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ARTICLE

Influence of caregiver input and language experience on the production of coda laterals by English–Malay bilingual preschoolers in multi-accent Singapore

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Abstract

Linguistic input in multi-lingual/-cultural contexts is highly variable. We examined the production of English and Malay laterals by fourteen early bilingual preschoolers in Singapore who were exposed to several allophones of coda laterals: Malay caregivers use predominantly clear-l in English and Malay, but their English coda laterals can also be l-less (vocalised/deleted) and in formal contexts, velarised. Contrastingly, the English coda laterals of the Chinese majority are typically l-less. Findings show that English coda laterals were overall more likely to be l-less than Malay laterals like their caregivers', but English coda laterals produced by children with close Chinese peer(s) were more likely to be l-less than those without. All children produced English coda clear-l, demonstrating the transmission of an ethnic marker that had emerged from long-term contact. In diverse settings, variation is intrinsic to the acquisition process, and input properties and language experience are important considerations in predicting language outcomes.

Keywords: Quality of input; variable input; peer effects; multi-dialectal; contact variety

Introduction

Many children are exposed to language input that is variable (Johnson, 2018; for an overview, see Sim & Post, forthcoming). Monolingual children in multi-accent environments may be exposed to phonetic, allophonic or phonological variability in the input from bidialectal or bilectal caregivers (e.g., Foulkes et al., 2005; Grohmann et al., 2016), or from caregivers who speak different regional dialects from each other (e.g., Durrant et al., 2015; Kartushina et al., 2021; van Heugten & Johnson, 2017). There can also be variability in the input of bilingual caregivers. Late-L2 bilingual caregivers and those experiencing L1 attrition, for example, may exhibit phonetic characteristics and patterns that differ from monolingual peers in their child-directed speech (CDS; Fish et al., 2017; Khattab, 2011; Stoehr et al., 2019). The phonetic input from these caregivers may be inconsistent, and further, as a result of the assimilation of or interactions between the categories of their two phonological systems (Flege, 2007), there may be phonetic overlap in the different phonemes of the two languages.

Children raised in societies characterised by widespread individual bilingualism and societal multilingualism may receive input that could be even more variable. In the case of immigrant families in largely monolingual communities, input variability may be restricted to the idiolect of caregivers, and their children are exposed to relatively more homogenous input from monolingual majority language speakers. By contrast, in societies that are linguistically and culturally more diverse, there is considerably greater inter- and intra-speaker variation across all speakers as a result of, *inter alia,* varying effects of individual bilingualism (e.g., age of acquisition, speaking a different other L1, language dominance), vertical and horizontal transmission, cultural affiliation and orientation, and stylistic variation and accommodation (Butler, 2012; Kirkham, 2017; Leimgruber, 2013; Schneider, 2007; Sharma, 2011). Moreover, contact-induced accent changes in multilingual, multicultural contexts may also be less homogenous due to the influence of different languages that are still spoken. Bilinguals in Singapore, for instance, share mainstream speech features that are distinctive of their stabilised contact variety, but they may remain differentiated through the variable use of ethnically distinctive features that are likely derived from their respective ethnic mother tongues (Sim, 2019, 2021, 2022a; Starr & Balasubramaniam, 2019). This implies that bilingual children acquiring their languages in such communities, as are the children in this study, have an additional challenge of navigating the highly variable input in the multi-lingual, multi-accent language environment, in addition to the complexity associated with the simultaneous acquisition of two phonological systems (Durrant et al., 2015; van Heugten & Johnson, 2017; Byers-Heinlein & Fennell, 2014).

Children are sensitive to sub-phonemic information in the input, and fine-grained variation has been shown to be reflected in child production and perception (Cristià, 2011; McMurray & Aslin, 2005; Sim & Post, 2021; Stoehr et al., 2019). Yet, studies on child bilingual production often assume a homogeneous input, and input properties are less often cited as a potential contributor to observed variable outcomes, much less directly explored. This relative lack of understanding of input effects on phonological acquisition means that the current knowledge of the field has limited applicability in modelling the phonological outcomes of children in diverse contexts. This present study explores the effects of variable input on the bilingual acquisition of laterals by early English–Malay bilingual preschoolers in Singapore who were exposed to several allophones of coda /l/ in the input of their caregivers and significant others in the wider community.

New Englishes and variation in Singapore English

Varieties of English that emerged from colonisation, often referred to as 'New Englishes' (also *postcolonial Englishes, multilingual contact varieties, Outer Circle varieties,* and *English as a Second Language*; see Schneider, 2014), are spoken in usually multilingual countries in which English plays important roles and functions. English in these contexts has undergone extensive long-term language contact with indigenous languages through processes of language acquisition and shift, which resulted in new dialects that bear structural features (or 'innovations', to distinguish them from learner errors of L2 speakers; see Buschfeld, 2013, pp. 56–70 for a discussion) that systematically differ from traditionally native varieties. The use of these innovations may become increasingly

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habitualised in usage in the majority of speakers in the community to become norms, and may stabilise into a fully-fledged nativised variety that is socially accepted and widely used, as is the case of Singapore English (SgE; Schneider, 2007).

Since the institution of the bilingual policy in Singapore in the 1960s that led to significant language shift towards English, more Singaporeans in the current generation are L1 speakers of SgE, but this may not have been the case for the grandparents of the preschoolers in this study, who might have acquired English as an L2, or were non-English speaking bilinguals of other heritage languages (Bolton & Ng, 2014). In addition, although many Singaporeans today are early bilinguals, they speak different ethnic mother tongues (e.g., Malay, Mandarin or an Indian language) and also differ considerably in their language dominance. Therefore, while Singaporeans share innovative phonological features that are pan-Singaporean, some features remain distinctive of particular ethnic groups because of long-term language contact between English and their other L1, which may have further undergone inter-generational transmission (e.g., Sim, 2019; Starr & Balasubramaniam, 2019). Moreover, the local norms, despite being accepted and widely used, are in variation with alternative forms that are associated with traditional native varieties. These exonormative norms are enregistered as prescriptively correct and standard by wide-ranging state-motivated meta-discursive/pragmatic practices, enacted through classroom instruction, the media and government campaigns. Many present-day Singaporeans therefore have an especially rich English repertoire that can be used creatively based on the socio-indexical meanings of the variants and their communicative needs (Leimgruber, 2013; Sim, 2021, 2022a; Starr & Balasubramaniam, 2019).

The Malay ethnic community in Singapore and variants of /l/ in Singapore English

The Malays[1], while being the indigenous people, constitute an ethnic minority in Singapore, and account for about 15% of the citizen population, compared to 75.9% who are ethnically Chinese, and 7.5% who are Indians (Department of Statistics, 2021). Almost all Malays in Singapore are Muslims, and they share customs, traditions and values that are shaped by their Islamic faith. The Malay language, being their common ethnic mother tongue, is also strongly associated with their cultural and religious identity in Singapore (Kassim, 2008). The members of the ethnic community have strong, dense ties and share a sense of ethnic group-belonging, despite being increasingly English dominant as a result of the significant language shifts towards English (Mathews & Selvarajan, 2020).

The coda laterals of SgE, which are the feature of interest in this study, are variable across Singaporeans. Cross-linguistically, alveolar laterals differ with regard to their degree of velarisation and/or pharyngealisation, with some languages having a darker (more velarised or pharyngealised) variant than others (Recasens, 2012), which is articulatorily characterised by a greater degree of tongue predorsum lowering and of postdorsum retraction towards the uvular area or upper pharyngeal wall. In addition, some varieties of languages exhibit a clearer or darker variant in all syllable positions, while in others the two variants are syllabically conditioned (Carter & Local, 2007; Kirkham et al., 2020). The vocalisation of postvocalic /l/, a process by which the tongue

[1]The Malays include subgroups such as the Bugis, Boyanese, Banjar, and Javanese, but most identify themselves as Malays and, by and large, follow the same social norms.

tip contact with the alveolar ridge is lost and is replaced by either a (labial-)velar approximant or a back vowel or semivowel, is also common in some languages and dialects (Thomas, 2007; Turton, 2017). This has been described to be the norm of Singaporeans, especially the Chinese, the ethnic majority (Deterding, 2007; Tan, 2005; Wee, 2008). Further, in SgE, coda laterals may also be deleted or assimilated to the nucleus after back vowels (e.g., *ball* [bɔː]) or after a schwa (e.g., *little* [lɪtə]; syllabic [l] does not typically occur in SgE). These two realisations are typically regarded as instances of l-vocalisation (Wee, 2008), and are here treated as one phonological phenomenon, l-lessness (Sim, 2021; Thomas, 2007).

English–Malay bilinguals in Singapore were found to have an English lateral system that can be regarded as a hybrid between the dominant l-less variety and the lateral system of Malay. Sim (2019) found that the English coda laterals of Malay Singaporeans were not categorically l-less like many Chinese Singaporeans, but their retained /l/ was clear in all syllable positions like Malay laterals, especially for those who belonged to more Malay-dominant families and social circles and identified with a Malay-speaking culture. Their use of coda clear-l could be learnt through the input of their caregivers or peers, i.e., through vertical and horizontal transmission, in ways similar to the use of coda clear-l by British Asians (Kirkham, 2017; Kirkham & McCarthy, 2021; Sharma, 2011). English-dominant Malays, contrastingly, produced coda laterals that were significantly darker, if not l-less (Sim, 2019), but some may switch to clear-l and assume a more ethnically distinctive repertoire when speaking to their Malay-dominant peers (Sim, 2022a). Sim (2021) further observed inter- and intra-adult variation in the use of variants of English /l/ in the CDS of Malay caregivers. In contexts involving casual play between caregiver and child, caregivers' English coda laterals, if not l-less, were as clear as onset laterals. In more formal contexts that involved teaching and learning, however, mothers but not fathers adopted a style that was less ethnically distinct, by either producing darker coda /l/ (exonormative norm) and/or by exhibiting more l-lessness (mainstream SgE norm). The social-indexical meanings of these /l/ variants could have conditioned their use: clearer /l/ was used even in CDS as it indexes ethnic group membership, while darker /l/ was used in literary contexts for its semiotic connections to formality, higher social class, and educational attainment (Sim, 2022a). The use of wide-ranging variants in CDS thus could have been a way to help their children construct a full sociolinguistic repertoire (Foulkes et al., 2005). The primary goal of this paper, therefore, is to explore how, in their acquisition of the lateral systems of the two languages, Malay preschoolers negotiate the many allophones of coda /l/ that is present not only in the input of their caregivers, but also in the speech of other significant adults and peers in the wider community.

Acquisition of /l/

Normative studies

Normative studies on lateral production by monolingual children speaking American, British and Australian English have shown that onset laterals are produced earlier than coda laterals (indicated by >75% accuracy), usually by 3;0-3;5 (Dodd et al., 2003; Lin & Demuth, 2015; Smit et al., 1990). Postvocalic or coda laterals that are velarised are acquired later, in part because their production is articulatorily complex since they require the coordination of both anterior and posterior constrictions. Lin and Demuth (2015), who examined the production of Australian English-speaking children aged between 3;0 and 7;11, found that only 5% of the coda laterals produced by children in the 3;0 group were perceptually target-like, and even for the oldest group, only 52% of the coda laterals were perceptually accurate, highlighting the difficulties for young children to consistently achieve adult-like anterior-posterior constrictions. These children relied on labial articulations like lip rounding or protrusion instead to achieve acoustic/auditory similarity to adults' speech. In contrast with English, there is no known allophonic variation in Malay /l/, which is clear in all syllable positions (Clynes & Deterding, 2011; Yunus Maris, 1980). The distribution of Malay /l/ is similar to English /l/: it occurs word-initially (e.g., *lima* 'five'), word-finally (e.g., *muncul* 'appear'), syllable-finally (usually forming a consonant cluster across morpheme boundaries before suffixes; e.g., *meninggalkan* 'to leave behind'), and intervocalically (e.g., *tilam* 'mattress'). Phoon et al. (2014) examined the consonant acquisition in Malay by 326 typically developing Malay-dominant Malay preschoolers between 4;0 and 6;5 living in Penang, Malaysia. They found that by 4;0-4;5, children mastered the production of syllable-initial /l/ (occurs when 90% of the children in an age group produced it correctly at least twice in two consecutive age groups). Children were only showing customary production of syllable-final /l/ at 4;0-4;5 (occurs when 50% of the children in an age group produced the segment correctly at least twice in two consecutive age groups); it was only mastered at the age of 5;6-5;11.

Acquisition of laterals by early child bilinguals

It is well established that bilingual children may systematically differ from their monolingual counterparts in specific speech properties that suggest cross-linguistic interactions (e.g., Hambly et al., 2013; Keffala et al., 2018; Kehoe & Havy, 2019). These interactions may manifest as an acceleration or delay in the acquisition of certain speech properties relative to monolinguals. They may also involve the transfer of features from one language to another, or the merging or deflecting of some properties of their two language systems that reduces or enhances contrast between them (Kehoe, 2015; Paradis & Genesee, 1996).

Studies on the acquisition of /l/ revealed that although child bilinguals do not perform identically to their monolingual counterparts, they show distinct production patterns for their two languages if the languages have different /l/ distributions. Barlow et al. (2013), for example, examined the acquisition of /l/ by early Spanish–English bilinguals with a mean age of 4;7 in the Southern California and Baja California area. English /l/ is darker than Spanish /l/ in all syllable positions, and postvocalic /l/ (/l/ that follows a vowel) is additionally velarised in English but not in Spanish. They found that the bilinguals' prevocalic English /l/ (/l/ that preceded a vowel, including ambisyllabic /l/) was almost as clear as monolingual Spanish /l/ in all positions. Their English postvocalic /l/ was darker than their English prevocalic /l/, and comparable to the postvocalic /l/ of English monolinguals, exhibiting phonological knowledge of the allophonic velarisation rule of the variety of English spoken. Barlow and colleagues interpreted the findings to be evidence of a merged phonetic category for prevocalic /l/ but not postvocalic /l/. That there was allophonic velarisation in English but not in Spanish was also taken as evidence of separate lateral systems. Kirkham and McCarthy (2021) also reported similar findings. In their study of the acquisition of allophonic contrast and phonetic details of laterals by second-generation Sylheti–English bilingual children (mean age = 6;7) in London, UK, they found that although there was transfer of hyper-clear laterals from Sylheti to English, the children did produce positional contrast in their English laterals (i.e., clearer onset and darker coda). This contrast, however, was much smaller than that produced by English monolingual children.

Bilingual phonological acquisition in contexts that involve competing variants between CDS and local norms is more complex. Specific speech features of children raised by immigrant caregivers or in an ethnic minority setting can diverge from CDS norms of their primary caregiver to approximate mainstream norms or those of their peers (e.g., Mayr & Siddika, 2018; Sharma & Sankaran, 2011). Khattab (2002), for example, examined the acquisition of /l/ in three English-Arabic bilingual heritage speakers born and raised in Yorkshire by Lebanese parents who had lived in Yorkshire for over ten years. The children in her study were 5, 7 and 10 years old. In the Yorkshire dialect, /l/ is reportedly dark in all positions, which contrasts with the clear-l of Arabic. The Lebanese parents in the study had used coda clear-l in their English speech to different extents. Their bilingual children, however, produced mainly dark-l or vocalised-l, similar to their English monolingual peers. Interestingly, when the children code-switched to English during the recording sessions in which Arabic was to be used, the /l/ in the code-switched words was clear in all positions, revealing effects of being in different language modes. This suggests that while they had acquired the mainstream norms, the children remained sensitive to the distinctive features in CDS and could have acquired them to form part of their linguistic repertoire to be used in certain contexts. Indeed, speakers in multicultural settings, such as British Asians, may variably use phonetic features associated with their heritage language in their English speech for social-indexical functions, once they recognise the sociolinguistic value of these variants (Kirkham, 2017; Sharma, 2011; Sharma & Sankaran, 2011).

Current study

This study is concerned with how English–Malay bilingual preschoolers who are faced with several allophones of coda /l/ in the overall input of their caregivers and potentially a different lateral system from Chinese peers and adults, acquire the lateral systems of their two languages. Their input model is summarised in Table 1. Based on the findings of previous studies and with reference to their input model, we ask:

(1) Whether and how do the children distinguish their English and Malay lateral systems.

It is predicted that children in this study will show evidence of two lateral systems (Barlow et al., 2013; Khattab, 2002; Kirkham & McCarthy, 2021). Whereas previous studies involve language varieties that differ based on the presence/absence of the allophonic velarisation rule, SgE differs from Malay in that the coda laterals of SgE are described to be typically l-less. L-lessness is therefore expected to occur more in the English than in the Malay production of these Malay children.

Another way by which laterals of their two languages may be distinguished is by exhibiting allophonic velarisation in English but not in Malay for the retained laterals. The studies above show that children as young as 3;0 begin to produce darker coda laterals if the language model presents an allophonic velarisation rule, but separate phonetic categories may not form if the laterals are phonetically similar or equivalent (Barlow et al., 2013; Kirkham & McCarthy, 2021). Studies have also shown that children after the age of three begin to show adult-like stylistic variation of use of alternative forms (e.g., Smith et al., 2007). Other than being l-less, the children's English coda laterals in this study may potentially show allophonic velarisation. This is because, seeing that the elicitation tasks

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Table 1. Laterals in the input of English–Malay bilingual children in Singapore

Language		English–Malay bilingual caregivers	Wider English–Malay bilingual community	English-speaking Chinese ethnic majority
English	Realisations of coda laterals	Retained and l-less (Sim, 2021)	Retained and l-less (Sim, 2019)	L-less, but some retain coda /l/ more often than others (Deterding, 2007; Tan, 2005)
	Darkness and positional contrast of retained laterals (Onset–Coda)	**Informal CDS:** Clear–Clear **Formal CDS:** Clear–Clear (fathers) Clear–Darker (mothers) (Sim, 2021)	**Malay dominant:** Clear–Clear **English dominant:** Clear–Darker (Sim, 2019)	Clear–Dark (Deterding, 2007; Tan, 2005)
Malay	Realisations of coda laterals	Retained (Clynes & Deterding, 2011; Sim, 2022b; Yunus Maris, 1980)		—
	Darkness and positional contrast of retained laterals (Onset–Coda)	Clear–Clear (Clynes & Deterding, 2011; Sim, 2022b; Yunus Maris, 1980)		—

are a form of a test of their language abilities, the children could have adopted the form that their mothers used in contexts of teaching and learning (i.e., darker coda /l/). Alternatively, the children in this study may in their production show preference for clearer-l, which occurs much more frequently, being phonetically similar across both languages. If this is the case, a question is then whether the children show any deflecting patterns to maximise contrast between the retained laterals of the two lateral systems (Kehoe, 2015).

(2) Whether language-external factors modulate their production patterns.

Language-external factors (i.e., factors outside of the language systems) such as language dominance (e.g., En et al., 2014; Sim, 2019; Simonet, 2010) and peer group (e.g., Khattab, 2002; Kirkham, 2017; Mayr & Montanari, 2015) have been shown to predict variation. For instance, as mentioned above, Arabic-English bilingual children in Khattab (2002, 2011) were exposed to Arabic-influenced clear coda [l] in the speech of their Lebanese-born caregivers, but these children produced dark laterals [ɫ] like their monolingual peers who spoke the Yorkshire dialect of English. Kirkham (2017) also explained that one reason for the use of very clear [l] by the Sheffield-born, ethnically Pakistani teenagers in his study could be their regular contact with peers who spoke British Asian English. The Malay children in this study could also exhibit differential production patterns based on their varying degrees of exposure to the lateral model of the Chinese ethnic majority. Therefore, while this study is primarily interested in overall group behaviours, three language-external factors were considered in the analyses to account for potential variation – namely, language dominance, preschool type, and peer group type.

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Methodology

Participants

The data used in this study belonged to a larger corpus that comprises recordings from 60 Singaporean families. 14 Malay children who were firstborns (to control for influence of older siblings) and had completed the English picture-naming task described below were selected for this study. The details of the 14 families are shown in Table 2; recordings of nine of the 14 families were used/analysed in Sim (2021).

The children (5 females, 9 males) in this study were aged between 3;1 and 5;8 (*Mdn* = 4;8). They were all typically developing early bilinguals, having been exposed to both English and Malay by the age of three (Genesee & Nicoladis, 2007). Their language experience was ascertained through a child language experience survey developed for the corpus (see Sim 2022b, Sim & Post, 2021 for a more detailed description of the tool). The language use of the child (both direct/indirect input and output) was calculated from an accumulated measurement of the language variety and estimated amount and proportion of time for which the language variety was used with the significant people in his/her immediate social environment, as well as their language use in self-interaction and exposure to media. The Malay children in this study were primarily exposed to Singaporean English and Malay (>89% of total language use). While some participants would be classified as English monolinguals for producing and hearing Malay less than 10% or 20% of the time (Kehoe & Havy, 2019; Lauro et al., 2020), Malay was used exclusively with some significant adults by these children – for example, in their interactions with their grandparents. This

Table 2. Description of participants including age and gender, age of acquisition (AoA), percent use of Singaporean English (SgE) and Malay (Mly), preschool type, and peer group type

Child	Age	Gender	AoA (SgE)	AoA (Mly)	% SgE use	% Mly use	Preschool	Peer group
Mi9	3;1	F	0	0	43	48	Malay	Malay
M9	3;1	F	0	0	74	23	Mix	Mix
M10	3;2	M	0	0	90	9	Mix	Mix
Mi23	3;6	F	0	3;0*	78	22	Malay	Malay
Mi1	3;8	M	0	0	56	43	Malay	Malay
Mi2	4;5	F	0	0	62	35	Malay	Malay
M7	4;6	M	0	1;6	87	12	Malay	Malay
M8	4;10	M	0	1;0	86	8	Mix	Mix
Mi21	4;10	F	0	0	62	37	Malay	Mix
M17	4;11	M	0	2;6	86	11	Malay	Malay
M6	5;1	M	2;0	0	61	39	Malay	Mix
M15	5;2	M	0	0	71	25	Mix	Malay
M18	5;7	M	0	0	77	23	Mix	Mix
M11	5;8	M	0	0	83	6	Mix	Mix

Note: Age is in years;months. Gender: F(emale), M(ale). Age of acquisition is in years;months. *Although the mother of child Mi23 indicated that the child started learning Malay from age 3;0, the child had begun attending a Malay-Muslim childcare/preschool from age 1;6, and therefore would have been exposed to Malay from a younger age.

study therefore considers all as functional bilinguals, with some being more English-dominant than others. Questions about three of the child's closest and most influential friends were also asked; the closest friends of some children were all ethnically Malay, while others had a mix of Malay and Chinese friends. Finally, the exposure to teachers and children of other ethnicities in their preschool was considered; children either attended Malay-Muslim bilingual preschools or mainstream preschools that were more diverse in their ethnic makeup. It is worth noting that variation in the language experience of children is characteristic of language acquisition in multicultural, multi-accent communities, and instead of testing a homogeneous sample, we seek commonalities as well as inter-child variation by considering the language-external factors in our statistical models.

Materials and procedure

The data came from a larger corpus that also elicited other speech features, and therefore the stimuli were not balanced in terms of their vowel context and number by syllable position. The lists of target words are presented in Table 3.

Data were elicited through a picture naming task and additionally, for children aged 3;8 and above, an information gap activity. Both activities were carried out by one of the caregivers, typically the mother, and facilitated by the first author. The activities were conducted in English first, followed by some interaction in Malay, before moving on to the Malay stimuli. In the picture naming task, target words were elicited twice using picture cards that were presented in a random order, although occasionally a greater or lower number of repetitions were obtained. Some Malay words were unfamiliar to the more English-dominant children, and in such cases, they imitated their caregiver's production. This is unlikely to have influenced their production; in all these cases, the children were already reliably producing Malay laterals in other known words, and further there were many instances in which the /l/ variants in the adult production and imitated response were different. Many of the same words in the picture naming task were elicited again in the information gap activity, during which the child had to help their mother match puzzle pieces by giving structured clues based on what they saw on picture cards (e.g., 'Lina is passing a ball'). Malay tokens were not elicited from the child of family Mi23. A total of 966 English and 505 Malay child tokens were recorded.

The recording took place in a quiet room with minimal reverberation and noise in the respective homes of the participants. Each child had pinned on their collar an omni-directional lapel microphone, which was connected to a NAGRA ARES-MII recorder recording at a sampling rate of 44.1 kHz at 16 bit.

Auditory and acoustic analysis

Tokens were hand-segmented and analysed aurally and acoustically based on visual inspection of the waveform and wide-band spectrogram on Praat (v. 6.1.4; Boersma & Weenink, 2022). Tokens were first individually labelled according to whether they were retained (i.e., clearer and darker /l/) or l-less (i.e., vocalised and deleted /l/). Laterals that could not be reliably measured due to reasons such as noise, creak or overlapping speech were marked as 'unclear' (51 English tokens and 19 Malay tokens). The difficulty in acoustically distinguishing dark-l and vocalised-l is well established, and consequently many have relied mainly on auditory cues, which have been found to be fairly reliable (Hall-Lew & Fix, 2012). A phonetician who was not involved in this study was trained in

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Table 3. Stimuli

Syllable position	Target word			
	English		Malay	
Onset (*n* = 201)	Cleaner	/ˈkli.nə/	Ahli bomba	/ah.li/ 'fireman'
	Ladybird(bug)	/ˈleɪ.di.bɜd/	Limau	/li.mau/ 'lemon'
	Lemon	/ˈlɛ.mən/		
	Lina	/ˈli.na/		
	Lion	/ˈlaɪən/		
Ambisyllabic (*n* = 548)	Ambulance	/ˈæm.bjʊ.ləns/	Bola	/bo.la/ 'ball'
	Balloon	/bəˈlun/	Bulan	/bu.lan/ 'moon'
	Binoculars	/bɪˈnɒ.kjʊ.ləz/	Gula-gula	/gu.la/ 'candy'
	Broccoli	/ˈbrɒ.kə.li/	Melukis	/mə.lu.kis/ 'to draw'
	Caterpillar	/ˈkæ.tə.pɪ.lə/	Membeli	/məm.bə.li/ 'to buy'
	Gorilla	/gəˈrɪ.lə/	Pengelap	/pə.ŋə.lap/ 'mop'
	Helicopter	/ˈhɛ.lɪ.kɒp.tə/	Ular	/u.lar/ 'snake'
	Jelly	/ˈdʒɛ.li/		
	Police	/pʊˈlis/		
	Television	/ˈtɛ.lɪ.vɪ.ʒn/		
	Umbrella	/ʌmˈbrɛ.lə/		
	Watermelon	/ˈwɔ.tə.mɛ.lən/		
Coda (*n* = 722)	Ball	/bɔl/	Almari	/al.ma.ri/ 'cupboard'
	Bowl	/boʊl/	Bakul	/ba.kul/ 'basket'
	Children	/ˈtʃil.drən/	Baldi	/bal.di/ 'pail'
	Cold	/koʊld/	Bantal	/ban.tal/ 'pillow'
	Crocodile	/ˈkrɒ.kə.daɪl/	Gatal	/ga.tal/ 'itchy'
	Elbow	/ˈɛl.boʊ/	Kecil	/kə.tʃil/ 'small'
	Fingernail	/ˈfɪŋ.gə.neɪl/	Mahal	/ma.hal/ 'expensive'
	Holding	/ˈhoʊl.dɪŋ/	Menjual	/mən.dʒu.al/ 'to sell'
	Milk	/mɪlk/	Panggil	/paŋ.gil/ 'to call'
	Pineapple	/ˈpaɪn.æ.pəl/	Salji	/sal.dʒi/ 'snow'
	Pool	/pul/		
	Selfie	/ˈsɛl.fi/		
	Snail	/sneɪl/		
	Vegetables	/ˈvɛdʒ.tə.bəlz/		
	Wolf	/wʊlf/		

Note: Syllabification of Malay words was based on Ramli et al. (2015) and Clynes and Deterding (2011). Syllabification of English words was based on the maximal onset principle.

the coding and asked to analyse the coda laterals of 70 randomly selected tokens (about 10% of 698 coda laterals) and rate whether they were retained (clear/dark) or l-less (vocalised/deleted). 88% of the tokens were in agreement; Cohen's κ analysis revealed a substantial agreement between the ratings, κ = 0.76 (95% CI, 0.66 to 0.85), $p < .001$.

Retained laterals were further analysed. They were hand-segmented for their onsets and offsets, defined as the first and last pitch period where there is a change in F2 intensity compared to the neighbouring vowel, and this is usually accompanied by a change in the amplitude of the waveform (Amengual, 2018; Kirkham, 2017). F1 and F2 were then extracted manually from the temporal midpoint of the laterals. An example is shown in Figure 1. Formant tracks were calculated with the built-in Burg algorithm in Praat. The effective window length was set at 25 ms, and the maximum number of formants was kept at five (1.0 mm dot size). The formant ceiling was adjusted according to speaker to minimise tracking errors; this was done based on inspection of spectrographic displays on a trial-and-error basis. The raw values in Hertz were converted to Bark, a psychoacoustic

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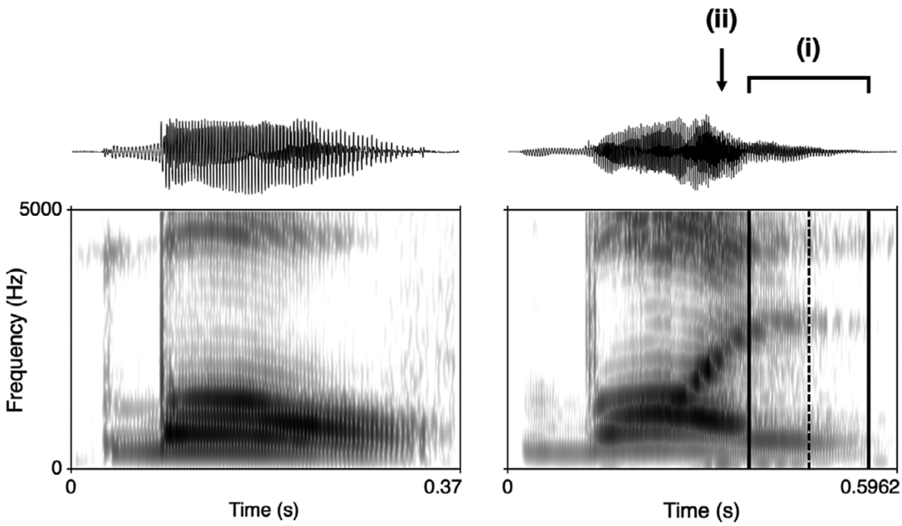

Figure 1. Representative waveforms and spectrograms of word-final lateral in *ball* (left: vocalised; right: retained). (i) lateral duration, (ii) 30 ms mark into offset of vowel, dotted line: lateral temporal midpoint.

scale, to reflect darkness of /l/ as a perceptual phenomenon. Following previous studies, the difference between F2 and F1 was used as a measure of lateral darkness (e.g., Amengual, 2018; Kirkham & McCarthy, 2021; Sim, 2021); clearer /l/ has higher F2–F1 values.

Several linguistic factors were considered to account for potential inter-speaker variation that may exist despite the controlled stimuli. The duration of the lateral defined by the landmarks was recorded to account for phonetic effects of duration, which has been found to positively correlate with darkness of /l/ (Sproat & Fujimura, 1993; Yuan & Liberman, 2009). Vowel context is also known to influence l-darkening. Specifically, laterals have been found to be clearer with fronter vowels (Morris, 2017; Sim, 2021; van Hofwegen, 2010). Following these studies, inter-speaker variation in the vowel realisation was accounted for by the F2 of the point 30 ms into the offset or onset of the neighbouring vowel; 30 ms was an arbitrary value that allowed for some transition into the vowel. For ambisyllabic /l/, the F2 of the following vowel was used, based on the assumptions of onset maximisation. Within-subject z-score standardization was then performed on the vowel F2 values to normalise between-speaker differences. Finally, in the elicitation tasks, some repetitions were done in quick succession, whereas in others a short pause (defined as silence longer than 300 ms, or breathing) was inserted between repetitions of a target word. There were also some slight variations in the production of target words (e.g., *vegetable* instead of *vegetables*). Since prepausal coda laterals are less likely to be l-less than preconsonantal ones (Scobbie & Wrench, 2003; Sim, 2021), the adjacent phonetic context was recorded. There is no inherent lexical stress in Malay (Clynes & Deterding, 2011), and stress in SgE is difficult to be determined (Deterding, 2007). Given that the stimuli in this study were controlled and that lexical stress was not a predictor of l-darkening nor likelihood of l-lessness in Sim (2021), lexical stress was not included as a linguistic factor in this study. Outliers in all raw measurements were detected using the interquartile range method and corrected if they were due to mismeasurement.

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Statistical analyses

Mixed-effects regression analyses were conducted using the R software (R Core Team, 2022), the 'lme4' package (Bates et al., 2015), and the 'lmerTest' package (Kuznetsova et al., 2017). Details about the fixed and random effects of each model are presented below. All continuous predictors were z-standardised. To account for the unequal sample sizes, categorical predictors were weighted effect coded (Darlington & Hayes, 2017, pp. 298–300; te Grotenhuis et al., 2017). Model selection was based on parsimony; only predictors that significantly improved model fit were retained in the best-fitting models, unless otherwise stated. To evaluate the contribution of each predictor for all models, and to arrive at a more restricted model, pairwise model comparisons between a full model that included all the explanatory variables and a more restricted model that excluded the predictor under consideration were performed using likelihood ratio tests.

Results

Distribution of realisations of coda /l/

The children's onset (n = 177) and ambisyllabic laterals (n = 521) were accurately and consistently produced, at 90.4% (n = 160) and 97.1% (n = 506) of all analysable tokens respectively, with the bulk of inaccurate production (n = 32) being a result of speech errors/slips. The remainder of this section focuses on their coda laterals. The distributions of the realisations of English and Malay coda /l/ for each child are presented in Figure 2, ordered by increasing age. A visual inspection of the figure revealed that overall, more English coda laterals were l-less compared to Malay laterals, but there is some observable inter-child variation in the production of English coda laterals. Their Malay coda laterals,

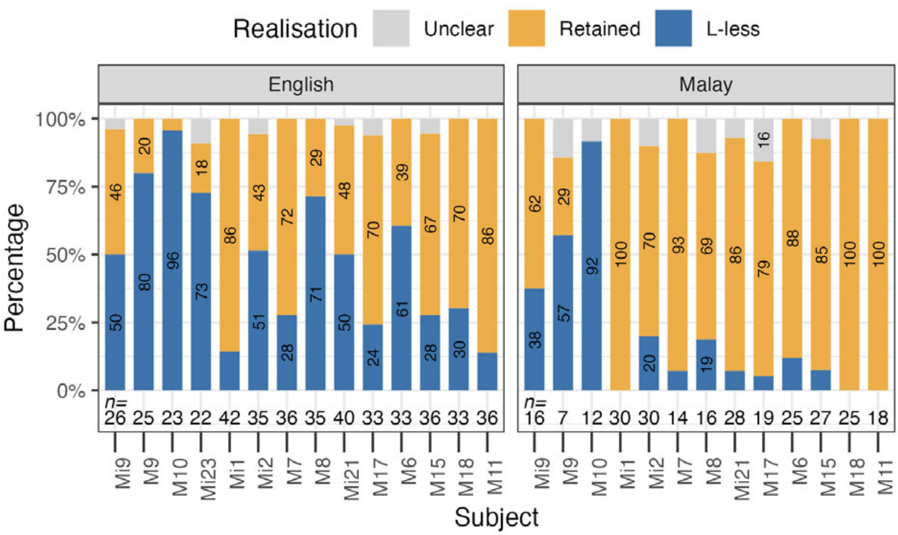

Figure 2. Distributions of realisations of coda /l/ of each child by language, ordered by increasing age. Note that Malay tokens were not elicited from Mi23. Percentages in the main plot are rounded to the nearest percent and only percentages above 15% are shown. Sample sizes (n) refer to the total number of coda /l/ tokens in the respective language for each child.

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contrastingly, were mostly retained, except for the younger children. It is likely that the coda laterals of the younger children, Mi9, M9, M10 and Mi23, were still developing, as they were only customarily producing coda laterals. Interestingly, a few of their coda laterals were vocalised with a high front vocoid (e.g., *mahal* [ma.hai], *ball* [bɔi]), similar to how /j/ is used in place of onset laterals, likely as a strategy to achieve acoustic/auditory similarity to clear-l. In some cases, because these children have yet to attain adult-like distribution in their production of /l/, they exhibited inconsistency or doubt in the choice of variant for some words (e.g., the consecutive repetitions of the word *ball* by M9: [bɔw], [bɔ], [bɔl]).

Coda laterals were further examined to find out whether the laterals of some lexical items were more likely to be l-less. The proportion of coda /l/ that was l-less for each target word (and their variations in parentheses) is shown in Figure 3, in order of increasing rate of l-lessness. Some English lexical items show very high rates of l-lessness; for example, /l/ in *wolf* and *milk* was almost always l-less. The overall trend may at first glance appear to be largely a result of phonetic environment, as many target words with laterals in the absolute word-final position were less likely to be l-less. However, recall that many child target words were repeated in quick succession during the elicitation tasks, while some were done with pauses in between repetitions; such differences in phonetic contexts are not reflected in the figure.

Mixed-effects generalised regression analysis was run on the coda laterals to model the binary outcome of l-lessness (l-less = 0, retained = 1). Tokens marked as 'unclear' ($n = 24$) were excluded. The first model examined overall differences between English and Malay coda laterals across children. Phonetic context was considered in this model. Age was also added as a predictor, to account for the potential developmental differences observed in Figure 2. The full model included language (contrast weights: English = −0.57, Malay = 1), phonetic environment (prepausal = −1.21, preconsonantal = 1) and age as fixed effects. Its random effect structure included intercepts for word and subject. In the best-fitting model

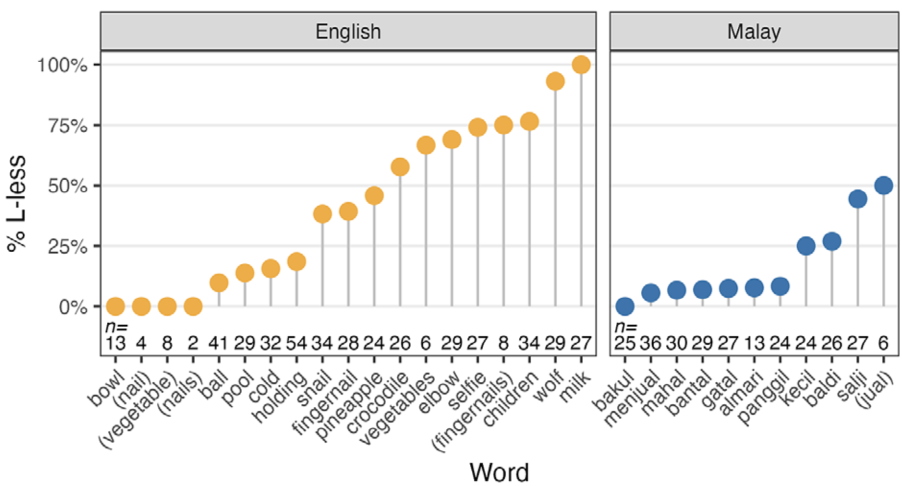

Figure 3. Percentage of coda /l/ that was l-less by language and lexical item, ordered by increasing rate of l-lessness. The sample sizes *(n)* refer to the total number of tokens for each word produced by all children. Words in parentheses are variations of target words: fingernail–(fingernail)/(nail)/(nails); vegetables–(vegetable); menjual–(jual).

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Table 4. Best-fitting mixed-effects logistic regression models fit to the coda laterals

Model	Fixed effects	*B*	*SE*	*OR*	95% CI	*p*
Eng-Mly	(Intercept)	1.13	0.69	3.08	0.80 – 11.89	.102
	Language	1.38	0.57	3.96	1.29 – 12.11	.016
	Phonetic environment	–0.82	0.21	0.44	0.29 – 0.67	< .001
	Age	1.65	0.53	5.19	1.84 – 14.68	.002
English	(Intercept)	0.36	0.76	1.43	0.32 – 6.36	.637
	Phonetic environment	–0.68	0.23	0.51	0.33 – 0.79	.003
	Age	1.70	0.46	5.47	2.20 – 13.56	< .001
	Peer group type	1.36	0.48	3.88	1.53 – 9.84	.004
Malay	(Intercept)	3.16	1.15	23.58	2.46 – 225.96	.006
	Age	2.53	0.86	12.55	2.32 – 67.90	.003

Note: **Model 'Eng-Mly'**: Observations = 698. Marginal R^2 = 0.31, conditional R^2 = 0.81. Syntax: glmer(realisation ~ language + phonetic_envr + age + (1|word) + (1|subject)). **Model 'English'**: Observations = 445. Marginal R^2 = 0.26, conditional R^2 = 0.79. Syntax: glmer(realisation ~ phonetic_envr + age + peer_type + (1|word) + (1|subject)). **Model 'Malay'**: Observations = 253. Marginal R^2 = 0.29, conditional R^2 = 0.84. Syntax: glmer(realisation ~ age + (1|word) + (1|subject)).

('Eng-Mly' in Table 4), all fixed and random effects significantly improved model fit; compared to the average, preconsonantal coda laterals were less likely to be retained (*OR* = 0.44; $\chi^2(1) = 13.00$, $p < .001$), and older children were more likely to retain their coda laterals (*OR* = 5.19; $\chi^2(1) = 7.60$, $p = .006$). After adjusting for effects of phonetic environment and age, Malay coda laterals were overall more likely to be retained (*OR* = 3.96; $\chi^2(1) = 5.13$, $p = .02$) than English coda laterals.

Two separate models were subsequently run to ascertain whether language dominance, peer group type or preschool type was associated with the likelihood of l-lessness in English and Malay coda laterals respectively. The results for the full models can be found in the Appendix (English: Model 1; Malay: Model 2). The full model for English coda laterals included age, phonetic environment (prepausal = −1.82, preconsonantal = 1), language dominance (using amount of use of English as proxy), peer group type (mix = −0.99, Malay = 1), and preschool type (mix = −1.39, Malay = 1) as fixed effects. The random effect structure included intercepts for word and subject. In the best-fitting model for English coda laterals ('English' in Table 4), the two random effects and the fixed effects of phonetic environment, age, and peer group type significantly improved model fit; after adjusting for similar effects of age (*OR* = 5.47; $\chi^2(1) = 12.32$, $p < .001$) and phonetic environment (*OR* = 0.51; $\chi^2(1) = 9.06$, $p = .003$) as in the model above, children whose three closest friends were ethnically Malay were more likely than average to retain their English coda laterals (*OR* = 3.88; $\chi^2(1) = 5.90$, $p = .02$).

The full model for Malay coda laterals also included age, phonetic environment (prepausal = −0.60, preconsonantal = 1), language dominance, peer group type (mix = −1.02, Malay = 1), and preschool type (mix = −1.56, Malay = 1) as fixed effects. The random effect structure included intercepts for word and subject. In the best-fitting model for Malay coda laterals ('Malay' in Table 4), the two random effects and only the fixed effect of age significantly improved model fit (*OR* = 12.55; $\chi^2(1) = 14.60$, $p < .001$).

In sum, the analyses on the distribution of realisations of coda laterals revealed that across children, Malay coda laterals were more likely to be retained compared to the

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average. The inter-child variation in the likelihood of English coda laterals being l-less was predicted by peer group type; children whose three closest friends were ethnically Malay were less likely than average to vocalise/delete their English coda laterals.

Darkness of laterals and positional contrast

The darkness of retained laterals was further analysed. The onset and coda /l/ of 41 tokens preceded or followed a vowel very closely, with a silence/pause shorter than 300 ms between segments (e.g., *a /l/ion*; *menjua/l/ ayam*), and these were analysed as ambisyllabic laterals. The mean F2 (raw and Bark-converted) and F2–F1 (Bark) values of the laterals by language and syllable position are shown in Table 5 (higher = clearer). Figure 4 compares the English and Malay laterals by their F2–F1 values (Bark). By visual inspection of the figure, their laterals across syllable positions and language are very similar in darkness. Malay onset laterals were observably clearer than Malay laterals in other positions; this

Table 5. Mean F2 (Hz), F2 (Bark), and F2–F1 (Bark) values of laterals grouped by language and syllable position.

Language		Syllable position		
		Onset *M* (*SD*), *n*	Ambisyllabic *M* (*SD*), *n*	Coda *M* (*SD*), *n*
English	F2 (Hz)	2577 (247.9), 118	2453 (304.8), 275	2448 (291.3), 225
	F2 (Bark)	14.67 (0.63), 118	14.31 (0.89), 275	14.30 (0.84), 225
	F2–F1 (Bark)	9.95 (0.94), 118	9.50 (1.26), 275	9.41 (0.94), 225
Malay	F2 (Hz)	2668 (200.2), 14	2408 (291.0), 195	2459 (301.1), 198
	F2 (Bark)	14.91 (0.50), 14	14.20 (0.80), 195	14.33 (0.89), 198
	F2–F1 (Bark)	10.54 (0.59), 14	9.60 (1.09), 195	9.33 (1.13), 198

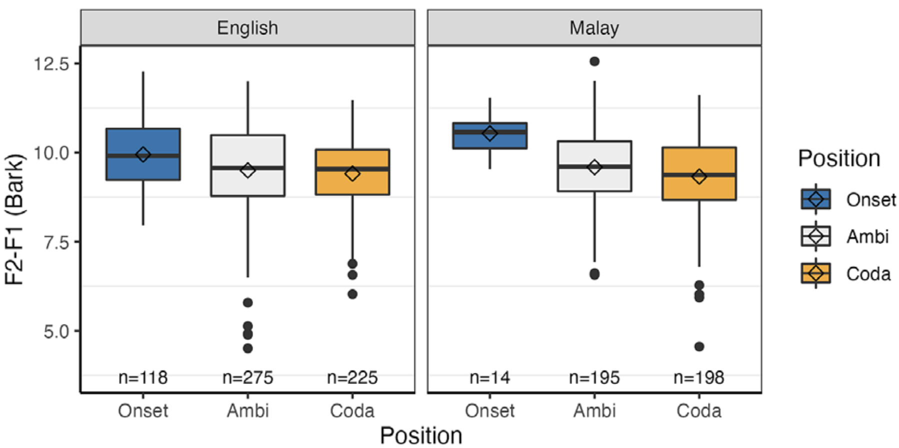

Figure 4. F2–F1 values (Bark) of English and Malay laterals across different syllable positions grouped by language. Diamonds indicate mean values.

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could be due to effects of vowel context, since the onset laterals in both target words (*ahli* and *limau*) preceded a high front vowel.

Mixed-effects linear regression analysis with F2–F1 (Bark) values as response was run. The first model examined the phonetic contrasts in lateral darkness between syllable positions and languages across children. Outliers with z-scores that were greater than ±3 were removed (n = 10). The full model (Model 3 in Appendix) included language (contrast weights: English = −0.66, Malay = 1), position (onsetCoda: coda = −0.32, onset = 1, ambi = 0; ambiCoda: coda = −1.11, ambi = 1, onset = 0), and the two-way interaction between language and position. Vowel context (F2 of vowel) and lateral duration, which are known to influence l-darkening, were also added as predictors. The random effects structure included intercepts for subject and word. In the reduced model ('Eng-Mly' in Table 6), only lateral duration (β = 0.16; $\chi^2(1) = 33.00$, $p < .001$) and vowel context (β = 0.38; $\chi^2(1) = 60.70$, $p < .001$) significantly improved fit; longer laterals and those neighbouring fronter vowels were clearer. None of the predictors of interest (i.e., language, position, and their two-way interaction) significantly improved model fit, but the main effects of language and position were included in the reduced model to confirm that they were not significant predictors of lateral darkness.

Another model was run on only English laterals to explore the effects of language-external factors on positional contrasts. To avoid a saturated model that is overly complex, only language dominance was included in this analysis; the exposure to Chinese others is expected to have little effect on lateral darkness and positional contrasts, since their English lateral system is predominantly l-less. To further reduce the complexity of the models, onset and ambisyllabic laterals were merged into one category (prevocalic) to be compared with coda laterals (postvocalic), following Barlow et al. (2013). Darker postvocalic laterals indicate allophonic velarisation (Barlow et al., 2013; Kirkham & McCarthy, 2021). The results for the full model can be found in the Appendix (Model 4). The full model included position (postvocalic = −1.74, prevocalic = 1), language dominance (% English use), vowel context and lateral duration, and the two-way

Table 6. Reduced mixed-effects linear regression models fit to the retained coda laterals.

Model	Fixed effects	*β*	*SE*	*t*	*p*
Eng-Mly	(Intercept)	–0.09	0.14	66.01	< .001
	Vowel context	0.38	0.05	8.14	< .001
	Lateral duration	0.16	0.03	5.79	< .001
	Language	–0.01	0.07	–0.18	.857
	Position: OnsetCoda	0.14	0.12	1.21	.226
	Position: AmbiCoda	0.03	0.05	0.64	.522
English	(Intercept)	–0.05	0.13	69.06	< .001
	Vowel context	0.38	0.06	6.34	< .001
	Lateral duration	0.16	0.04	4.15	< .001
	Position	0.03	0.05	0.50	.616

Note: **Model 'Eng-Mly'**: Observations = 1015. Marginal R^2 = 0.17, conditional R^2 = 0.49. Syntax: lmer(F2–F1~ vowel_context + lateral_duration + language + position + (1|word) + (1|subject)). **Model 'English'**: Observations = 611. Marginal R^2 = 0.17, conditional R^2 = 0.44. Syntax: lmer(F2–F1~ vowel_context + lateral_duration + position + (1|word) + (1|subject)).

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interaction between position and language dominance. The random effect structure included intercepts for word and subject. In the reduced model for English coda laterals ('English' in Table 6), only the two random effects, vowel context ($\beta = 0.38$; $\chi^2(1) = 38.10$, $p < .001$), and lateral duration ($\beta = 0.16$; $\chi^2(1) = 18.00$, $p < .001$) significantly improved model fit. Position as a main effect did not significantly improve model fit, but it was included in the reduced model to confirm that it was not a significant predictor.

In sum, after adjusting for effects of vowel context and lateral duration, the children's English and Malay retained laterals did not differ considerably in their darkness across languages and syllable positions.

Discussion

This present study set out to better understand early bilingual phonological acquisition in multicultural and multilingual contexts in which intra- and inter-speaker variation is the norm. Specifically, we investigated the lateral production of 14 early English–Malay bilingual preschoolers in Singapore who were exposed to several allophones of coda /l/ in their overall input (see Table 1). We asked whether and how the children showed the development of distinct lateral systems for English and Malay. While this study is primarily interested in overall group behaviours, there is potential variability in the outcomes due to effects of language dominance and varying exposure to different lateral systems by significant others (as described in Table 1). We therefore also considered their amount of English use, peer group type and preschool type in the exploratory analyses.

Realisations of coda laterals

Singapore English (SgE) differs from Malay in that the coda laterals of SgE are typically l-less, that is, vocalised or deleted (Sim, 2021; Tan, 2005; Wee, 2008). We had predicted that one way by which the children in this study would distinguish their lateral systems was by vocalising or deleting their English coda laterals more often than they do for Malay laterals. Our findings revealed that across children, Malay coda laterals were overall more likely to be retained than English coda laterals, as predicted. In addition, l-lessness in the children's coda laterals was constrained by phonetic environment; compared to preconsonantal coda laterals, their prepausal coda laterals were more likely to be retained. The same linguistic constraint also predicted the likelihood of l-lessness in the English coda laterals of English–Malay bilingual caregivers (Sim, 2021, 2022b). This contrasts with the predominantly l-less English lateral system of many Chinese Singaporeans, who typically vocalise or delete even prepausal or prevocalic word-final English coda laterals. We performed a preliminary analysis on the same tokens produced by three Chinese children aged 4;7, 5;8 and 6;1, who were highly English dominant (Mandarin use below 15%) and raised by English-dominant caregivers, and found that their English coda laterals were almost categorically l-less, about 86–100% of the time.

Our exploratory analysis also revealed some inter-child variation in the l-lessness of English coda laterals that was predicted by peer group type: children who had at least one close ethnically Chinese friend were more likely to vocalise/delete their English coda laterals than those whose three closest peers were ethnically Malay. This finding should be interpreted with caution due to the small sample size. Nevertheless, many previous studies have shown that when children are faced with competing alternatives, the speech model of peers or the dominant community norms often supersede caregiver norms (e.g., Kerswill

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& Williams, 2000; Khattab, 2002; Mayr & Montanari, 2015). In their investigation of the stop production of two English–Italian–Spanish simultaneous trilingual sisters in Los Angeles, California (aged 6;8 and 8;1), Mayr and Montanari (2015) reported that despite being exposed to Italian on a regular basis from their native Italian-speaking mother and heritage speakers, not all their Italian stops were target-like. This was attributed to the regular exposure to English-accented Italian of their English-dominant peers. It remains unclear whether the variation in the present study is related to social factors such as peer group identity and the nascent awareness of ethnic differences, or is a result of statistical learning of linguistic patterns present in the consistently l-less lateral system of their ethnically Chinese close friend(s). An initial analysis of the differential production patterns by lexical items revealed that while children with close Chinese peer(s) were more likely to vocalise the coda laterals in some items than those with Malay close peers, word-final laterals in monosyllabic words (e.g., *bowl, ball, pool*) were almost always retained (and perceptually clear) by all children. A related question therefore is whether the variability reflects an acquisition process that is better explained by the learning through copying of surface forms of whole words, or by the learning of phonological rules or the re-ranking/re-weighting of constraints. Future work can explore these questions by including a more robust way to operationalise peer group type and social network.

Darkness of retained coda laterals and positional contrasts

Sim (2021) reported that in caregiver-child interactions that involved teaching and learning, Malay mothers were found to use a much darker coda /l/ in their English child-directed speech, thereby presenting to the child the allophonic velarisation rule. We asked whether children's English coda laterals in this study might potentially show allophonic velarisation as the children could have, seeing that the elicitation tasks were a form of a test of their language abilities, adopted the form that their mothers used in literary contexts. Alternatively, they may in their production show preference for clear-l, which occurs much more frequently in both languages, and if so, a question is whether they would show any deflecting patterns (Kehoe, 2015) to maximise the contrast between their two lateral systems.

Our findings revealed that, when not l-less, the children's retained English coda laterals were generally clear (M_{F2} = 2448 Hz, 14.30 Bark), and comparable to the very clear English coda laterals produced by 6-7 year-old Sylheti–English bilingual children ($M_{\mathrm{F2-F1}} \approx 2000$ Hz, compared to $M_{\mathrm{F2-F1}} = 1948$ Hz for this study) in Kirkham and McCarthy (2021). Our analyses did not reveal significant difference in lateral darkness within and between languages: the English coda laterals of the children in the present study were similar in their darkness to their onset (M_{F2} = 2577 Hz, 14.67 Bark) and ambisyllabic laterals (M_{F2} = 2453 Hz, 14.31 Bark), and also similar to Malay onset (M_{F2} = 2668 Hz, 14.91 Bark), ambisyllabic (M_{F2} = 2408 Hz, 14.20 Bark) and coda laterals (M_{F2} = 2459 Hz, 14.33 Bark). The absence of a significant effect of language, position and their interaction could be due to a lack of statistical power as a result of the small sample size, such that very small positional differences between clear laterals as attested in the Sylheti–English bilingual children in Kirkham and McCarthy (2021), or small overall differences between languages that suggest deflecting patterns, cannot be detected. The same could be said about the lack of a significant effect of language dominance on the lateral darkness of their English laterals. However, in many studies that reported a clear–dark positional contrast in the laterals of children, velarised coda laterals often have considerably lower F2

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than onset laterals. Barlow et al. (2013), for example, reported that their Spanish–English bilinguals (M_{age} = 4;7) produced prevocalic (onset and ambisyllabic) English laterals with a mean F2 of 1865.82 Hz and postvocalic (coda) laterals with a mean F2 of 1269.16 Hz (compared to their English monolinguals [M_{age} = 4;10] who produced prevocalic laterals with a mean F2 of 1509.48 Hz and 1384.59 Hz for postvocalic laterals). Khattab (2011) also reported that their English monolingual and English-Arabic bilingual children (aged 5, 7 and 10) produced English onset laterals with an F2 (Bark) that ranged between 11 and 15 and coda laterals with an F2 (Bark) that ranged between 8 to 11. Moreover, the reported mean difference in F2 between clear onset (8.02 Bark) and darker coda lateral (5.78 Bark) in Singaporean Malay mothers' CDS was 2.24 Bark (Sim, 2021). Therefore, while it is uncertain whether (some of) the children in the present study did produce very small positional contrasts in their laterals because of a potential lack of statistical power, comparisons with past studies and impressionistic analysis suggest that the children in this study produced mostly very clear (i.e., not velarised) laterals in both of their languages overall if they were not l-less.

A simple explanation could be that children had acquired the velarised allophone but did not treat the elicitation tasks to be a context in which dark-l should be used. An impressionistic analysis of their spontaneous data, however, revealed that the children rarely produced the much darker variant, if they did at all, even during contexts of teaching and learning. One other explanation could be developmental, in particular the difficulty for young children to achieve an anterior-posterior lingual articulation. Lin and Demuth (2015) found that their Australian English-speaking children only produced coda dark-l accurately about 10% of the time at age four, and even by five years only around 40% of their coda laterals were adult-like. This, however, fails to explain why even the older children in this study did not produce velarised laterals. A more likely account could be that the children had not recognised dark-l as an allophone nor had they gained awareness of its socio-indexical meanings, and its late acquisition could be attributed to its relatively lower rate of occurrence and its lack of phonetic salience. Compared to children in other studies whose dominant input model is the one with consistent allophonic velarisation (e.g., Barlow et al., 2013; Khattab, 2002; Kirkham & McCarthy, 2021), dark-l in the CDS of these Malay caregivers is limited to literary contexts and to maternal CDS (Sim, 2021). Moreover, vocalised-l is used in CDS in all contexts, which could have made dark-l less perceptually salient for a separate phonetic category to be formed. Future work can explore when and how Malay children acquire the velarised variant to match adult norms.

Modelling variable outcomes in bilinguals and input effects

The findings of this study contribute to the growing body of work that directly investigates variation in specific phonetic and phonological properties of the input and its effects on bilingual phonological development (e.g., Fish et al., 2017; Khattab, 2011; Mayr & Montanari, 2015; Ramon-Casas et al., 2021; Sim, 2022b; Sim & Post, 2021; Stoehr et al., 2019). Especially in diverse settings, variable outcomes in bilingual phonological acquisition may not be satisfactorily explained by effects of individual bilingualism such as cross-linguistic interaction alone; the input models that children are exposed to play a significant role in shaping language outcomes. In the present study, it is evident that the very clear English coda laterals produced by the children were primarily learned from their caregiver input, and less likely to be a phonetic property transferred from Malay, especially since the children in this study were balanced if not highly English-dominant

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early bilinguals. This study therefore also illustrates the vertical transmission (i.e., across generations) of an ethnically-distinctive differential feature that had emerged from long-term language contact.

Particularly in diverse settings like this one, children are also necessarily exposed to input of significant adults and peers that can qualitatively differ from that received at home, and these competing input models may play a role in shaping language outcomes; the present study provides some preliminary evidence. In pluralistic societies that are organised around the languages and cultures of the dominant groups that have historically constituted them, there may be strong social pressure for minorities to assimilate, and it is not uncommon for later-generation ethnic minorities to diverge from the accented input at home towards the more dominant accent (e.g., Khattab, 2002; Mayr & Siddika, 2018; McCarthy et al., 2013). In contrast, societies that adopt the multiculturalism model preserve and accentuate ethnic diversity, and therefore ethnic-specific markers may arguably play more important roles in indexing ethnic identities and ethnic cultural orientations. Future work can examine how the dynamics of child language variation and change are moderated by socio-political forces associated with multiculturalism. In regards to this study, a question that can be explored is whether, when and how Malay children would eventually vary in or diverge from their use of coda clear-l, an ethnic marker.

Conclusion

In this study, we set out to better understand early bilingual phonological acquisition in contexts in which inter- and intra-speaker variation is the norm. We examined the bilingual acquisition of laterals by early English–Malay bilingual preschoolers in Singapore who were exposed to several allophones of coda /l/ in their overall input. Our findings revealed that, like their caregivers, English coda laterals were overall more likely to be vocalised or deleted than Malay laterals. There was however some variation in their production patterns that was predicted by their peer group. All children also acquired the ethnically distinctive properties of their caregiver input by using very clear coda laterals in English. One of the goals in the field of child bilingual acquisition is to construct a developmental theory or model that can satisfactorily explain if not predict the variable language outcomes that have been observed in bilingual children. Much of the research towards this endeavour has taken on a psycholinguistic perspective that focuses on linguistic factors. This study, along with many others as described, demonstrates that variation is inherent in the input and intrinsic to the acquisition process, and that language-external factors are also important considerations in predicting language outcomes.

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Appendix

Model 1

Fixed effects	*B*	*SE*	*OR*	95% CI	*p*
(Intercept)	0.43	0.75	1.53	0.35 – 6.65	.568
Phonetic environment	–0.68	0.23	0.51	0.33 – 0.79	.002
Age	1.84	0.46	6.32	2.56 – 15.61	< .001
% English use	–0.67	0.48	0.51	0.20 – 1.31	.163
Peer group type	1.39	0.53	4.02	1.44 – 11.27	.008
Preschool type	–0.23	0.47	0.79	0.32 – 1.97	.615

Note: Observations = 445. Marginal R^2 = 0.28, conditional R^2 = 0.80. Syntax: glmer(realisation ~ phonetic_envr + age + eng_use + peer_type + preschool_type + (1|word) + (1|subject)).

Model 2

Fixed effects	*B*	*SE*	*OR*	95% CI	*p*
(Intercept)	3.07	1.02	21.45	2.88 – 159.68	.003
Phonetic environment	–0.79	0.58	0.45	0.15 – 1.41	.172
Age	2.90	0.81	18.13	3.68 – 89.31	< .001
% English use	–0.95	0.68	0.39	0.10 – 1.49	.167
Peer group type	0.60	0.64	1.82	0.52 – 6.43	.352
Preschool type	0.26	0.58	1.29	0.42 – 4.03	.656

Note: Observations = 253. Marginal R^2 = 0.35, conditional R^2 = 0.81. Syntax: glmer(realisation ~ phonetic_envr + age + eng_use + peer_type + preschool_type + (1|word) + (1|subject)).

Model 3

Fixed effects	*β*	*SE*	*t*	*p*
(Intercept)	–0.09	0.13	68.62	< .001
Language	–0.00	0.07	–0.07	.941
Position: OnsetCoda	0.16	0.12	1.34	.180
Position: AmbiCoda	0.03	0.05	0.55	.581
Vowel context	0.38	0.05	8.31	< .001
Lateral duration	0.16	0.03	5.79	< .001
Language * OnsetCoda	0.09	0.16	0.60	.546
Language * AmbiCoda	0.01	0.06	0.23	.815

Note: Observations = 1015. Marginal R^2 = 0.17, conditional R^2 = 0.47. Syntax: lmer(F2–F1 ~ language + position + vowel_context + lateral_duration + language*position + (1|word) + (1|subject)).

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Model 4

Fixed effects	*β*	*SE*	*t*	*p*
(Intercept)	–0.04	0.12	–0.35	< .001
Position	0.02	0.05	0.49	.084
% English use	–0.12	0.11	–1.12	.263
Vowel context	0.39	0.06	6.50	< .001
Lateral duration	0.16	0.04	4.27	< .001
Position * % Eng use	–0.04	0.02	–1.65	.100

Note: Observations = 611. Marginal $R^2 = 0.20$, conditional $R^2 = 0.43$. Syntax: lmer(F2–F1 ~ position + eng_use + vowel_context + lateral_duration + position*eng_use + (1|word) + (1|subject)).

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