speakers, they mistook “bet” for “bat” 13% to 23% of the time, and “bat” for “bet” 34% to 49% of the time (Bohn & Flege, 1992). A study looking at relatively inexperienced Spanish speakers’ production of Dutch vowels found that the Dutch vowel /œy/ was mispronounced as /ɔu/ 89% of the time (as reported by two phoneticians): this vowel was nearly always produced as a “bad map” (Bohn & Flege, 1992).

In order to understand how listeners adapt to non-native productions, it is important to have an idea of what those productions are like. Perhaps surprisingly, we are not aware of any systematic report of how non-native productions are perceived. Therefore, we have searched the literature for studies on listeners’ perception of accented phonemes, and have summarized the results in Table 1. This review makes it clear that non-native speakers do sometimes substitute one phoneme for another, and that this is reflected in native listeners’ comprehension. The frequency of these substitutions, or bad maps, varies from speaker to speaker (depending on things like experience with the language, for example) and from one phoneme contrast to the next. As a result, there is no single number to summarize how often bad maps occur for speakers with an accent, but Table 1 demonstrates that these are reasonably frequent. Therefore, if perceptual recalibration is to be a mechanism for accented-speech accommodation, it is important to explore how it operates in such bad map scenarios – we must move beyond the “perfectly ambiguous phoneme” paradigm.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Reference | Number of speakers | L1 | L2 | L2 experience | Phonemes | Raters | % misperceived |
| Aoyama et al. (2004) | 16 | Japanese | English | Low to high | /l, ɹ, w/ | 12 native English speakers | 5% to 70% |
| Best et al. (2015) | 8 | London and Yorkshire English (regional accents of English) | |  | /æɪ, əʉ, ɐ, ʊ, æ, ɐː/ | 80 native Australian speakers | 37% to 67% |
| Bion et al., (2008) | 5 | California English (regional accent of English) | |  | /i, I, ɛ, æ/ | 11 North Carolina English speakers and 11 Welsh English speakers | <5% to 68% |
| Bohn & Flege (1992) | 10 | German | English | Low to high | /i, I, ɛ, æ/ | 3 native English speakers | 5% to 50% |
| Burgos et al. (2014) | 23 | Spanish | Dutch | Low to high | 14 vowels, 21 consonants | 2 native Dutch phoneticians | <5% to 89% |
| Cebrian (2007) | 30 | Catalan | English |  | /I, i, ɛ, e/ | 8 native English speakers | <5% to 29% |
| Cutler et al., (2005) | 1 | American English ( regional accent of English) | |  | /i, I, e I,ε.æ. ɔ, o℧, u, ə̢, ɑ, Λ, ℧,aI , oI. a℧/ | 10 native Australian speaker | <5% to 82% |
| Fabra & Romero (2012) | 27 | Catalan | English | Low to high | /i, I, ɛ,æ,ɑ, ʌ, ʊ, u/ | 5 native English speakers | 30% to 57% |
| Flege, Bohn & Jang (1996) | 80 | German, Spanish, Korean, Mandarin | English | Low to high | /i, I, ɛ, æ/ | 3 native English speakers | 0% to 82% |
| Hanulíková & Weber (2010) | 74 | Dutch, German | English | High | / θ , t, s, f/ | 3 native speakers (1 trained phonetician) | 40% to 50% |
| Jia et al. (2006) | 169 | Mandarin | English | Low to high | /i, I, e, ɛ, æ, u, ʊ, o, ɔ, ʌ, ɑ / | 5 native English speakers | 5% to 55% |
| Levy & Law (2010) | 27 | English | French | Low to high | /i, y, u, ɛ, œ, o, a/ | 9 native French speakers | 10% to 45% |
| Roger & Dalby (2005) | 8 | Mandarin | English | Low to high | 18 vowels and 26 consonants | 45 native English speakers | <5% to 60% |
| Zhang & Xiao (2014) | 32 | Mandarin | English | 9 years of English education | / θ, ð, s, z, v, ʃ, Ʒ / | 2 ESL teachers | 17% to 50% |

Table 1. Non-exhaustive list of accented phoneme misperception studies. Most involved small groups of native English listeners asked to report what they heard.

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