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# Developmental change in tone perception in Mandarin monolingual, English monolingual, and Mandarin–English bilingual infants: Divergences between monolingual and bilingual learners

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ABSTRACT

Most languages use lexical tone to discriminate the meanings of words. There has been recent interest in tracking the development of tone categories during infancy. These studies have focused largely on monolingual infants learning either a tone language or a non-tone language. It remains to be seen how bilingual infants learning one tone language (e.g., Mandarin) and one non-tone language (e.g., English) discriminate tones. Here, we examined infants' discrimination of two Mandarin tones pairs: one salient and one subtle. Discrimination was investigated in three groups: Mandarin–English bilinguals, English monolinguals, and Mandarin monolinguals at 6 months and 9 months of age in a cross-sectional design. Results demonstrated relatively strong Mandarin tone discrimination in Mandarin monolinguals, with salient tone discrimination at 6 months and both salient and subtle tone discrimination at 9 months. English monolinguals discriminated neither contrast at 6 months but discriminated the salient contrast at 9 months. Surprisingly, there was no evidence for tone discrimination in Mandarin–English bilingual infants. In a second experiment, 12- and 13-month-old Mandarin–English bilingual and English monolingual infants were tested to determine whether bilinguals would demonstrate tone sensitivity at a later age. Results revealed a lack of tone sensitivity at 12 or 13 months in bilingual infants, yet English monolingual infants were sensitive

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to both salient and subtle Mandarin tone contrasts at 12 or 13 months. Our findings provide evidence for age-related convergence in Mandarin tone discrimination in English and Mandarin monolingual infants and for a distinct pattern of tone discrimination in bilingual infants. Theoretical implications for phonetic category acquisition are discussed.



## Introduction

A critical step toward native language development is determining the sounds that make up one's native language. From the first few months of life, infants make tremendous progress in this regard. Over the first year, for many sounds they progress from demonstrating highly general sensitivities to linguistic contrasts to specific sensitivities that align with their native language (Kuhl et al., 2006; Tsao, Liu, & Kuhl, 2006; Werker & Tees, 1984, but see Best, McRoberts, & Sithole, 1988; Narayan, Werker, & Beddor, 2010; Tyler, Best, Goldstein, & Antoniou, 2014). This critical development is viewed as a hallmark of early language acquisition and foreshadows later vocabulary acquisition during early childhood (Kuhl et al., 2008). To date, the development of native phonetic categories has been charted quite extensively for two types of phonological constituents: vowels and consonants. There has been a more modest focus on lexical tone in spite of tone being a highly frequent source of phonological variation. The small set of studies investigating developmental change in tone discrimination has focused almost exclusively on monolingual infants, with no studies to date investigating bilingual infants exposed to a tone language and a non-tone language. The goal of the current study was to investigate age-related change in lexical tone discrimination in monolingual English, monolingual Mandarin, and bilingual English–Mandarin learners.

Investigations of how native tone categories develop are important on the grounds that most of the world speaks tone languages (Yip, 2002). Furthermore, tones are different from vowels and consonants in a way that may introduce specific challenges in acquiring native phonetic categories. Unlike segments (consonants and vowels), the pitch movements that underlie tone changes surface in every human language and are varied to distinguish questions from statements, emotional properties of speech, focus, and stress in both tone and non-tone languages but also vary to distinguish lexical items in tone languages (Gussenhoven, 2004). There are no obvious constraints on pitch movements selected for tones versus those selected for intonation (see Pierrehumbert & Beckman, 1988). Therefore, bilingual speakers of a tone language and a non-tone language, such as English and Mandarin, must sort pitch movements by language and assign them intonational or lexical functions in Mandarin or intonational functions in English. Therefore, tone places a complex interpretive burden on bilingual learners of languages that assigns different linguistic roles to tones.

The acquisition of tone categories during infancy has been explored in monolingual learners, producing mixed results. In an influential study, Mattock and Burnham (2006) reported that Chinese-learning infants demonstrated sustained sensitivity to Thai lexical tones at 6 and 9 months of age. In contrast, English-learning infants were sensitive to Thai tones at 6 months but not at 9 months (see Mattock, Molnar, Polka, & Burnham, 2008, for a replication with French learners). Yeung, Chen, and Werker (2013) demonstrated that 4-month-old English-learning infants were sensitive to Cantonese lexical tones, whereas 9-month-old English-learning infants were not. In contrast, Cantonese-learning infants were sensitive to Cantonese lexical tones at 4 and at 9 months, as were Mandarin-learning infants. Each of these studies is suggestive of age-related perceptual narrowing akin to that widely demonstrated for vowels and consonants. In general, these studies suggest that all infants begin with high sensitivity to lexical tones, which is maintained only if they learn a tone language.