This is the accepted manuscript. To appear in Language and Speech.

Systematicity in variability: English coda laterals of English-Malay bilinguals in multi-accent Singapore

Jasper Hong Sim, Brechtje Post

ABSTRACT

Outcomes of early phonological acquisition in multi-accent contexts can be especially wide-ranging, raising the question of whether children exposed to multiple accents in one community are building the same linguistic systems. This present study investigates the English coda clear laterals in the spontaneous, mother-directed speech of English-Malay early bilingual preschoolers raised in multi-accent Singapore. Previous work has shown that these children were exposed to highly variable input involving three different English coda /l/ variants within and outside of their ethnic community. To elucidate the complex nature of language acquisition in such diverse settings, we examine both individual differences and group behaviours. Our findings reveal that despite the considerable between- and within-child variation, production patterns are generally systematic. Malay children with close Chinese peers, however, exhibited greater variability and unpredictability in their production, revealing word-specific inconsistencies that suggest a restructuring of or instability in their phonological representations. This study underscores the complexity of phonological development in multi-accent contexts and highlights the challenges in predicting the contributors of these variable outcomes.

Keywords: variable input, multi-accent, contact varieties

INTRODUCTION

There is, in recent years, increasing recognition of and interest in variability in the speech input to children. Variability in terms of accent variation, whether it be phonetic, allophonic, or phonological, is commonplace in bilingual and multi-cultural settings (Fish et al., 2017; Kutlu et al., 2024; Mayr & Montanari, 2015; Sim, 2021, 2024; Stoehr et al., 2019), and this is also the case for monolinguals, especially those raised in multi-dialectal contexts (Durrant et al., 2015; Floccia et al., 2009; Kartushina et al., 2021; Kartushina & Mayor, 2023; Levy et al., 2019; Stanford, 2008; Smith et al., 2007). While there is ample evidence showing that very young children are sensitive to the properties of their ambient input, and that they can detect and perceptually adapt to accent variability and make social inferences based on accent information (E. K. Johnson et al., 2022), much less is currently understood as to how multi-accent input affects phonological outcomes, especially in terms of production (E. K. Johnson, 2018; E. K. Johnson et al., 2022; Kehoe, 2015; Sim & Post, 2024).

Previous research has predominantly centred on psycholinguistic aspects related to word recognition and representations when investigating the impact of multi-accent input on language development, while production studies involving variable input have primarily delved into the acquisition *of* sociolinguistic variation, as opposed to the impact of sociolinguistic variation *on* acquisition. Nevertheless, as we will elaborate below, these previous studies provide indications that the outcomes in a child's language production vary based on the type of input and sociolinguistic context when exposed to multi-accent or variable input. These outcomes may encompass the following: (i) Production could exhibit instability and inconsistency, in part due to relaxed or less well specified phonological-lexical representations. (ii) Variation in production might be somewhat predictable and influenced by stylistic, linguistic, and lexical factors. (iii) Production may show little or no variability; the child may have regularised its inconsistencies. (iv) Variation may also arise from social forces such as peers or dominant accents that may additionally influence phonological development. Given the wide-ranging outcomes, this raises the question as to whether children exposed to multiple accents and variable input in one community are building the same linguistic systems. We explore this question by investigating the spontaneous production of English coda laterals by early English-Malay bilingual preschoolers raised in multi-accent Singapore.

Links between variable input and production

Depending on the nature of variation, variable input can have diverse impacts on early phonological development (see Sim & Post, 2024, for an overview). Some studies examining early word representations in young bi-dialectal children found that the phonological representations of very young infants may be less well specified or possess more relaxed categorical boundaries, resulting in poorer performance in tasks involving non-word recognition and the detection of mispronunciations (e.g., Durrant et al., 2015; Kartushina & Mayor, 2023; van Heugten & Johnson, 2017). These less stable word form representations may in turn lead to variable production. In a study involving children exposed to mixed-accent input, Ramon-Casas et al. (2021) tested the perception and production of the Catalan /e/-/ɛ/ contrast by Spanish-Catalan 4- to 5-year-old bilinguals. They found that not only were Spanish-dominant bilingual children outperformed by their Catalan-dominant peers in identifying correct and mispronounced words with the /e/-/ɛ/ contrast, but they were also more error-prone in their production of words containing these vowels. Yet, the Spanish-dominant bilinguals, who were classified as Spanish dominant based on the language spoken by the main caregiver, had had regular and consistent exposure to Catalan before entering kindergarten at age three years. The authors suggested that the variable performance of the Spanish-dominant bilinguals could be attributed to the Spanish-accented Catalan input extensively used in their home and social environment.

In other production studies, variability in terms of fine-grained acoustic differences in the input has been shown to be reflected in children's production. For instance, coda stops in Singapore English tend to be unreleased, but this varies among Singaporeans. Sim & Post (2021) indeed found considerable inter-caregiver variability in their coda stop release, and this variation was also reflected in their preschoolers' production: they found that mothers who released coda stops to a lesser degree also had children who tended to not release their stops, and the same was true for mothers who released their stops to a higher degree.

However, children do not always veridically replicate inconsistencies in the input. Instead, they may impose consistency by choosing a more regular form than one that is less frequent, which has been demonstrated in statistical learning experiments that involved learning of artificial languages with unpredictable variation (Hudson Kam & Newport, 2005, 2009), and also in the acquisition of natural languages (Singleton & Newport, 2004; Smith et al., 2007). Habib (2017) found that older boys in the village of Oyoun Al-Wadi in Syria began to approach men's local linguistic patterns by using more of the rural form [q] than girls and their mothers, but this was not observed in boys aged six to eight, who were categorical users of the urban [ʔ] that most mothers used. Habib explained that the lack of gendered variation in the younger children was less likely to be due to the replication of patterns in caregiver input, since there was considerable linguistic difference between fathers and mothers. Instead, Habib proposed that the children could have regularised the multi-variable input by using the form that was predominant in their overall input, i.e., [ʔ] used by their mothers.

Additionally, social forces can modulate language outcomes when children encounter competing language models. Variationist studies have found that variation that is conditioned by sociolinguistic cues such as age, social class, gender, and context is evident in children's production from an early age (Foulkes & Hay, 2015; Nardy et al., 2013; Smith et al., 2007), but peers and dominant community norms often supersede caregiver norms (Mayr & Siddika, 2018; McCarthy et al., 2014; Smith & Holmes-Elliott, 2022). For example, Kerswill & Williams (2000) observed that 4-year-old children's production patterns of the (ou) variable correlated with their caregivers' production, but by the age of 8 and 12, the children's production oriented towards the variants of the New Town koine in Milton Keynes, UK. Mayr & Montanari (2015) also found that even though the two English-Italian-Spanish simultaneous trilingual sisters in their study were regularly exposed to Italian from birth by their native-speaking mother and heritage speakers, not all of their Italian stops were target-like. Instead, their Italian production showed effects of English, attributed to the exposure to English-accented Italian from their English-dominant peers. Similar studies on multi-generational ethnic communities conducted in largely monolingual societies have shown that second-generation heritage speakers may use more ethnically-distinctive features based on their social network and cultural affiliation (e.g., Kirkham, 2017; Sharma, 2011; Sim, 2019) and/or behave more like their monolingual peers than their foreign-born caregivers (e.g., (Mayr & Siddika, 2018; McCarthy et al., 2014; Nguyen, 2020).

English coda clear [l] and other variants of /l/ in Singapore English

The primary variable of interest in this study, English coda clear [l], is an ethnic marker in Singapore English that had likely emerged from the language acquisition of and contact between English and indigenous languages with clear laterals (Sim, 2019, 2022a), in ways similar to how the same feature in British Asian English was formed between English and heritage languages such as Sylheti and Punjabi (Sharma, 2011; Kirkham & McCarthy, 2021). Coda clear [l] is used by the Singaporean Malay ethnic community variably in English (Sim, 2019, 2021; Sim & Post, 2023) and consistently so in Malay, an Austronesian language that has clear laterals in all syllable positions (Sim, 2022b; Yunus Maris, 1980). By contrast, the

English coda laterals of Chinese Singaporeans, the ethnic majority, were found to be typically vocalised (K. K. Tan, 2005), a process in which the alveolar lateral is replaced by either a (labial-)velar approximant or a back vowel or semivowel (e.g., *pill* [piu]). After back vowels or schwa, coda /l/ may be deleted or assimilated with the vowel (e.g., *ball* [bɔ]). 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). These two locally-derived coda /l/ variants are alternative forms with a third variant—dark or velarised [ɫ]—which is present in more established standard accents of English (Kirkham et al., 2020; Sproat & Fujimura, 1993), and is the variant used predominantly by more English-dominant Singaporeans (Sim, 2015, 2019). In Singapore, recognised standard varieties of English and their features are enregistered as standard and regarded as prescriptively correct. It is therefore not unexpected that compared to the other two /l/ variants, clear [l]—being acoustically more salient and distant from dark [ɫ] and used by the ethnic minority—is mostly negatively evaluated by non-Malay Singaporean listeners and indexed social types that were less educated and thought to be lower in their socioeconomic status and their English proficiency. To many Malays, however, clear [l], along with other ethnic markers, is socially meaningful as they are used to mark group membership and solidarity (Sim, 2022a). That English coda clear [l] indexes Malay identity can be observed in how it is used by members and non-members in stylistic expressions of stereotypical Malay personae (Sim & Post, 2021a).

The community: Malays and multi-accent input

The Malays are an ethnic minority based on numbers, as they account for about 15% of the citizen population of Singapore, compared to 75.9% who are ethnically Chinese, and 7.5% who are Indian (Department of Statistics, 2021). The Malay ethnic community, which has particularly strong, dense ties (Mathews & Selvarajan, 2020), is regarded to be more linguistically homogeneous than the other two ethnic groups, as most members speak Malay, and the language is strongly associated with their cultural and Muslim identity in Singapore (Kassim, 2008). Although English had been used in colonial Singapore in the 1800s, many Singaporeans only began to formally learn and speak English after the institution of the bilingual policy in the 1960s (Low & Brown, 2005). Therefore, while the use of English coda clear [l] by first-generation L1-Malay/L2-English speakers is likely a result of processes associated with late acquisition, effects of bilingualism alone cannot account for the use of ethnically distinctive features by later-generation speakers of English, and therefore their differential speech features are typically ascribed to sociolinguistic factors. Indeed, effects of individual bilingualism, prolonged language contact and intergenerational transmission, differences in cultural affiliation and orientation, and stylistic variation may all modulate the English speech of Singaporeans to different extents and in different ways, and concomitant with these is the extensive inter- and intra-speaker variation in their speech that is not always predictable (Alsagoff, 2010; Deterding, 2007; Kalaivanan et al., 2020, 2022; Kwek, 2015; Kwek & Low, 2021; Lim, 2000; Sim, 2023; Sim & Post, 2021b, 2021c; Starr & Balasubramaniam, 2019; Y.-Y. Tan, 2012).

Children raised in Singapore are therefore constantly exposed to multi-accent input that is highly variable. Sim (2021) found that in casual caregiver-child interactions, the English coda laterals of English-Malay bilingual caregivers were clear [l] and typically as clear as onset laterals, but their preconsonantal laterals were prone to being l-less. In teaching and literary contexts, most Malay mothers but not fathers adopted a less ethnically distinct style, by producing velarised coda laterals [ɫ] and/or by being more l-less. Malay children are also exposed to different distributions of English coda laterals by the wider English-Malay bilingual community depending on the language dominance of the speaker: Malay-dominant speakers typically use coda clear [l], whereas English-dominant speakers use coda dark [ɫ], if the coda laterals are not l-less (Sim, 2019). Moreover, being in a multicultural society, these preschoolers are increasingly exposed to the coda laterals of peers and other significant adults belonging to the Chinese ethnic majority in extra-familial contexts, which are typically l-less if not velarised [ɫ] (K. K. Tan, 2005), or the laterals of Indian Singaporeans, which may also be clear [l] or retroflex [ɭ]. These local /l/ norms are in further competition with extraneous /l/ models introduced through mass media and the speech of non-local significant others, such as live-in helpers from the Philippines and Indonesia.

Child acquisition of English /l/

Normative studies involving monolingual children speaking American, British and Australian English have shown that while clear onset laterals are produced usually by 3;0-3;5 (indicated by >75% accuracy; Dodd et al., 2003; Lin & Demuth, 2015; Smit et al., 1990), coda laterals, which are typically velarised in these varieties examined, are acquired much later. Lin & Demuth (2015), for instance, showed that velarised [ɫ] were still developing in older Australian English-speaking children aged about 7;11.

Studies involving bilingual children reveal that the outcomes of the development of dual linguistic systems are much more variable. Although there is consensus that bilinguals do not perform identically to their monolingual peers, early bilinguals are able to form distinct lateral systems if the languages have different /l/ distributions. Barlow et al. (2013), for instance, found that Spanish–English bilinguals with a mean age of 4;7 in the Southern California and Baja California area exhibited phonological knowledge of the allophonic velarisation rule by producing postvocalic /l/ that was darker than prevocalic /l/ in English, whereas their Spanish laterals were clear in all positions. Their English prevocalic /l/ in English, however, was clearer than the /l/ of their monolingual peers, and as clear as Spanish laterals, which suggests some influence of Spanish laterals on their English laterals. In a similar study that examined the laterals produced by second-generation Sylheti–English bilingual children aged about 6;7 in London, UK, Kirkham & McCarthy (2021) also found that although there was transfer of hyper-clear laterals from Sylheti to English, the children produced positional contrast in their English laterals.

A few other studies examined the direct relationship between input properties and production. In their investigation of the English laterals of second-generation English-Arabic bilingual children, Khattab (2002, 2011) found that although Lebanese-born caregivers living in Yorkshire, England had used coda clear [l] in their English speech, their bilingual children, however, produced mainly dark [ɫ] or vocalised /l/ in English, similar to their English monolingual peers. Sim & Post (2023), using controlled stimuli in a picture-naming task, also investigated the bilingual acquisition of English and Malay lateral systems in 14 Malay preschoolers aged 3;1 to 5;8 who had been exposed to multiple variants of /l/ in their overall input. They found that all children used hyper-clear [l] in English, including those who had used very little Malay, indicating the inter-generational transfer of an ethnic marker. Children also generally reflected the production patterns of their caregivers, by being more l-less in English than in Malay, which also suggests the development of two lateral systems. However, Sim and Post found that there was some inter-child variation; English coda laterals produced by children with close Chinese peer(s) were more likely to be l-less than those without. In other words, Malay children with at least one close Chinese peer had a lateral system that was closer to that of their Chinese peers than those without. Interestingly, they also found potential lexical effects: all children used clear [l] for *ball* and *bowl*, but variably so for *snail* and *elbow*. Word-final laterals in monosyllabic words were also almost always retained and clear, regardless of peer group effects. The authors were however unable to examine word-specific effects due to the limited set of lexical items in the controlled stimuli.

Current objectives

As mentioned above, previous research conducted in multi-accent contexts has primarily focused on word recognition and representations in children, while production studies involving variable input have predominantly delved into the acquisition of sociolinguistic variation, rather than examining how (socio)linguistic variation in the input impacts acquisition. Moreover, despite the wide-ranging outcomes, past studies have often observed differences at the group level or limited their comparisons between groups based on macrosocial categories. This approach may inadvertently conceal individual differences that hold significant importance in comprehending the nuanced effects of multi-accent input on phonological development.

In this present study, we focus on the spontaneous production of coda laterals in the mother-directed speech of 19 English-Malay bilingual Singaporean preschoolers to examine the individual differences that exist in their production of English coda clear [l] and determine whether the between- and within-child variation is in any way systematic or predictable.

METHODOLOGY

Participants

The data belonged to a larger speech corpus that comprises 60 Singaporean families (Sim, 2022b). English-Malay bilingual children in the corpus who were firstborn and whose caregivers had completed a language background and experience questionnaire created for the corpus were included in this study. Information about the 19 children who met the criteria (f = 8, age range: 2;3-6;1; median age = 4;6) is shown in Table 1; 14 of whom were participants in Sim & Post (2023). Participants were all typically developing early bilinguals who had been exposed to both languages by the age of three. At the time of data collection, all 19 children were attending preschool; children in Singapore begin primary school in the year they turn seven. Their language use (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 their immediate social environment and in their self-interaction and exposure to media, as self-reported by their caregivers. Information about the child's closest peers and preschool that they attended, which could be indicative of substantial exposure to different language models in their input, was also obtained. Caregivers were asked questions about the child's three closest and most influential friends ('peer group' in Table 1); some children had a mix of Malay and Chinese friends (mix), while the closest peers of others were all ethnically Malay (Malay). In addition, some children attended Malay-Muslim bilingual preschools (Malay under 'preschool' in Table 1), while some others attended preschools that were considerably more ethnically diverse (mix).

Table 1 Description of child participants including their age, 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
Mi16	2;3	F	0	0	47	48	Malay	— ***
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
Mi19	3;4	F	0	0	68	27	Malay	Malay
Mi23	3;6	F	0	3;0 **	78	22	Malay	Malay
Mi1	3;8	M	0	0	56	43	Malay	Malay
M2	4;4	M	0	0	85	13	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
M16	5;7	M	0	0	70	28	Malay	Malay
M11	5;8	M	0	0	83	6	Mix	Mix
M21	6;1	F	2;0	0	47	51	Malay	Malay

Note: Age is in years;months. Gender: F(emale), M(ale). Age of acquisition is in years;months. %SgE and %Mly do not always add up to 100% of all language use because of the marginal exposure to other varieties such as American and British English and other language varieties of their live-in domestic helpers. *The original coding used to identify subgroups in the corpus ('M' or 'Mi') are retained. **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. ***No information about the child's closest peers was received.

Materials and procedure

Naturalistic data from unstructured play and semi-structured interaction between mother and child were analysed for this study. Unstructured play included, but were not limited to, playing with toys, puzzle play and sketching/drawing. Semi-structured interaction involved literary activities; mothers were asked to name animals, food, objects, and people in a large picture card of a park scene. They also read a children's book, 'Duck and Goose' (Hills, 2006) to their child. In this set of activities, mothers were instructed to only use English with their child; there was minimal use of Malay, if at all. The mother-child interactions lasted approximately 30-40 minutes, without the presence of any other adult. 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 solid-state audio recorder that was recording at a sampling rate of 44.1 kHz at 16 bit.

Acoustic analysis

Only English coda laterals produced by the children were analysed. Words with coda laterals were first hand-segmented and labelled by a research assistant trained in experimental phonetics. The transcription was then checked by the first author, a native speaker of Singapore English, and any mistakes were corrected. A total of 778 coda laterals were identified, but 73 laterals could not be reliably analysed due to, for instance, noise, creak, voicelessness or overlapping speech, and they were removed from further analysis.

As the primary interest is in the variable production of clear [l], tokens were labelled according to whether they were clear [l] or not. Laterals were analysed aurally and acoustically based on visual inspection of the wide-band spectrogram on Praat (v. 6.3.14; Boersma & Weenink, 2023). Clear [l] can be reliably identified both aurally and also acoustically by the high F2 in the lateral steady-state in the spectrogram (Kirkham, 2017; Sim, 2021; Simonet, 2015), as shown in the left panel in Figure 1. Most laterals that were coded as 'not clear [l]' were l-less, i.e., vocalised or deleted (right panel in Figure 2); only seven tokens were perceivably velarised [ɫ]. The distinction between velarised or vocalised /l/, which is difficult to be made acoustically because they share similar acoustic signals (Hall-Lew & Fix, 2012), is not crucial for this study. A second research assistant trained in experimental phonetics and unaware of the study's objective was tasked with annotating the data of three participants (n = 172; about 22% of dataset). The transcription achieved 100% agreement, while the annotation (i.e., clear [l] or not) showed 95% agreement (Cohen's Kappa, $\kappa = 0.91$, $z = 12$, $p < .001$, indicated near perfect agreement).

Previous work including those that involved Singapore English speakers revealed that preconsonantal laterals were more likely to be l-less than prepausal laterals (Scobbie & Wrench, 2003; Sim, 2021; Sim & Post, 2023); coda laterals in this study were categorised according to whether they were prepausal (defined as a silence longer than 150 ms, or breathing) or preconsonantal, which included word-final laterals that immediately preceded the onset of the following word. Resyllabified coda laterals and intervocalic coda laterals, i.e., coda laterals that immediately preceded a vowel (n = 63), were excluded from analysis, as onset laterals are categorically clearer [l] in Singapore English. One limitation of spontaneous speech data is that lexical effects are difficult to be predicted and controlled. Nevertheless, past studies (Sim, 2021, 2022b; Sim & Post, 2023) revealed several lexical items in Singapore English that were typically if not categorically l-less in both child and adult speech. These were removed from further analysis as their frequency was not uniform across children: *wolf* (n = 24); *selfie* (n = 22); *milk* (n = 20); *middle* (n = 6); *little* (n = 6); *also* (n = 20); and *already* (n = 8). The remaining 536 coda laterals were included in the main analyses.

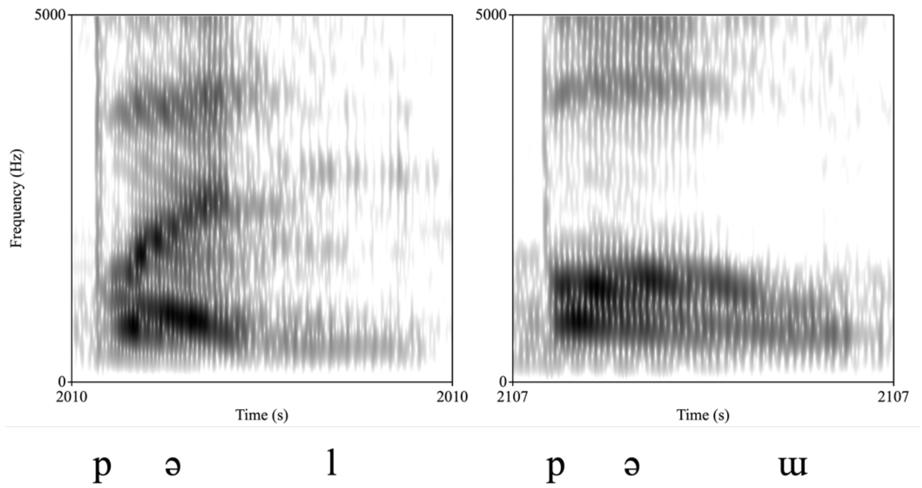

Figure 1. Representative spectrograms and IPA transcriptions of prepausal word-final laterals in the second syllable of *people*, both produced by child M15 (left: clear; right: vocalised).

Statistical analyses

In this study, we seek to find patterns amidst expected individual differences and are concerned with the extent to which the observed variation can be predicted by language-external factors. To uncover individual differences, we began by analysing the overall distributions of /l/ for each child across phonological environments (i.e., prepausal and preconsonantal) which have been previously identified as a consistent linguistic constraint conditioning the presence of l-lessness in Singapore English. Two main approaches were then employed to identify patterns across children and assess whether the variation is systematic or predictable. We first asked if the children could be grouped based on the similarity of their production patterns by conducting agglomerative hierarchical clustering, considering both their production patterns and social attributes. Following this, we performed a manual analysis of their production patterns by lexical items that could not be captured in the clustering process. To assess the specific influence of individual linguistic and social factors on the likelihood of clear [l] production, regression modelling was subsequently performed. By combining clustering and regression, we were able to approach the data from both descriptive and predictive angles: clustering revealed the inherent structure and potential groupings in the data, while regression allowed us to ascertain how linguistic and social factors influenced the production patterns.

We analysed our data using Bayesian mixed-effects regression, as we are more interested in probability distributions and degree of uncertainty about particular effects (posterior distributions), than binary outcomes as in frequentist modelling (Vasishth et al., 2018). The analyses were conducted in R (v.4.2.1) using the *brms* package (v.2.20.4; Bürkner, 2017). Weakly informative priors were used for the intercept [*Normal*(0,1.5)] and the beta parameters and random effects [*Normal*(0,1)]; they are not expected to exert a strong influence on the posterior. To account for the unequal sample sizes, categorical predictors were weighted effect coded (Darlington & Hayes, 2017; te Grotenhuis et al., 2017). All continuous predictors were z-standardised. More details about the fixed and random effects of the Bayesian model are presented below. Model convergence was assessed using Rhat values (all = 1) and visual inspection of plotted chains, and posterior predictive checks using *pp_check* function confirmed that the model mimics the data. Interpretation of results of the Bayesian analysis was performed by making inferences from the posterior distributions of main effects and interactions (Vasishth et al., 2018).

RESULTS

Overall distributions of /l/ by child

The initial analysis of the overall distributions revealed high inter-child variability: the percentage of coda laterals that were produced as clear [l] by each child ranged widely, from 0% (Mi19 and M2) to 100% (M17), and phonological environment as a linguistic constraint did not apply to all children in the same way. The distribution of realisations by phonological environment for each child is presented in Figure 2, arranged in increasing order of overall percentage of clear [l]. A visual inspection of the figure revealed that overall, for most children, prepausal coda laterals were more likely to be clear [l] than preconsonantal coda laterals, which by contrast were more likely to be l-less. It also appears that M11, M21, Mi1 and M17 had (nearly) categorically produced coda clear [l] regardless of phonological contexts. In contrast, for Mi23, Mi16, M8, Mi9 and M16, coda clear [l] only occurred in prepausal contexts (note that M8 produced one coda clear [l] in a preconsonantal context).

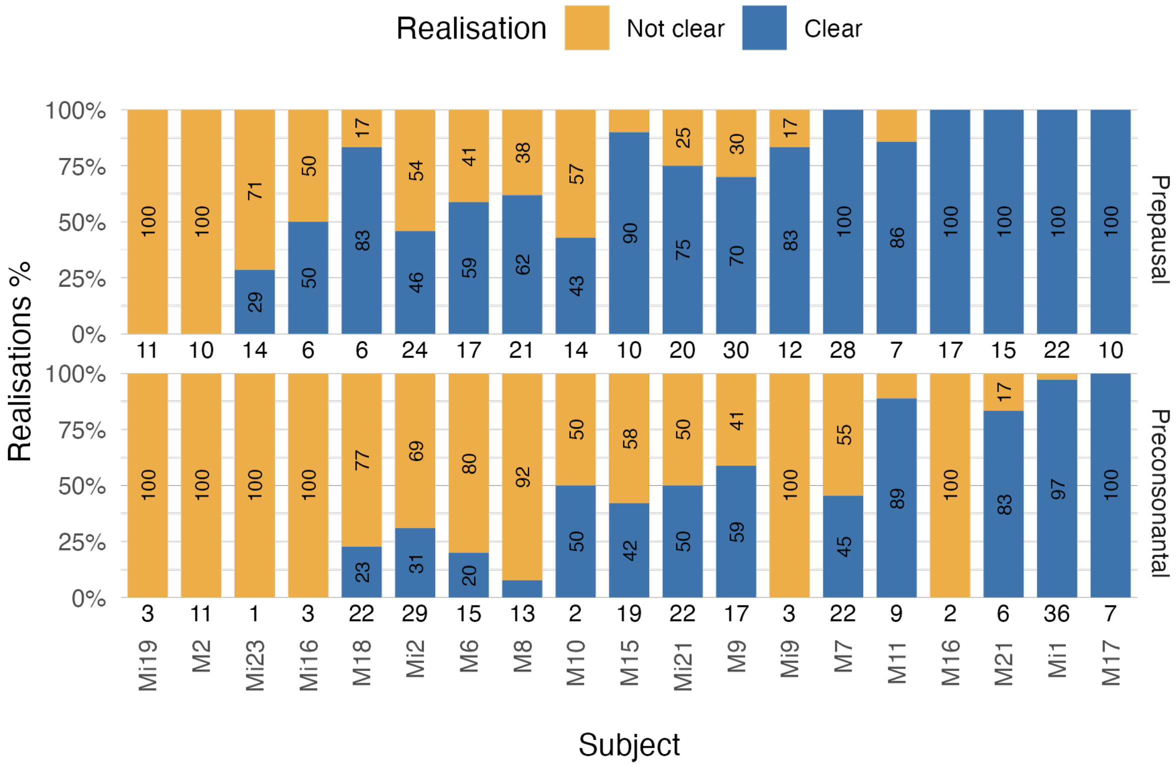

Figure 2. Distributions of realisations of coda /l/ of each child by phonological environment, ordered from left to right by increasing overall percentage of clear [l] produced. Percentages in the main plot are rounded to the nearest percent and only percentages above 15% are shown. Number below each bar refers to the total number of coda /l/ tokens in the phonological environment for each child.

The data of Mi19 and M2 were further analysed to ascertain whether the two children's categorically l-less production could be due to their ambient speech (that is, caregivers who were also categorically l-less) and/or developmental. In the exploratory analysis of the child-directed speech in the caregiver-child interactions described above, mothers of Mi19 and M2 produced mostly l-less or dark [ɫ], while fathers produced perceivably clear tokens more frequently. These patterns are consistent with the production of other English-Malay bilingual caregivers in the corpus (Sim, 2022b). This suggests that Mi19 and M2 were exposed to clear [l] in their overall English input, albeit to varying degrees; ambient speech therefore cannot fully account for the categorical l-lessness of these two children. The onset and ambisyllabic laterals of these two children were subsequently analysed to ascertain if the absence of coda alveolar laterals was developmental. It was revealed that, despite being 4;4 and only slightly younger than the median age of the sample population, M2 was consistently unable to produce onset and ambisyllabic alveolar laterals in the interactions with her caregivers, and these laterals were typically replaced by glides (*like* [waɪk̚]; *ladder* [wɛdʒ]), rhotics (*climb* [kraɪmb]; *lift* [rif]) or deleted (*close* [kus][kos]; police [puis]). The categorical l-lessness in the coda laterals of child M2, in this case, could indeed be developmental (Lin & Demuth, 2015). By contrast, Mi19 (age = 3;4) was able to produce onset and ambisyllabic alveolar laterals consistently and accurately. While the absence of coda clear [l] in Mi19 could be due to her young age, it is worth noting that children in this study who were younger (i.e., Mi9, M9, M10) had already started producing clear [l].

Categorisation

Categorisation by hierarchical clustering

Agglomerative hierarchical clustering was performed using the *hclust* function of R's *stats* package (R Core Team, 2022) to determine if the children could be grouped based on how distant they are to each other in their production patterns and social attributes. The technique starts by considering each child as a separate cluster and bigger clusters are formed in a hierarchical fashion based on the similarity distance between children. M2 was excluded from this analysis due to his developing laterals, and Mi16 was excluded for missing information about her peer group. The variables that were used in the classification were: the proportion of clear [l] produced by each child by phonological environment (i.e., one value each for prepausal laterals and preconsonantal laterals), age, amount of use of Malay, gender, peer group, and preschool type. Continuous variables were scaled. Given the combination of numerical and categorical data, proximity matrix was calculated using Gower's distance. Hierarchical clustering was subsequently performed using Ward's method (ward.D2). Three clusters were identified, and the number of clusters were confirmed by bootstrapping using *clusterboot* function (Hennig, 2023) to be adequate and stable (average Jaccard > 0.80; division by four and six clusters resulted in considerable instability in some clusters). The dendrogram output, with rectangles that identify the three clusters, is shown in Figure 3. Initial analysis revealed that cluster A consists of children who had mixed peer group, while clusters B and C consist of those who had Malay-only close friends, but those in cluster B were less likely to produce clear [l] or that they only produced clear [l] in prepausal contexts.

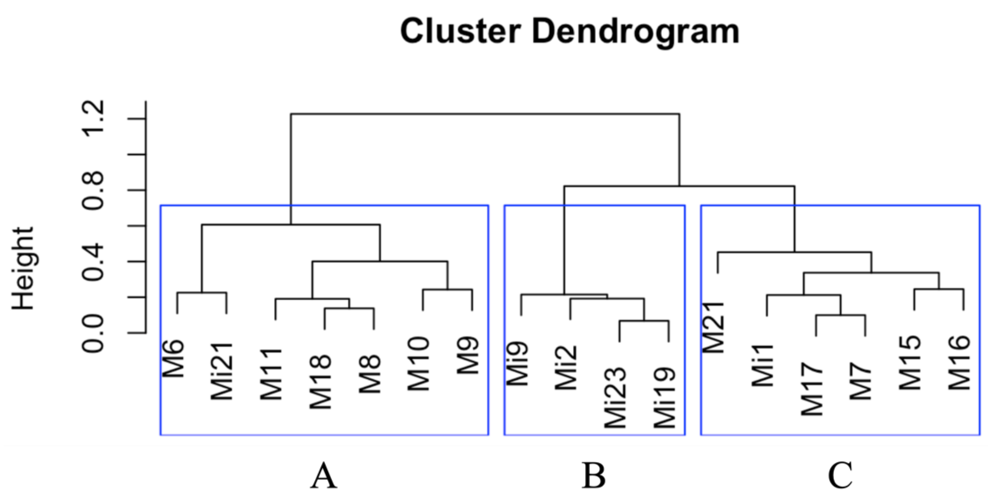

Figure 3. Dendrogram derived from agglomerative hierarchical clustering using Ward's method (ward.D2). Rectangles indicate three clusters (A, B, C) that were identified.

Categorisation by production patterns based on lexical items

To consider lexical effects and other phonological contexts not accounted for in the clustering that could influence clear [l] production, the distribution of realisations of /l/ of each child by lexical item was manually analysed (see Appendix A). Based on their production patterns by lexical item, children could be classified in four main groups. The first three groups (A, B, C) from this analysis closely reflect the clusters with the same labels in the dendrogram (Figure 3), but with some deviations in their members. Some children were placed in a fourth group (D), as their production patterns could be somewhat explained by a phonological context that was not considered in the clustering analysis. Interestingly, out of six members in group A whose production patterns were more variable and unpredictable, five belonged to mixed peer groups, i.e., children who had at least one Chinese close peer.

A. Highly variable production that seems to be unpredictable; the same lexical items may be variably clear and l-less (M6, Mi21, M8, M10, M9, Mi2)
B. The youngest children in the sample (Mi9, Mi23, Mi16) who only produced clear [l] in prepausal contexts and not in preconsonantal contexts.
C. (Very nearly) categorically clear or l-less overall (l-less: Mi19, M2; clear: M21, Mi1, M17, M11, M16).
D. Preconsonantal laterals or those in coda clusters (a factor not considered in the clustering analysis) were typically l-less (M15, M7, M18)

In summary, overall distributions in the production of coda clear [l] revealed very high inter-child variability. Subsequent analyses that aimed to categorise the children based on how similar they are in terms of their production patterns and social factors revealed that peer group, age, and phonological contexts may be more predictive of the children's variable production than other factors that were also considered.

Bayesian analysis

To explore the extent to which the observed variation could be predicted by language-external factors, Bayesian linear mixed-effects models were fitted with a Bernoulli distribution to the data with a binary response (clear [l], or not). The data of child M2 were also excluded from this analysis as his laterals were likely to be still developing. The fixed effects included phonological environment (contrasts weights: prepausal = -0.81, preconsonantal = 1), peer group (Malay = -0.74, mix = 1), preschool (Malay = -0.49, mix = 1), gender (male = -0.72, female = 1), age, amount of use of Malay, and the two-way interactions between peer*phonological environment and age*phonological environment. Random effects included random intercepts for speaker and word, and by-speaker slopes for phonological environment.

The posterior distributions overlaid with 50% (shaded area) and 95% credible intervals (curved lines) is shown in Figure 4: these are the ranges over which we can be 50% and 95% certain that the true values of the parameter lie, given the data. The posterior distribution for phonological environment shows an entirely negative distribution (99.79% values below zero), which suggests good evidence that across children, prepausal coda laterals are more likely than average to be clear [l], b = -0.98 [-1.61, -0.37]. There is a tendency for those with Malay-only close peers to produce more clear [l] than average, but that only 80.59% of values fall below zero and the wide interval indicates that there is a high degree of uncertainty about this effect, *b* = -0.50 [-1.65, 0.68]. The distribution of preschool is very wide and centred close to zero with a slightly negative shift (52.22% of values below zero), suggesting that those who attended Malay preschools were not distinct from the average in their clear [l] production, *b* = -0.04 [-1.42, -1.31]. Older children show a tendency to produce more clear [l] (90.53% of values above zero), but the wide distribution and values that cross zero suggest that the effects of age remain uncertain, *b* = 0.65 [-0.33, 1.66]. Those who used more Malay were more likely to produce clear [l], but since only 77.53% of values fall above zero, there is also high uncertainty about this effect, *b* = 0.40 [-0.66, 1.45]. The posterior distribution of gender showed that 87.29% of values below zero, *b* = -0.73 [-1.96, 0.53], which suggests that males were more likely than average to produce clear [l], but the very wide interval and values that cross zero again suggest high uncertainty.

The peer*phonological environment interaction shows that 87.01% of values were above zero, *b* = 0.36 [-0.30, 1.05]. Analysis of marginal effects and pairwise comparisons revealed that those with Malay-only close peers produced more prepausal clear [l] than those with mixed close friends, *b* = -1.39 [-3.52, 0.93], but only marginally more for preconsonantal clear [l], *b* = -0.26 [-2.61, 2.08]. The wide intervals and values that cross zero suggest some uncertainty about this effect. Finally, the age*phonological environment interaction is skewed towards negative values, with 91.74% values below zero, *b* = -0.43 [-1.06, 0.20]. The marginal effects reveal that much younger children begin by producing equally few prepausal and preconsonantal clear [l]. As age increases, the likelihood of prepausal laterals produced as clear [l] increases at a greater degree than preconsonantal laterals, which only increases marginally across age. There is reasonable uncertainty about this effect, given the values that cross zero.

In summary, the Bayesian model shows certainty in the effects of phonological environment; prepausal laterals were more likely than average to be clear [l]. The main effects of peers, preschool, age, and amount of Malay use were weak and highly uncertain. Interaction effects revealed that, with some uncertainty, those with Malay-only peers were more likely than average to produce clear [l], but only for prepausal laterals. The interaction between age and phonological environment also revealed with some uncertainty that much younger children produced equally few prepausal and preconsonantal clear [l], and as age increases, the likelihood of prepausal clear [l] increases much more than preconsonantal clear [l].

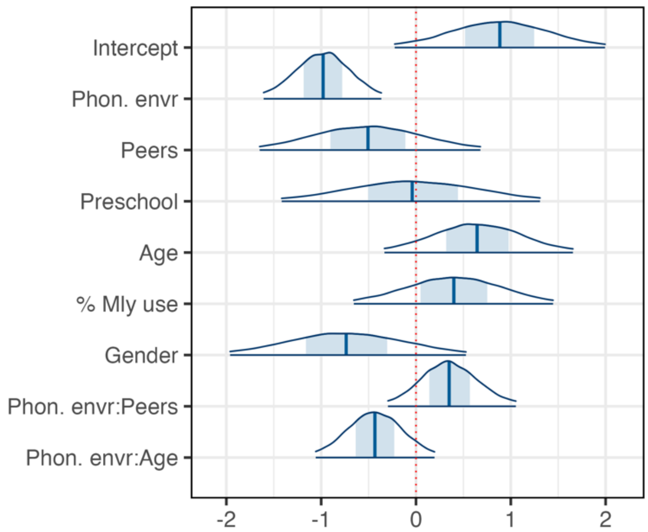

Figure 4. Posterior distributions of the parameters for the Bayesian logistic model investigating the effects of social factors on coda clear [l] production. Each distribution shows the 95% Bayesian credible interval (curved line), 50% posterior probability distribution (shaded area) and the posterior mean (solid vertical line). Syntax: brm(formula = 1 + realisation ~ Phon_envr + peer + preschool + age + mly_use + gender + peer*Phon_envr + age*Phon_envr + (1+Phon_envr|subject) + (1|word).

Discussion

The primary aim of this study is to understand the extent and nature of variability in the production of preschoolers exposed to highly variable input. We first explored the individual differences in the spontaneous production of English coda laterals among 19 English-Malay bilingual preschoolers raised in multi-accent Singapore, before we ask whether the observed between- and within-child variation is in any way systematic or predictable.

Individual variation

To remind the reader, in casual speech, the English coda laterals of English-Malay early bilingual caregivers in Singapore are variably clear [l] and l-less, and preconsonantal laterals are more likely to be l-less than prepausal laterals (Sim, 2022b). Our Bayesian model revealed the same effect of phonological environment on the *overall* production of coda laterals in children. However, a detailed analysis at the lexical level revealed that while some children conform to this pattern, others do not. Notably, when examining individual patterns, a significant inter-child variability emerged in the percentages of English coda laterals produced as clear [l], with values ranging from 26.7% to 100%; two did not produce any /l/ at all, i.e., they were categorically l-less. In addition, the linguistic constraint of phonological environment did not apply to all children equally; some consistently produced clear [l] in more than 80% of instances, irrespective of phonological context, while a few others predominantly produced coda [l] in prepausal contexts. Despite the high variability, which is perhaps expected of spontaneous speech data, subsequent analyses involving individual lexical items, hierarchical clustering, and Bayesian modelling revealed some systematicity and predictability in the inter- and intra-child variation. We discuss these patterns below.

Age and developmental trajectory

In our Bayesian analysis and examination of individual lexical items produced by each child, we found expected age effects. Three youngest children who did produce clear [l]— Mi9 (3;1), Mi23 (3;6) and Mi16 (2;3)—seemed to produce clear [l] exclusively in the prepausal position, and even then, not all instances of prepausal /l/ were consistently produced. Interestingly, preconsonantal /l/, whether in a consonant cluster or as word-final /l/ preceding the onset of the subsequent word, was consistently avoided. Consistent l-lessness in preconsonantal /l/ could be developmental, given that these children only begin to produce clusters at around two years, and the clusters may be inaccurate or unstable (En et al., 2014; McLeod et al., 2001). It could also be due to their input: these children are more likely to encounter prepausal /l/ in their linguistic environment, as it is less prone to being l-less compared to preconsonantal /l/. The saliency of coda clear [l] could also play a role, both acoustically because of the vowel-to-consonant transition and in terms of duration owing to boundary effects. Preconsonantal /l/, on the other hand, might be shorter in duration and more susceptible to articulatory undershoot, being in a consonant cluster.

Categorical (non)-producers of clear [l]

Two children, Mi19 and M2, did not produce any clear [l] at all, despite exposure to English coda clear [l] in caregiver input. Additional analyses revealed that M2 consistently substituted onset and ambisyllabic laterals with glides, rhotics, or omitted them altogether, indicating that M2's categorical l-lessness likely stemmed from developmental factors. In contrast, M11, M16, M21, Mi1 and M17 exhibited (nearly) categorical production of clear [l], at between 87.5%–100% of all their coda laterals. In addition, these children also produced clear [l] for words that were found to be typically l-less in adult norms (e.g. *middle, milk, wolf, selfie*) and also in their caregivers' production (Sim, 2021, 2022b), which suggests that the children could have overgeneralised the phonetic form to orthographic <l>. That these children did not reproduce the irregularity in the input suggests that they could have regularised the input, by producing only coda clear [l] or, in the case of Mi19, none at all. This aligns with studies who have also found disparity between variable input and high regularity in production (Habib, 2017; Smith et al., 2007, 2013), supporting previous work on statistical learning of inconsistent input (Austin et al., 2021; Hudson Kam & Newport, 2005, 2009). A question emerges as to why certain children imposed regularity in their production but others did not, despite exposure to similar variability in the input. Unfortunately, none of the social factors considered in this present study could provide any conclusive insights, and any speculative conclusions are constrained by lack of comparable data across children.

Peer effects

We sought patterns in variability by first employing agglomerative hierarchical clustering, which built clusters based on how similar the children were to each other in their production patterns and social attributes. The analysis identified two higher-level clusters based on peer group. Bayesian analysis revealed that those with Malay-only close peers were more likely than average to produce clear [l] for prepausal laterals, although there was considerable uncertainty in this effect. This uncertainty is not surprising, considering the substantial variation in production observed among children with Malay-only close friends: children in this group ranged from those who were categorically l-less, to those who only produced clear [l] in prepausal contexts, and others who produced clear [l] categorically. This underscores the challenges inherent in using regression modelling to capture nuanced intra-group variations. Subsequent analysis of production patterns by lexical items revealed a subgroup of six children characterised by observably higher variability and unpredictability in their production of coda /l/ compared to other children, to an extent that some lexical items within the same phonological context could be variably l-less or clear. Interestingly, consistent with the findings of the clustering analysis, five of six children in this subgroup had at least one Chinese close peer. In our previous work (Sim & Post, 2023) where we analysed the controlled speech of Malay preschoolers, 14 of whom are participants in the present study, we identified similar peer effects: those who had at least one Chinese peer were more likely to be l-less in their coda laterals than those with only Malay close friends. The analyses conducted in the present study further substantiate that these peer effects are not attributable to differences in attention to speech or speech style.

These findings prompt several questions. If these peer effects are indeed present, why and how does exposure to the categorically l-less model of Chinese peers lead to considerably higher variability in the production of coda /l/? Which lexical items are more resistant to changes to their phonological representations, and why? In an initial exploration of these questions, we conducted a by-lexical item analysis of the production of the five children—M6, Mi21, M8, M10 and M9—who had notably variable production patterns and Chinese peers. We found that *ball, girl, small, circle, all* were predominantly produced with clear [l], whereas words such as *triangle, uncle, cereal, turtle, will, people, crocodile* and especially *children* and *snail* were more likely to be l-less. This lexical divergence does not appear to be attributable to differences in caregiver input, since in their casual child-directed speech (Sim, 2021, 2022b), caregivers did not produce substantially more clear [l] in the former five words (77%, n=48) than the others (60%, n=30). Interestingly, the five words that were predominantly produced with clear [l] by most children are also likely to be encountered earlier and more frequently in the input than those words whose production was more variable across children.

Modelling variable outcomes

One of the goals of child language research is to construct a developmental theory or model that can account for the variability and complexity of language outcomes (Hambly et al., 2013; Kehoe & Havy, 2019; Lleó & Cortés, 2013; Sim, 2022b). This goal is made especially challenging due to the inherent unpredictability of these outcomes particularly when acquisition occurs in diverse, multilingual contexts, as demonstrated by this study. In concluding this paper, we explore how our findings might be interpreted within the two dominant frameworks of early phonological acquisition: constructivist, emergentist or usage-based models, and generativist approaches. The central theoretical concern of generativist approaches is in language universals and therefore language acquisition is often minimised to (variable) rules and (weighted) constraints (see Coetzee & Pater, 2011). By contrast, usage-based approaches are maximalist in nature as linguistic knowledge is assumed to be derived 'bottom-up' through experiences and usage events with the input (see Vihman & Keren-Portnoy, 2013). Acquisition in this perspective occurs through learning of surface forms of lexical items or exemplars for the same word (Docherty & Foulkes, 2014; Foulkes & Docherty, 2006; Nardy et al., 2013). While we ask how these approaches might account for the variability in production observed in our data, we do not advocate for one approach over the other. The data presented here is insufficient to definitively support either, and no specific hypothesis was tested, as this was not the aim of the study. Nonetheless, as we show below, it would seem that individual variability due to non-linguistic factors can be accounted for in both approaches, but the question remains to what extent variable realisations of coda /l/ *within* children can be satisfactorily captured.

Our findings indicate that while prepausal /l/ production increases consistently with age, many older children in this study still struggled with preconsonantal /l/. Both constructivist and generativist approaches readily account for age-related effects. From a constructivist perspective, the higher frequency and saliency of prepausal /l/ in the input as previously described could lead to stronger and more stable representations, making it more likely to be produced, while the less frequent preconsonantal /l/ may take longer to emerge or stabilise (Ellis et al., 2015). From a generativist viewpoint, age-related individual patterning is seen to reflect the evolving stability of the child's phonological representations as their phonological grammar develops over time. In an Optimality Theoretic (OT) model (Tesar & Smolensky, 2000; Prince & Smolensky, 2004), for example, a child's output is determined by a set of ranked constraints, which dictate the optimal production of a word. Differences between child and adult forms arise because children have not yet fully reranked Markedness constraints (which discourage complex structures) over Faithfulness constraints (which dictate that output should be as similar to the input as possible). This will vary from child to child, since it depends on their individual maturation as well as evidence for the presence of such features in the language variety that they are exposed to.[1]

Both theoretical perspectives also explain the observed categorical (non) production of clear [l] that deviates from adult norms. In OT, overgeneralisations resulting in the categorical absence or presence of features can straightforwardly be accounted for by the

---

[1] More specifically, in the adult grammar, coda /l/ surfaces when Faithfulness constraints like *Max* (enforcing elements, thus militating against deletion) dominate Markedness constraints like **Coda* (prohibits syllables with codas) and **Complex* (prohibits phonologically complex structures like consonant clusters and secondary features like velarisation in dark /l/). As discussed, the Malay-English caregivers' /l/ was typically clear, and vocalised/deleted before consonants (Sim, 2021), an outcome that obtains if **Complex* crucially outranks *Max*, which in turn crucially outranks **Coda*. Moreover, in order to distinguish between candidates with coda /l/ and vocalised/deleted /l/ in pre-consonantal (Pre-C) and/or pre-pausal (Pre-P) position, structure-preserving Faithfulness constraints such as *Max-Pre-P* and *Max-Pre-C* would need to be brought into play as well. In the developing child, *Max* would initially dominate the constraint hierarchy, blocking the emergence of /l/ in any and all contexts, but it would gradually be demoted when the child encounters instances of coda /l/.

ranking of constraints[2]. In a usage-based account (Bybee, 2001), the child would pick up on the regularities of the input and make (over)generalisations driven by, for instance, type-statistical learning creating more or less well-defined templates (Pierrehumbert, 2003; e.g., Vihman & Croft, 2007; Vihman & Velleman [1989] for the emergence of word templates). In the early stages, this could be supported, among other things, by vocal motor schemes (VMSs) which aid the infant in producing 'consistent phonetic forms [through] a formalized pattern of motor activity that does not require heavy cognitive resources to enact' (McCune & Vihman, 2001, p. 152).

Besides variability that occurs *between* individuals, we observed variability in patterning *within* individuals, in caregivers as well as their children. For instance, gender and speaking style played a role in the likelihood that coda /l/ was velarised or vocalised/deleted by the Malay-English caregivers. While a usage-based account would predict such effects since primacy of non-grammatical factors over grammatical factors is possible (Bybee, 2001; Pierrehumbert, 2003), generativist approaches have assumed certain rules can be optional (Labov's [1969] 'variable rules', see also Vaux, 2008) or in OT, that constraints can sometimes be partially ranked (Anttila, 1997) or that they are weighted probabilistically (Boersma, 1998). As Antilla argues '[t]he most straightforward way of dealing with non-phonological factors in an optimality-theoretic analysis is to include them in the grammar as so many constraints' (2007: 91), but they could also be modelled as acting independently on the output of a linguistically determined constraint hierarchy.

Finally, we observed lexical-specific effects: Malay children with Chinese close peers were more variable in their production of clear [l], to an extent that some lexical items within the same phonological context could be variably l-less or clear. While these children were more likely to produce l-less forms overall, words that are likely to be encountered earlier and more frequently appear to be more 'resistant' to changes to their phonological representations than more complex, less frequent words. An exemplar-based account could explain these idiosyncratic, word-specific effects as straightforwardly as the phonologically conditioned and non-linguistic effects discussed so far (K. Johnson, 2007; Pierrehumbert, 2016). Since instead of an abstract underlying form, lexical items are defined as probability distributions over phonetically detailed exemplars, probabilities for different contexts (both linguistically and non-linguistically determined) can interact directly with those lexical distributions. Any words that are more 'resistant' to variability are encountered more frequently due to higher frequency and earlier acquisition, and these words have denser probability distributions resulting in 'stronger' and more precise lexical representations, so that more alternative exemplars are required to exact changes to their probability distributions, i.e., their representations. Words that are less frequently encountered, such as more complex words, by contrast, may have weaker, less defined representations in these children, and so may be produced more variably in the increasing exposure to contrasting language models. By contrast, such lexical effects would appear to be problematic for generativist theories in

---

[2] In the case of absence of features, markedness blocks /l/ across the board (M2) or it trumps Faithfulness in specific conditions (e.g., phonologically conditioned clear /l/ for Mi19). This is assumed to reflect earlier stages in development, as mentioned above. When by contrast, a feature is categorically present (coda clear [l], here), Faithfulness trumps the Markedness constraints ensuring coda /l/ can surface, while the Markedness constraint that affects velarisation blocks it from surfacing as dark [ɫ].

which the variable application of phonological processes cannot be affected directly by the lexicon. A viable alternative may be to index the relevant Faithfulness constraints to individual lexical items, with their own probabilities attached, as proposed by Pater (2000) to account for the variable realisation of English secondary stress (see also Coetzee & Pater, 2011).

CONCLUSION

By examining both the individual differences and group behaviours in the production of English laterals by English-Malay bilingual preschoolers raised in multi-accent Singapore, we found that, despite the wide-ranging outcomes in acquisition that are typical of children in such contexts, the variation between and within children was largely systematic. Consistent with previous studies, we also found that children exposed to competing language models through peers were more inconsistent and unpredictable in their production, which suggests a restructuring of or instability in their phonological representations. We further explored how these findings might be explained by existing usage-based and rule/constraints-based approaches. While both frameworks accounted for most of our observations, word-specific effects that we identified were more effectively captured by usage-based models. Overall, the findings of this study underscore the complexity of language acquisition in diverse settings that involve variable input and competing language models, highlighting the complex interplay of developmental, social, and linguistic factors in early phonological acquisition in such contexts.

APPENDIX

Appendix A: Distribution of realisations of coda laterals by lexical item across children, categorised by phonological environment (PC = preconsonantal; PP: prepausal), and ordered from top to bottom by increasing overall percentage of clear [l] produced. Numbers in brackets refer to frequency. X = no tokens.

Child	Realisation	Words and phonological environment
Mi19	Clear (0)	PC: X PP: X
	Not clear (14)	PC: people (1) sprinkle (1) sprinkles (1) PP: ball (5) crocodile (2) snail (2) table (1) turtle (1)
M2	Clear (0)	PC: X PP: X
	Not clear (21)	PC: all (1) bell (1) call (1) children (1) crocodile (2) people (1) peoples (1) school (1) vegetables (1) wheel (1) PP: ball (1) bell (1) jail (1) people (2) school (2) shell (1) uncle (1) wheel (1)
Mi23	Clear (4)	PC: X PP: ball (1) circle (1) crocodile (1) puzzle (1)
	Not clear (11)	PC: children (1) PP: ball (1) circle (2) oval (1) people (1) purple (1) shell (1) snail (2) turtle (1)
Mi16	Clear (3)	PC: X

		PP: ball (1) circle (1) people (1)
	Not clear (6)	PC: circles (1) turtles (2) PP: crocodile (1) purple (1) shell (1)
M18	Clear (10)	PC: all (2) ball (1) falls (1) feel (1) PP: girl (1) jungle (1) school (1) snail (1) uncle (1)
	Not clear (18)	PC: child (3) children (5) crocodiles (1) itself (1) melts (2) pebbles (1) shelter (1) uncle (1) vegetable (1) wolves (1) PP: people (1)
Mi2	Clear (20)	PC: Ariel (1) cereal (1) curl (3) fill (1) hold (1) small (1) uncle (1) PP: Ariel (1) apple (1) ball (2) hole (1) people (2) petal (1) purple (1) snail (1) tickle (1)
	Not clear (33)	PC: Ariel (1) Ariel’s (1) always (1) cereal (1) children (2) curl (2) petals (1) shoulder (2) shoulders (2) snail (2) still (1) style (1) turtle (2) vegetables (1) PP: Ariel (2) animal (2) crocodile (2) curl (2) people (1) petal (2) shell (1) turtle (1)
M6	Clear (13)	PC: all (1) tail (1) uncle (1) PP: circle (4) crocodile (1) small (1) still (1) turtle (1) uncle (1) waddle (1)
	Not clear (19)	PC: I’ll (1) circles (2) people (2) triangles (2) turtle (1) vegetables (1) will (2) wills (1) PP: circle (2), tail (1) they’ll (1) triangle (2) will (1)
M8	Clear (14)	PC: cereal (1) PP: all (1) ball (4) crocodile (1) football (1) girl (1) purple (1) small (1) triangle (2) turtle (1)
	Not clear (20)	PC: all (3) beautiful (1) cereal (1) children (2) circles (1) shells (1) tails (1) triangle (1) uncle (1) PP: crocodile (1) girl (1) people (1) shell (1) snail (2) uncle (2)
M10	Clear (7)	PC: careful (1) PP: careful (3) purple (2) uncle (1)
	Not clear (9)	PC: bowl (1) PP: cold (1) crocodile (5) snail (1) turtle (1)
M15	Clear (17)	PC: all (5) call (1) shield (1) will (1) PP: all (2) ball (1) people (3) purple (1) tail (2)
	Not clear (12)	PC: almost (1) called (2) crocodile (2) he’ll (1) help (2) people (1) twelve (2) PP: people (1)
Mi21	Clear (26)	PC: circle (1) crocodile (1) fold (1) heel (1) hold (1) people (1) real (1) small (1) triangle (1) will (2) PP: ball (1) cereal (1) circle (5) girl (4) people (1) purple (1) small (1) twirl (1)
	Not clear (16)	PC: ball (1) children (2) crocodile (1) hold (1) people (1) shell (1) small (1) snail (2) whole (1) PP: ball (1) bowl (1) crocodile (1) shell (1) turtle (1)
M9	Clear (31)	PC: all (1) call (1) girl (2) hold (1) pretzel (1) Rapunzel (3) scolded (1) PP: (pret)zel (1) (tur)tle (1) all (4) ball (10) Rapunzel (2) rule (2) vegetable (1)
	Not clear (16)	PC: child (1) children (3) help (2) yelled (1) PP: bowl (1) cereal (2) circle (1) crocodile (1) pretzel (2) snail (2)
Mi9	Clear (10)	PC: X PP: ball (1) bowl (1) circle (1) crocodile (1) people (2) shell (2) snail (1) turtle (1)
	Not clear (5)	PC: cereal (1) children (2)

		PP: cereal (2)
M7	Clear (38)	PC: all (1) animal (1) call (1) small (1) turtle (1) we'll (1) wheel (4) PP: all (2) ball (3) bowl (1) cereal (1) circle (1) crocodile (1) girl (2) people (2) purple (1) shell (1) small (2) snail (1) tail (1) turtle (2) uncle (3) well (2) wheel (2)
	Not clear (12)	PC: all (1) animal (1) call (1) children (1) girl (1) purple (1) still (1) twelve (1) uncle (4) PP: X
M11	Clear (14)	PC: circle (1) Deadpool (2) shelters (1) shield (3) snail (1) PP: ball (2) crocodile (1) Deadpool (1) shell (1) snail (1)
	Not clear (2)	PC: children (1) PP: crocodile (1)
M16	Clear (17)	PC: X PP: ball (3) cereal (1) crocodile (2) owl (1) people (3) shell (2) small (1) snail (1) turtle (2) whale (1)
	Not clear (2)	PC: children (2) PP: X
M21	Clear (20)	PC: alphabet (1) Elsa (1) hold (1) turtle (1) vegetables (1) PP: apple (1) ball (2) eagle (1) girl (2) pencil (2) people (1) puzzle (1) shell (1) snail (1) tickle (1) turtle (2)
	Not clear (1)	PC: children (1) PP: X
Mi1	Clear (57)	PC: all (12) animals (9) hold (2) people (2) peoples (2) puzzles (1) still (1) tickle (1) turtle (1) turtles (1) wild (1) wonderful (1) world (1) PP: ball (9) crocodile (2) people (2) puzzle (2) shell (1) snail (1) triangle (1) turtle (1) uncle (3)
	Not clear (1)	PC: animals (1) PP: X
M17	Clear (17)	PC: all (2) male (1) purple (1) shell (1) shells (1) told (1) PP: ball (2) colourful (1) male (2) purple (1) shell (2) snail (1) turtle (1)
	Not clear (0)	PC: X PP: X

ACKNOWLEDGEMENTS

We would like to thank the participants of Building Linguistic Systems Conference 2022 whose insightful comments and questions contributed to the research questions of this paper. Earlier versions of this article were presented at the 16th International Congress for the Study of Child Language. We would like to thank all the families who participated in the study, as well as Emily Lau and Mohamed Zaheer for their help on this project.

AUTHOR CONTRIBUTIONS

Jasper Hong Sim: Conceptualisation and design (lead), data collection, formal analysis and interpretation of results, original draft (lead), review and editing (equal)

Brechtje Post: Conceptualisation and design, interpretation of results, original draft, review and editing (equal)

Statement and declarations

The authors declare none.

Ethical considerations

The Ethics Committee for the School of the Humanities and Social Sciences, University of Cambridge reviewed and approved the research protocol (19/199).

Consent to participate

Written participant consent was obtained prior to the commencement of data collection.

Consent for publication

Not applicable.

Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding statement

This work was supported by fieldwork grants from the Faculty of Modern and Medieval Languages and Linguistics, and Jesus College, University of Cambridge. The first author would also like to thank the National Institute of Education, Nanyang Technological University, Singapore for the fieldwork grants and PhD funding that made the study possible.

Data availability

As the corpus contains speech data of very young children, the parents were assured raw data would remain confidential and would not be shared.

References

Alsagoff, L. (2010). Hybridity in ways of speaking: The glocalization of English in Singapore. In L. Lim, A. Pakir, & L. Wee (Eds.), *English in Singapore: Modernity and management* (pp. 109–130). Hong Kong University Press.

Anttila, A. (1997). Deriving Variation from Grammar. In F. L. Hinskens, R. vanHout, & W. L. Wetzels (Eds.), *Current Issues in Linguistic Theory* (Vol. 146, p. 35). John Benjamins Publishing Company. https://doi.org/10.1075/cilt.146.04ant

Austin, A. C., Schuler, K. D., Furlong, S., & Newport, E. L. (2021). Learning a Language from Inconsistent Input: Regularization in Child and Adult Learners. *Language Learning and Development*, *0*(0), 1–29. https://doi.org/10.1080/15475441.2021.1954927

Barlow, J. A., Branson, P. E., & Nip, I. S. B. (2013). Phonetic equivalence in the acquisition of /l/ by Spanish–English bilingual children. *Bilingualism: Language and Cognition*, *16*(1), 68–85. https://doi.org/10.1017/S1366728912000235

Boersma, P. (1998). *Functional phonology: Formalizing the interactions between articulatory and perceptual drives*. Holland Academic Graphics.

Boersma, P., & Weenink, D. (2023). *Praat: Doing phonetics by computer* (Version 6.3.14) [Computer software]. http://www.praat.org/

Bürkner, P.-C. (2017). **brms**: An *R* Package for Bayesian Multilevel Models Using *Stan*. *Journal of Statistical Software*, *80*(1). https://doi.org/10.18637/jss.v080.i01

Bybee, J. L. (2001). *Phonology and Language Use*. Cambridge University Press. https://doi.org/10.1017/CBO9780511612886

Coetzee, A. W., & Pater, J. (2011). The Place of Variation in Phonological Theory. In J. Goldsmith, J. Riggle, & A. C. L. Yu (Eds.), *The Handbook of Phonological Theory* (1st ed., pp. 401–434). Wiley. https://doi.org/10.1002/9781444343069.ch13

Darlington, R. B., & Hayes, A. F. (2017). *Regression analysis and linear models: Concepts, applications, and implementation*. Guilford Press.

Department of Statistics (with Wong, W. K.). (2021). *Singapore Census of Population 2020, Statistical Release 1: Demographic Characteristics, Education, Language and Religion*. Singapore Dept. of Statistics. https://www.singstat.gov.sg/-/media/files/publications/cop2020/sr1/cop2020sr1.pdf

Deterding, D. (2007). The Vowels of the Different Ethnic Groups in Singapore. In D. Prescott, A. Kirkpatrick, I. Martin, & A. Hashim (Eds.), *English in Southeast Asia: Literacies, Literatures and Varieties* (pp. 2–29). Cambridge Scholars Press.

Docherty, G. J., & Foulkes, P. (2014). An evaluation of usage-based approaches to the modelling of sociophonetic variability. *Lingua*, *142*, 42–56. https://doi.org/10.1016/j.lingua.2013.01.011

Dodd, B., Holm, A., Hua, Z., & Crosbie, S. (2003). Phonological development: A normative study of British English-speaking children. *Clinical Linguistics & Phonetics*, *17*(8), 617–643. https://doi.org/10.1080/0269920031000111348

Durrant, S., Delle Luche, C., Cattani, A., & Floccia, C. (2015). Monodialectal and multidialectal infants' representation of familiar words. *Journal of Child Language*, *42*(02), 447–465. https://doi.org/10.1017/S0305000914000063

Ellis, N. C., O'Donnell, M. B., & Römer, U. (2015). Usage-Based Language Learning. In B. MacWhinney & W. O'Grady (Eds.), *The Handbook of Language Emergence* (pp. 163–180). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118346136.ch7

En, L. G. W., Brebner, C., & McCormack, P. (2014). A preliminary report on the English phonology of typically developing English-Mandarin bilingual preschool Singaporean children: English phonology of typically developing English-Mandarin Singaporean children. *International Journal of Language & Communication Disorders*, *49*(3), 317–332. https://doi.org/10.1111/1460-6984.12075

Fish, M. S., García-Sierra, A., Ramírez-Esparza, N., & Kuhl, P. K. (2017). Infant-directed speech in English and Spanish: Assessments of monolingual and bilingual caregiver VOT. *Journal of Phonetics*, *63*, 19–34. https://doi.org/10.1016/j.wocn.2017.04.003

Floccia, C., Butler, J., Girard, F., & Goslin, J. (2009). Categorization of regional and foreign accent in 5- to 7-year-old British children. *International Journal of Behavioral Development*, *33*(4), 366–375. https://doi.org/10.1177/0165025409103871

Foulkes, P., & Docherty, G. (2006). The social life of phonetics and phonology. *Journal of Phonetics*, *34*(4), 409–438. https://doi.org/10.1016/j.wocn.2005.08.002

Foulkes, P., & Hay, J. B. (2015). The Emergence of Sociophonetic Structure. In B. MacWhinney & W. O'Grady (Eds.), *The Handbook of Language Emergence* (pp. 292–313). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118346136.ch13

Habib, R. (2017). Parents and their children's variable language: Is it acquisition or more? *Journal of Child Language*, *44*(3), 628–649. https://doi.org/10.1017/S0305000916000155

Hall-Lew, L., & Fix, S. (2012). Perceptual coding reliability of (L)-vocalization in casual speech data. *Lingua*, *122*(7), 794–809. https://doi.org/10.1016/j.lingua.2011.12.005

Hambly, H., Wren, Y., McLeod, S., & Roulstone, S. (2013). The influence of bilingualism on speech production: A systematic review. *International Journal of Language & Communication Disorders*, *48*(1), 1–24. https://doi.org/10.1111/j.1460-6984.2012.00178.x

Hennig, C. (2023). *fpc: Flexible Procedures for Clustering* (Version 2.2-10) [Computer software]. https://CRAN.R-project.org/package=fpc

Hills, T. (2006). *Duck & Goose* (1st ed). Schwartz & Wade Books.

Hudson Kam, C. L., & Newport, E. L. (2005). Regularizing Unpredictable Variation: The Roles of Adult and Child Learners in Language Formation and Change. *Language Learning and Development*, *1*(2), 151–195. https://doi.org/10.1080/15475441.2005.9684215

Hudson Kam, C. L., & Newport, E. L. (2009). Getting it right by getting it wrong: When learners change languages. *Cognitive Psychology*, *59*(1), 30–66. https://doi.org/10.1016/j.cogpsych.2009.01.001

Johnson, E. K. (2018). Putting the terms "monolingual" and "bilingual" under the microscope. *Applied Psycholinguistics*, *39*(4), 753–756. https://doi.org/10.1017/S0142716418000206

Johnson, E. K., van Heugten, M., & Buckler, H. (2022). Navigating Accent Variation: A Developmental Perspective. *Annual Review of Linguistics*, *8*(1), 365–387. https://doi.org/10.1146/annurev-linguistics-032521-053717

Johnson, K. (2007). Decisions and mechanisms in exemplar-based phonology. In M.-J. Solé, P. S. Beddor, & M. Ohala (Eds.), *Experimental approaches to phonology* (pp. 25–40). Oxford University Press.

Kalaivanan, K., Sumartono, F., & Tan, Y.-Y. (2020). The Homogenization of ethnic differences in Singapore English? A consonantal production study. *Language and Speech*, *64*(1), 123–140. https://doi.org/10.1177/0023830920925510

Kalaivanan, K., Sumartono, F., & Tan, Y.-Y. (2022). Influence of age of acquisition, language proficiency and language use on Singapore English consonant perception. *Journal of Monolingual and Bilingual Speech*, *4*(1). https://doi.org/10.1558/jmbs.19174

Kartushina, N., & Mayor, J. (2023). Coping with dialects from birth: Role of variability on infants' early language development. Insights from Norwegian dialects. *Developmental Science*, *26*(1), e13264. https://doi.org/10.1111/desc.13264

Kartushina, N., Rosslund, A., & Mayor, J. (2021). Toddlers raised in multi-dialectal families learn words better in accented speech than those raised in monodialectal families. *Journal of Child Language*, 1–26. https://doi.org/10.1017/S0305000921000520

Kassim, A. M. (2008). Malay language as A foreign language and the Singapore's education system. *Gema Online Journal of Language Studies*, *8*(1). Publicly Available Content Database; Social Science Premium Collection. https://ezp.lib.cam.ac.uk/login?url=https://www.proquest.com/docview/2407362346?accountid=9851

Kehoe, M. (2015). Cross-linguistic interaction: A retrospective and prospective view. *Proceedings of the International Symposium on Monolingual and Bilingual Speech 2015*. International Symposium on Monolingual and Bilingual Speech.

Kehoe, M., & Havy, M. (2019). Bilingual phonological acquisition: The influence of language-internal, language-external, and lexical factors. *Journal of Child Language*, *46*(2), 292–333. https://doi.org/10.1017/S0305000918000478

Kerswill, P., & Williams, A. (2000). Creating a New Town koine: Children and language change in Milton Keynes. *Language in Society*, *29*(1), 65–115. https://doi.org/10.1017/S0047404500001020

Khattab, G. (2002). /L/ production in English-Arabic bilingual speakers. *International Journal of Bilingualism*, *6*(3), 335–353. https://doi.org/10.1177/13670069020060030701

Khattab, G. (2011). Acquisition of Lebanese Arabic and Yorkshire English /l/ by bilingual and monolingual children: A comparative spectrographic study. In Z. M. Hassan & B. Heselwood (Eds.), *Current Issues in Linguistic Theory* (Vol. 319, pp. 325–354). John Benjamins Publishing Company. https://doi.org/10.1075/cilt.319.15kha

Kirkham, S. (2017). Ethnicity and phonetic variation in Sheffield English liquids. *Journal of the International Phonetic Association*, *47*(1), 17–35. https://doi.org/10.1017/S0025100316000268

Kirkham, S., & McCarthy, K. M. (2021). Acquiring allophonic structure and phonetic detail in a bilingual community: The production of laterals by Sylheti-English bilingual children. *International Journal of Bilingualism*, *25*(3), 531–547. https://doi.org/10.1177/1367006920947180

Kirkham, S., Turton, D., & Leemann, A. (2020). A typology of laterals in twelve English dialects. *The Journal of the Acoustical Society of America*, *148*(1), EL72–EL76. https://doi.org/10.1121/10.0001587

Kutlu, E., Baxelbaum, K., Sorensen, E., Oleson, J., & McMurray, B. (2024). Linguistic diversity shapes flexible speech perception in school age children. *Scientific Reports*, *14*(1), 28825. https://doi.org/10.1038/s41598-024-80430-1

Kwek, G. (2015, September 3). *Rhotics in Singapore English: Variation between two ethnic groups*. UK Language Variation and Change, University of York, UK.

Kwek, G., & Low, E. (2021). Emergent features of young Singaporean speech: An investigatory study of the labiodental /r/ in Singapore English. *Asian Englishes*, *23*(2), 116–136. https://doi.org/10.1080/13488678.2020.1759249

Labov, W. (1969). Contraction, Deletion, and Inherent Variability of the English Copula. *Language*, *45*(4), 715. https://doi.org/10.2307/412333

Levy, H., Konieczny, L., & Hanulíková, A. (2019). Processing of unfamiliar accents in monolingual and bilingual children: Effects of type and amount of accent experience. *Journal of Child Language*, *46*(2), 368–392. https://doi.org/10.1017/S030500091800051X

Lim, L. (2000). Ethnic group differences aligned? Intonation patterns of Chinese, Indian and Malay Singaporean English. In A. Brown, D. Deterding, & E.-L. Low (Eds.), *The English Language in Singapore: Research on Pronunciation*. Singapore Association for Applied Linguistics.

Lin, S., & Demuth, K. (2015). Children's acquisition of English onset and coda /l/: Articulatory evidence. *Journal of Speech, Language, and Hearing Research : JSLHR*, *58*(1), 13–27. https://doi.org/10.1044/2014_JSLHR-S-14-0041

Lleó, C., & Cortés, S. (2013). Modeling the outcome of language contact in the speech of German-Spanish and Catalan-Spanish bilingual children. *International Journal of the Sociology of Language*, *2013*(221), 101–125. https://doi.org/10.1515/ijsl-2013-0025

Low, E. L., & Brown, A. (2005). *English in Singapore: An introduction*. McGraw-Hill.

Mathews, M., & Selvarajan, S. (2020). Malay ethnic identity and culture in multicultural Singapore. In Z. A. Rasheed, W. H. Zoohri, & N. Saat, *Beyond Bicentennial* (pp. 727–742). World Scientific. https://doi.org/10.1142/9789811212512_0044

Mayr, R., & Montanari, S. (2015). Cross-linguistic interaction in trilingual phonological development: The role of the input in the acquisition of the acquisition of voicing contrast. *Journal of Child Language*, *42*(5), 1006–1035. https://doi.org/10.1017/S0305000914000592

Mayr, R., & Siddika, A. (2018). Inter-generational transmission in a minority language setting: Stop consonant production by Bangladeshi heritage children and adults. *International Journal of Bilingualism*, *22*(3), 255–284. https://doi.org/10.1177/1367006916672590

McCarthy, K. M., Mahon, M., Rosen, S., & Evans, B. G. (2014). Speech Perception and Production by Sequential Bilingual Children: A Longitudinal Study of Voice Onset Time Acquisition. *Child Development*, *85*(5), 1965–1980. https://doi.org/10.1111/cdev.12275

McCune, L., & Vihman, M. M. (2001). Early Phonetic and Lexical Development: A Productivity Approach. *Journal of Speech, Language, and Hearing Research*, *44*(3), 670–684. https://doi.org/10.1044/1092-4388(2001/054)

McLeod, S., Doorn, J. V., & Reed, V. A. (2001). Normal Acquisition of Consonant Clusters. *American Journal of Speech-Language Pathology*, *10*(2), 99–110. https://doi.org/10.1044/1058-0360(2001/011)

Nardy, A., Chevrot, J.-P., & Barbu, S. (2013). The acquisition of sociolinguistic variation: Looking back and thinking ahead. *Linguistics*, *51*(2). https://doi.org/10.1515/ling-2013-0011

Nguyen, L. (2020). *Cross-generational linguistic variation in the Canberra Vietnamese heritage language community: A corpus-centred investigation* [Apollo - University of Cambridge Repository]. https://doi.org/10.17863/CAM.65721

Pater, J. (2000). Non-uniformity in English secondary stress: The role of ranked and lexically specific constraints. *Phonology*, *17*(2), 237–274. https://doi.org/10.1017/S0952675700003900

Pierrehumbert, J. B. (2003). Phonetic diversity, statistical learning, and acquisition of phonology. *Language and Speech*, *46*(2–3), 115–154. https://doi.org/10.1177/00238309030460020501

Pierrehumbert, J. B. (2016). Phonological Representation: Beyond Abstract Versus Episodic. *Annual Review of Linguistics*, *2*(1), 33–52. https://doi.org/10.1146/annurev-linguistics-030514-125050

Prince, A., & Smolensky, P. (2004). *Optimality Theory: Constraint Interaction in Generative Grammar* (1st ed.). Wiley. https://doi.org/10.1002/9780470759400

R Core Team. (2022). *R: A language and environment for statistical computing.* [Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/

Ramon-Casas, M., Cortés, S., Benet, A., Lleó, C., & Bosch, L. (2021). Connecting perception and production in early Catalan–Spanish bilingual children: Language dominance and quality of input effects. *Journal of Child Language*, 1–22. https://doi.org/10.1017/S0305000921000787

Scobbie, J. M., & Wrench, A. A. (2003). An articulatory investigation of word final /l/ and /l/-sandhi in three dialects of English. In M.-J. Solé, D. Recasens, & J. Romero (Eds.), *Proceedings of the 15th International Conference of Phonetic Sciences* (pp. 1871–1874). Universitat Autnoma de Barcelona. https://eresearch.qmu.ac.uk/handle/20.500.12289/2248

Sharma, D. (2011). Style repertoire and social change in British Asian English. *Journal of Sociolinguistics*, *15*(4), 464–492. https://doi.org/10.1111/j.1467-9841.2011.00503.x

Sim, J. H. (2015). *Language dominance and accent variation: A phonetic study of two groups of educated Malay speakers of Singapore English*. Unpublished MPhil Thesis, University of Cambridge.

Sim, J. H. (2019). “But you don’t sound Malay!”: Language dominance and variation in the accents of English-Malay bilinguals in Singapore. *English World-Wide*, *40*(1), 79–108. https://doi.org/10.1075/eww.00023.sim

Sim, J. H. (2021). Sociophonetic variation in English /l/ in the child-directed speech of English-Malay bilinguals. *Journal of Phonetics*, *88*, 101084. https://doi.org/10.1016/j.wocn.2021.101084

Sim, J. H. (2022a). Negotiating social meanings in a plural society: Social perceptions of variants of /l/ in Singapore English. *Language in Society*, 1–28. https://doi.org/10.1017/S0047404522000173

Sim, J. H. (2022b). *Phonological acquisition in a multidialectal and multicultural context: The case of bilingual preschoolers in Singapore* [Apollo - University of Cambridge Repository]. https://www.repository.cam.ac.uk/handle/1810/339069

Sim, J. H. (2023). Influence of bilingualism or caregiver input? Variation in VOT in simultaneous bilingual preschoolers in Singapore. In R. Skarnitzl & J. Volín (Eds.), *Proceedings of the 20th International Congress of Phonetic Sciences* (pp. 2344–2348). Guarant International.

Sim, J. H. (2024). Variation in VOT in English child-directed speech of English-Mandarin and English-Malay early bilinguals in Singapore. *Asian Englishes*, 1–17. https://doi.org/10.1080/13488678.2024.2391234

Sim, J. H., & Post, B. (2021a, Setember). *Clear /l/ and the Malays in Singapore: Origin, social meanings and ethnic identity*. UK Language Variation and Change 13, University of Glasgow.

Sim, J. H., & Post, B. (2021b). Variation in quality of maternal input and development of coda stops in English-speaking children in Singapore. *Journal of Child Language*, 1–26. https://doi.org/10.1017/S0305000921000593

Sim, J. H., & Post, B. (2021c, June 21). *Variation in pitch scaling in English of young simultaneous bilinguals in Singapore*. Phonetics and Phonology in Europe 2021, Barcelona.

Sim, J. H., & Post, B. (2023). Influence of caregiver input and language experience on the production of coda laterals by English–Malay bilingual preschoolers in multi-accent Singapore. *Journal of Child Language*, 1–26. https://doi.org/10.1017/S0305000923000375

Sim, J. H., & Post, B. (2024). Early phonological acquisition in multi-accent contexts. In E. Babatsouli (Ed.), *Multilingual Acquisition and Learning: An ecosystemic view to diversity* (pp. 192–215). John Benjamins Publishing Company.

Simonet, M. (2015). An acoustic study of coarticulatory resistance in “dark” and “light” alveolar laterals. *Journal of Phonetics*, *52*, 138–151. https://doi.org/10.1016/j.wocn.2015.07.006

Singleton, J. L., & Newport, E. L. (2004). When learners surpass their models: The acquisition of American Sign Language from inconsistent input. *Cognitive Psychology*, *49*(4), 370–407. https://doi.org/10.1016/j.cogpsych.2004.05.001

Smit, A. B., Hand, L., Freilinger, J. J., Bernthal, J. E., & Bird, A. (1990). The Iowa Articulation Norms Project and its Nebraska replication. *The Journal of Speech and Hearing Disorders*, *55*(4), 779–798.

Smith, J., Durham, M., & Fortune, L. (2007). “Mam, my trousers is fa’in doon!”: Community, caregiver, and child in the acquisition of variation in a Scottish dialect. *Language Variation and Change*, *19*(01). https://doi.org/10.1017/S0954394507070044

Smith, J., Durham, M., & Richards, H. (2013). The social and linguistic in the acquisition of sociolinguistic norms: Caregivers, children, and variation. *Linguistics*, *51*(2). https://doi.org/10.1515/ling-2013-0012

Smith, J., & Holmes-Elliott, S. (2022). Tracking linguistic change in childhood: Transmission, incrementation, and vernacular reorganization. *Language*, *98*(1), 98–122. https://doi.org/10.1353/lan.2021.0087

Sproat, R., & Fujimura, O. (1993). Allophonic variation in English /l/ and its implications for phonetic implementation. *Journal of Phonetics*, *21*(3), 291–311. https://doi.org/10.1016/S0095-4470(19)31340-3

Stanford, J. N. (2008). Child dialect acquisition: New perspectives on parent/peer influence. *Journal of Sociolinguistics*, *12*(5), 567–596. https://doi.org/10.1111/j.1467-9841.2008.00383.x

Starr, R. L., & Balasubramaniam, B. (2019). Variation and change in English /r/ among Tamil Indian Singaporeans. *World Englishes*, *38*(4), 630–643. https://doi.org/10.1111/weng.12357

Stoehr, A., Benders, T., van Hell, J. G., & Fikkert, P. (2019). Bilingual preschoolers' speech is associated with non-native maternal language input. *Language Learning and Development*, *15*(1), 75–100. Scopus. https://doi.org/10.1080/15475441.2018.1533473

Tan, K. K. (2005). Vocalisation of /l/ in Singapore English. In D. Deterding, A. Brown, & E. L. Low (Eds.), *English in Singapore: Phonetic Research on a Corpus*. McGraw Hill.

Tan, Y.-Y. (2012). To r or not to r: Social correlates of /ɹ/ in Singapore English. *International Journal of the Sociology of Language*, *2012*(218), 1–24. https://doi.org/10.1515/ijsl-2012-0057

te Grotenhuis, M., Pelzer, B., Eisinga, R., Nieuwenhuis, R., Schmidt-Catran, A., & Konig, R. (2017). When size matters: Advantages of weighted effect coding in observational studies. *International Journal of Public Health*, *62*(1), 163–167. https://doi.org/10.1007/s00038-016-0901-1

Tesar, B., & Smolensky, P. (2000). *Learnability in Optimality Theory*. The MIT Press. https://doi.org/10.7551/mitpress/4159.001.0001

Thomas, E. R. (2007). Phonological and phonetic characteristics of African American Vernacular English. *Language and Linguistics Compass*, *1*(5), 450–475. https://doi.org/10.1111/j.1749-818X.2007.00029.x

van Heugten, M., & Johnson, E. K. (2017). Input matters: Multi-accent language exposure affects word form recognition in infancy. *The Journal of the Acoustical Society of America*, *142*(2), EL196–EL200. https://doi.org/10.1121/1.4997604

Vasishth, S., Nicenboim, B., Beckman, M. E., Li, F., & Kong, E. J. (2018). Bayesian data analysis in the phonetic sciences: A tutorial introduction. *Journal of Phonetics*, *71*, 147–161. https://doi.org/10.1016/j.wocn.2018.07.008

Vaux, B. (2008). Why the Phonological Component must be Serial and Rule-Based 1. In B. Vaux & A. Nevins (Eds.), *Rules, Constraints, and Phonological Phenomena* (pp. 20–60). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199226511.003.0002

Vihman, M. M., & Croft, W. (2007). Phonological development: Toward a “radical” templatic phonology. *Linguistics*, *45*(4). https://doi.org/10.1515/LING.2007.021

Vihman, M. M., & Keren-Portnoy, T. (Eds.). (2013). *The Emergence of Phonology: Whole-word Approaches and Cross-linguistic Evidence* (1st ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511980503

Vihman, M. M., & Velleman, S. L. (1989). Phonological Reorganization: A Case Study. *Language and Speech*, *32*(2), 149–170. https://doi.org/10.1177/002383098903200204

Wee, L.-H. (2008). Phonological patterns in the Englishes of Singapore and Hong Kong: Phonological patterns in the Englishes of Singapore and Hong Kong. *World Englishes*, *27*(3–4), 480–501. https://doi.org/10.1111/j.1467-971X.2008.00580.x

Yunus Maris. (1980). *The Malay sound system*. Penerbit Fajar Bakti.