# Sociophonetic variation in English /l/ in the child-directed speech of English-Malay bilinguals

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**Abstract:**

Three realisations of syllable-final /l/ have been described in previous work on Singapore English: vocalised-l (or deleted-l in some phonetic contexts; the local norms), dark-l (a form associated with the exonormative standards), and clear-l (a Malay-derived phonetic trait observed in the speech of some English-Malay bilinguals). This study examined whether, how and why Singaporean English-Malay bilinguals vary their English /l/ in their child-directed speech, and whether the phonetic variation, if any, could be socially-conditioned. The laterals in the English child-directed speech of ten father-mother dyads with their preschoolers were analysed using auditory and acoustic methods. All participants were simultaneous or early English-Malay bilinguals. The findings revealed that in informal contexts, both mothers and fathers used a relatively clearer /l/ in all syllable positions. Contrastingly, in formal contexts that involved teaching and learning, the coda laterals of mothers were significantly darker, thereby exhibiting positional contrast between onset and coda laterals. They also produced significantly more vocalised-l in these contexts. Fathers, however, did not show differentiation in the darkness of the laterals, nor did their laterals show significant positional differences in formal contexts, although some fathers of younger children did produce more vocalised-l than they did in informal contexts. The variation observed was discussed by exploring the potential socio-indexical meanings of these variants of /l/ within the context of variationist accounts of Singapore English and by drawing parallels with socially-conditioned variation in bilectal monolinguals and ethnolect speakers. Differences between maternal and paternal CDS patterns could be attributed to gender roles and cultural expectations of mothers' dominant role in child-rearing, and may also be a result of and enabled by Malay women's potentially more complex repertoire range.

**Keywords:** socio-indexical; ethnicity; repertoire; lateral; language contact; New English; gender

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

## 1. Introduction

Adults often modify their speech when interacting with very young children. In contrast with adult-directed speech (ADS), child-directed speech (CDS) is generally characterised as having shorter, syntactically simpler utterances, with many repetitions and isolated words and phrases. Speaking rate is also reduced, and there are also more prosodic repetitions, longer pauses, and a higher average pitch and wider pitch range (see Saint-Georges et al. [2013] for a review). One of the roles of CDS is to engage the attention of the child and convey emotional affect through acoustic exaggerations (e.g. Singh, Morgan, & Best, 2002). CDS also facilitates language learning as it conveys language-specific phonological information, and caregivers enhance phonetic contrasts to provide more canonical input and reduce variability in their production (e.g. Kuhl et al., 1997; Werker et al., 2007; Cristià, 2010). Modifications in CDS may also be socially-conditioned and involve the use of alternative phonetic forms, thereby encoding indexical information (Foulkes & Hay, 2015; Nardy et al., 2013). This study examines whether, how, and why English-Malay bilingual caregivers in Singapore vary their use of variants of /l/ in their English CDS towards their preschoolers.

Segmental modifications in CDS have been found to vary with the age and gender of the child, and communicative context. Foulkes et al. (2005) examined the use of standard versus other less prestigious and stigmatised local variants of (t) by mothers of children aged 2;0–4;0 living in Tyneside, England. They found that, not only did mothers in general use more standard [t] in CDS than in ADS, but more standard [t] was also used by mothers of girls and with younger children. Some evidence, however, showed that men made fewer modifications in their CDS. In other studies, Smith and colleagues (Smith et al., 2007, 2013) examined the use of several sociolinguistic variables in Buckie, Scotland in adults and children aged 2;6–4;2. One of the features studied was the lexically-conditioned *hoose* variable, which involves the alternation between standard diphthong [ʌʉ] and the monophthong [uː] in the MOUTH lexical set of words like *house, down*. The latter variant is stereotypical of Scots or northern varieties of English and used most by working-class males in spontaneous informal speech. They found that, not only was there more use of the standard variant in CDS than ADS and in CDS towards younger children, but there were also stylistic constraints on use. According to one of Labov's (2006) principles of transmission that linguistic variation is transmitted to children as stylistic differentiation on the formal-informal dimension (p.437), they found that caregivers used more of the local variant in contexts of play/routine than in those of teaching/discipline. However, they found that the same effects were not observed for most of other variables; some variables mirrored community norms very quickly while others remained variable in the early stages of language acquisition. This led Smith and colleagues to conclude that variables have different 'sociolinguistic value' in CDS. Roberts (2013), who investigated mothers' variable use of monophthongal long (ay) variable, as in [ka:t] for *kite* in Southern American English, also found that mothers used more diphthongal (ay) when talking to their children (aged 1;6–1;7) than when talking to an interviewer. One mother also emphasised and exaggerated the diphthongal glide when teaching new vocabulary to her child. Roberts explained that the use of the more standard variant was in part due to their role as teachers of language. As Foulkes et al. (2005) pointed out, segmental choice in CDS must be "viewed with one eye on the social-indexical values of the alternatives" (p.198); caregivers in these studies used both standard and nonstandard forms in CDS according to the norms of the community, and this was argued to be important in helping children construct a full sociolinguistic repertoire.

CDS in bilingual contexts involves even more variability. Compared to monolinguals, bilinguals vary greatly in their language experiences and background, and so do the specific phonetic and phonological properties of their CDS, which can differ from one bilingual to another, and from their monolingual counterparts, to varying degrees. Differential features in CDS may be due to caregivers being non-native speakers or late learners of the L2 (e.g. Fish, García-Sierra, Ramírez-Esparza, & Kuhl, 2017). Khattab (2002, see also Khattab, 2011), for example, reported that the Lebanese caregivers in her study who had lived in Yorkshire for over 10 years used clear-l syllable-finally instead of dark-l in their English CDS, possibly due to the influence of their Arabic L1. In some communities, distinctive features that emerge from language contact and acquisition are transmitted to and retained by later generations to become associated with particular socio-demographic groups, and further become reallocated with social functions (e.g. Sharma and Sankaran, 2011). The social-indexical meanings of these features allow them to be strategically used as part of one's ethnolinguistic repertoire, such as to index their ethnic identities or cultural affiliations (Benor, 2010; Eckert, 2008; Hoffman & Walker, 2010), even if they are not dominant in or no longer bilinguals of the substrate or ethnic community language (e.g. Kirkham, 2017). Sharma (2011), for example, examined the use of ethnically-marked variants in the production of /t/, coda /l/, and the FACE and GOAT vowels in second generation British-born Asians (younger and older males and females) towards different interlocutors. She found that the older men and younger women were more strategic and differentiated than others in their use of the different variants; they were generally more ethnic in their use of variants with Asian speakers and with their direct family, and more mainstream with Anglo interlocutors. She argued that the differences in the diversity of the social networks of the participants, the socio-political context that the speakers grew up in, and their cultural orientation could explain why some speakers commanded a more complex repertoire range.

In the same way that bilectal monolinguals and ethnolect speakers vary their speech styles, Singaporeans may choose from their English repertoire features belonging to established standards (the prescriptive norms) and local forms, some of which more ethnically marked than others (see Leimgruber, 2013, pp. 26-63, for a discussion). Recent descriptions of variation in

Singapore English (SgE) that are aligned with third-wave variationist sociolinguistics examined language use based on the socio-indexical meanings of these linguistic resources (e.g. Alsagoff, 2007; Leimgruger, 2013). Depending on the context of use, variants that are associated with standard varieties of English may index formality, authority, and educational attainment. Contrastingly, local features, which include 'Singlish' and ethnic markers, embody sociocultural capital and may index informality, camaraderie, and group membership. In terms of segmental modifications, Moorthy & Deterding (2000), for example, found that Singaporean undergraduates used more dental fricatives in a formal conversation with a British lecturer compared to speaking with a Singaporean student that they were familiar with, where th-stopping was more frequent. Leimgruber (2013, p. 66) also described the release or aspiration of coda stops, which are usually not released in SgE, to index a pretentious or pedantic stance in some contexts. In formal styles, Singaporeans were also found to be less ethnically accented (e.g. Deterding & Poedjosoedarmo, 2000; Sim, 2019). As a result of significant language shifts since the 1960s, Bolton & Ng (2014) described the various ethnic groups in Singapore to be in a similar situation to immigrant groups elsewhere in the world, in that the third generation of Singaporeans is increasingly more competent in English than their ethnic languages. Like the second-generation speakers in Sharma (2011) and Sharma and Sankaran (2011), therefore, language choices that the current generation of Singaporeans make, including the use of ethnically distinct features, are less likely to be related to English proficiency, imperfect learning or cognitive constraints, but more so to be as a result of and motivated by socio-cultural factors.

This study aims to find out whether and how Singaporean English-Malay bilingual caregivers make segmental modifications in their CDS towards their young children, and the possible socio-indexical factors that modulate its variation. The feature of focus is syllable-final /l/. This presents an interesting case as there are potentially three forms that have been described in previous SgE studies that may be used by these caregivers: vocalised-l (or deleted-l in some phonetic contexts; the predominant local forms), dark-l (the variant associated with exonormative standards), and clear-l (a Malay-derived variant used by some English-Malay bilinguals).

### 1.1. *L-allophony and variants of /l/ in Singapore English*

Cross-linguistically, alveolar laterals differ with regard to their degree of velarisation and/or pharyngealisation, with some languages having a darker (more velarised/pharyngealised) variant than others. Articulatorily, darker /l/ is characterised by a greater degree of tongue predorsum lowering and of postdorsum retraction towards the uvular area or upper pharyngeal wall, and the alveolar closure may also be more anterior (see Recasens and Espinosa, 2005). While the darkness of /l/ is a scalar phonetic property, language varieties can be categorised according to whether they exhibit a clearer or a darker /l/ variant (Recasens, 2012). In addition, some languages exhibit a clear or dark variant in all syllable positions, while others exhibit both that are syllabically conditioned (Recasens, 2004, 2012; Recasens & Espinosa, 2005). Southern varieties of British English and American English, for instance, are typically described to have a clearer lateral in the syllable onset and a darker lateral in coda position (Sproat & Fujimura, 1993; Wells, 1992). Coda laterals may also be vocalised in some language varieties, where the tongue tip contact with the alveolar ridge is lost, and is replaced by either a (labial-)velar approximant or a back vowel or semivowel. Further, for some varieties of English (e.g. Hong Kong English [Wee, 2008] and African American English [Thomas, 2007]), coda /l/ is argued to be deleted in certain phonetic environments, such as after a back, rounded vowel.

Syllable-final /l/ in SgE tends to be vocalised. Deterding (2007) added that coda /l/ may also be deleted after back vowels (e.g. *ball* [bɔː], *pull* [puː]) or when it follows a schwa (e.g. *little* [lɪtə]; syllabic [l̩] does not occur in SgE). Using a generative approach, Wee (2008) argued that the underlying representation for lateral-final words in SgE is similar to Standard English, and the surface forms are derived from L-vocalisation rule and not L-deletion. He further explained that laterals that are preceded by back vowels also undergo the vocalisation rule, but the vocalised /l/ may assimilate to the respective preceding back vowel due to ease of articulation, thereby lengthening the vowel. As with past descriptions of and studies on coda /l/ in SgE, syllable-final /l/ vocalisation and deletion are treated as forms of one dialectal feature in this study, which is referred to here as *L-lessness,* following studies on African American English (see Thomas, 2007). Tan (2005) examined the production of syllable-final /l/ in conversational speech and read speech of educated Chinese Singaporeans. Based on listening judgement tests by ten Chinese Singaporeans and four British listeners, he found that while no speakers consistently used dark-l or vocalised-l in all their speech, the percentage of vocalised-l varied significantly between speakers, ranging from 39% to 89%, but reported no significant gender effects. There were also significantly more incidences of vocalised-l in faster read speech, though no effect of style between read speech and conversational data was observed. However, as he pointed out, the conversational speech and read speech data were not matched, and therefore linguistic factors such as phonetic environment could not be controlled.

Some studies have found that there are ethnic differences in the speech of Singaporeans, such that their ethnicity could be identified from their speech alone (e.g. Deterding & Poedjosoedarmo, 2000). Sim (2015, 2019) found differences in the production of /l/ by Singaporean English-Malay bilinguals. Malay /l/ is typically realised as a voiced alveolar lateral, and laterals are always clear, in all word positions (Clynes & Deterding, 2011; Yunus Maris, 1980). The distribution of Malay /l/ is also 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'). Sim measured the production of /l/ by ten Singaporean English-Malay early sequential bilinguals[1] between the ages of 19 and 28 ($M$ = 23.1, $SD$ = 2.51) in spontaneous speech using F1 and F2 as acoustic cues. He found that the Malay subjects preserved 54.8% of all absolute word-final /l/, and the rest were vocalised or dropped. He also noted that the coda laterals of English-dominant subjects were darker, whereas almost all produced by the Malay-dominant subjects were much clearer, with a statistically significant difference in the F2 but not F1. All participants were early or simultaneous bilinguals, however, and should have formed separate phonetic categories for their two languages or at least show distinct production patterns for the two languages (Barlow et al., 2013; Khattab, 2002, 2011). Sim posited that, rather than this being an effect of cross-linguistic influence, clear-l could have been learned through the input, similar to how British Asians acquired ethnically-marked features (e.g. Kirkham, 2017; Sharma, 2011). The retention and use of coda clear-l could have been motivated by socio-indexical reasons; based on the results from the language background survey, his Malay-dominant subjects were associated with more Malay-dominant families and social circles, and identified more with a Malay-speaking culture.

### 1.2. *Socio-indexical meanings of /l/*

Several studies show how the use of allophones of the alveolar lateral can be socially conditioned. British Asian English, for instance, is often characterised as having clearer allophones of coda /l/, due to likely effects of languages with clearer /l/ variants such as Panjabi, Urdu or Arabic, and is used variably to signal group membership or to index social distinctions among peer groups (e.g. Khattab, 2002; Kirkham, 2017; Sharma, 2011). The use or avoidance of distinctive features can also be attributed to other social meanings that emerged from various sociohistorical processes. One such example is Simonet's (2010a, 2010b) study of the alveolar laterals of Catalan-Spanish adult bilinguals. Majorcan Catalan has dark-l in all positions, while Spanish has clear-l in all positions. Simonet revealed that, especially in Majorca, dark laterals seemed to index local and rural origin of a speaker and used stereotypically by native Spanish speakers and Spanish-dominant bilinguals when joking about Catalan-accented Spanish. He further explained that this was perhaps so because Spanish monolingual speakers settled mostly in the main Majorcan metropolitan areas during the mass migratory waves in the 1950s and 1960s, when Majorcan Catalan had a low level of social prestige for socio-political reasons. This led Simonet to posit that a reason why his Spanish-dominant female subjects had a merged L1+L2 lateral category could be because they may have distanced themselves from what they might have perceived as Catalan-accented Spanish, which could also explain why they also produced clearer laterals than older

[1] These participants did not take part in the present study.

females of similar linguistic background. A few studies have also reported gender effects. Mackenzie et al. (2015), for instance, studied the English speech of speakers in Irish-settled areas of Newfoundland, Canada, which was reported to exhibit clear-l in all positions. They found that, like the pattern in standard North American English, darker /l/ was used word-finally. However, they observed acoustic differences between women and men, where women made a significantly greater difference in terms of lateral darkness between initial and final /l/. They interpreted this as indicating that men were preserving more traditional variants than women. In another study, Clothier (2019) compared the production of /l/ between Australians with Lebanese ethnic identities that had parents and/or grandparents who were born in Lebanon, and Australia English speakers of Anglo-Celtic Australian heritage. He found that Lebanese Australian women with stronger, denser ties with the Lebanese community made a sharper distinction between dark-l in final position and clear-l in initial position, showing no substratum transfer, illustrating how men and women can be socialised into their ethnicities differently.

### 1.3. *Objectives of this study*

The above studies have shown how social factors modulate the linguistic choices of bilectal monolinguals in their CDS, and also described how alternative speech forms, in particular the variants of /l/, can be used strategically by bilinguals or speakers of ethnolects based on their socio-indexical meanings. Many of the same social factors influence the linguistic choices that Singaporeans make, as they choose from their repertoire alternative forms belonging to standard varieties and local dialect features, the latter including features that are ethnically distinct, based on their communicative needs. This study aims to find out whether and how Singaporean English-Malay bilingual caregivers vary their use of variants of /l/ in their English CDS towards their preschoolers, and the possible social factors that modulate its variation. To this end, it aims to answer these research questions:

1. What syllable-final /l/ variant(s) do English-Malay bilingual caregivers use in their CDS?
2. Do the variants of /l/ used in CDS vary according to situational context?
3. Are there differences in the production patterns between mothers and fathers?
4. Is the phonetic variation, if any, socially conditioned?

## 2. Methodology

### 2.1. *Participants*

The corpus used in this study comprises ten Singaporean English-Malay bilingual families that included the father, mother and their firstborn of ages 3;1 to 6;4 (*M* = 55.8 months, *SD* = 12.43). The child participants had not started attending primary school; children in Singapore only enter Primary school upon the year they turn seven. The children were all simultaneous bilinguals, having been exposed to both languages by the age of three (Genesee & Nicoladis, 2007). The families were recruited through friends of friends, while families Mi1 and Mi21 were recruited through a local preschool. All participants were born and raised in Singapore and spoke the same ethnolect. The details of the participants, including their age, age of acquisition (AoA), language dominance, socioeconomic status (SES) and gender of the children are presented in Table 1.

The adults were between 29 and 37 years of age (*M* = 32.8 years, *SD* = 2.41) and were all simultaneous or early sequential bilinguals, having learnt both languages by five, except for the father of family M11, who only started learning Malay in primary school at around seven years of age. Despite learning Malay late, his English accent was perceptually distinctively Malay. He attributed this to the influence of his Malay peers in school and his Malay-speaking friends in the army, where he served the compulsory conscription at about 18–19 years old. The language dominance of the adults was measured using the Bilingual Language Profile (BLP; Birdsong et al., 2012), a self-reported measure of their language history, proficiency, use and attitudes. The dominance scores were automatically tabulated, and possible scores ranged from −218 (Malay-dominant) to +218 (English-dominant). The mean BLP score for the mothers was 45.16 (*SD* = 47.14, *Mdn* = 56.81, range = -30.78–127.77,) and 24.64 for the fathers (*SD* = 58.78, *Mdn* = 35.38, range = -32.24–147.66). Given that social class/socioeconomic status (SES) may have an effect on the language patterns of parents (Hoff, 2006), their SES was also ascertained using the established Family Affluence Scale (FAS) (Currie et al., 2008) that was modified to fit the Singaporean context[2]. The FAS assesses SES by aggregating information on material affluence based on the material condition of the household. This study also included education level and profession of the parents as part of the measure. These items in the survey generate a composite score, with the highest possible SES score being 35; the mean SES score of the participants was 21.5 (*SD* = 2.63).

**Table 1.** Description of the participants, including their age, age of acquisition (AoA), the Bilingual Language Profile (BLP) score of the adults, socioeconomic status (SES) score and the gender of the children

| Family ID | Age | | | AoA English | | | AoA Malay | | | BLP | | SES | Gender of child |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | C | M | F | C | M | F | C | M | F | | |
| M6 | 31 | 37 | 5;1 | 4 | 4 | 1 | 0 | 1 | 0 | -8.35 | -32.24 | 23 | Male |

[2] The question in the original FAS, "Do you have your own bedroom for yourself" was replaced with "What type of home does this child live in?". The question "Do you pay people from outside the family to work at your home on a regular (that is, on a daily or weekly) basis?" was also added.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M7 | 30 | 32 | 4;6 | 0 | 0 | 0 | 0 | 0 | 1 | 68.57 | 46.32 | 21 | Male |
| M9 | 31 | 32 | 3;1 | 0 | 5 | 0 | 0 | 0 | 0 | 57.40 | 34.33 | 20 | Female |
| M10 | 29 | 32 | 3;2 | 0 | 0 | 0 | 0 | 0 | 0 | 127.77 | 36.42 | 17 | Male |
| M11 | 36 | 36 | 5;8 | 0 | 0 | 0 | 4 | 7 | 0 | 87.27 | 147.66 | 25 | Male |
| M17 | 35 | 36 | 4;11 | 0 | 0 | 0 | 0 | 0 | 1 | 60.76 | 61.03 | 21 | Male |
| M18 | 33 | 35 | 5;7 | 0 | 5 | 0 | 0 | 0 | 0 | 56.22 | 37.15 | 24 | Male |
| M21 | 35 | 37 | 6;0 | 5 | 5 | 1 | 0 | 0 | 0 | -30.78 | -17.71 | 24 | Female |
| Mi1 | 31 | 33 | 3;8 | 0 | 5 | 0 | 0 | 0 | 0 | 11.35 | -65.20 | 23 | Male |
| Mi21 | 32 | 34 | 4;10 | 3 | 0 | 0 | 0 | 0 | 0 | 21.34 | -1.36 | 16 | Female |

Note: M=Mother, F=Father, C=Child. Age and AoA are measured in years. The data used in this study belong to a larger corpus and their original Family ID and the coding used to identify subgroups in the corpus (i.e. "M" or "Mi") are retained.

### 2.2. *Materials*

Naturalistic data from unstructured play and semi-structured interaction between each parent-child dyad, which lasted approximately 30 to 40 minutes, were used in the analysis. Following Smith et al. (2007), casual conversation and unstructured play were defined as informal, while teaching and reading were formal. Informal activities during unstructured play and interaction included but were not limited to playing with toys, puzzle play, sketching/drawing, or a casual conversation about people or past events. The activities that constituted formal interaction included a picture description task. The parents were given a large picture card that featured a park scene with many animals, food, objects and people engaged in leisure activities and were told to describe and teach the child the names of the items. Mothers were also tasked to read to the child a book titled "Duck and Goose" by Tad Hills, while fathers were asked to read a book of their choice. As this study focuses on the variation in CDS, only the recordings of adult speech were analysed. Parents were also instructed to use only English to interact with their children, in order to avoid a bilingual mode (Grosjean, 2011); very minimal use of Malay, if at all, was found in their interactions in the recordings.

### 2.3. *Recording procedures*

The recording took place in a quiet room with minimal reverberation in their respective homes, without the presence of the researcher or any other person other than the parent and the child during each session. To ensure that the recordings were of adequate quality for acoustic analysis of fine phonetic details, they each 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. The mothers were also given instructions to ensure a good recording; they were instructed on the optimal position of the microphones if adjustments were needed and were made aware of potential noise that could arise from the activities that would affect the recording. They were also reminded to speak as how they would normally with the child, and to avoid talking at the same time as the child. Noise from various sources such as traffic and electric fans was attenuated and kept to a minimum.

### 2.4. *Auditory and acoustic analysis*

To avoid coarticulation effects and ambisyllabicity of intervocalic /l/ in various morphosyntactic environments (e.g. Lee-Kim, Davidson and Hwang, 2013; Yuan & Liberman, 2011), only tokens from the following environments were included in the analysis: syllable-onset /l/ that were preceded by a pause or a stop and followed by a vowel (i.e. C_V and #_V positions), such as *look, blue,* and *exclaimed.* Syllable-coda /l/ were those that were preceded by a vowel and followed by a pause or consonant (i.e. V_# and V_C# positions), such as *ball, called* and *shelter*. Syllabic /l/ does not occur normally in SgE. Laterals next to another lateral were excluded. Tokens that could not be analysed due to devoicing or external noise were also excluded. The analysis yielded a total of 1770 tokens. The number of tokens according to parent, formality and syllable position is presented in Table 2.

**Table 2.** Number of tokens according to parent, formality, and syllable position

| Parent | Formal | | Informal | |
|---|---|---|---|---|
| | Onset | Coda | Onset | Coda |
| Mothers | 197 | 509 | 87 | 167 |
| Fathers | 195 | 408 | 81 | 126 |
| Subtotal | 392 | 917 | 168 | 293 |

Tokens were segmented and analysed aurally and acoustically using Praat (v. 6.1.6; Boersma & Weenink, 2019). In the first part, coda /l/ tokens were coded according to whether they were (1) retained (i.e. clearer and darker /l/) or (2) l-less (vocalised or deleted). Representative spectrograms of the word *ball* for the various realisations are shown in Figure 1. Very clear /l/ can be easily identified both aurally and also acoustically by the high F2 in the lateral steady-state in the spectrogram, as shown in spectrogram (a) in Figure 1. Distinguishing between darker /l/ and vocalised-l was more challenging, as acoustically dark-l and [w, o, u] have almost identical acoustic signals (as shown in (b) and (c) in Figure 1 respectively). An acoustic cue of a dark-l may be a fainter F3 (Thomas, 2011), but this method was highly unreliable, as F3 was not always clearly present, as can be seen in (b). F2 of a vocalised-l may also be lower, as seen in (c), but this acoustic cue requires the comparison of words with similar phonetic environments, and such a difference can be subtle. Due to the difficulty in acoustically distinguishing the two variants reliably, their identification was based largely on auditory methods. In the case of l-vocalisation, the main auditory cues were the transition from the nucleus to a more back and/or close vowel, giving a percept of a diphthong, and this was often accompanied by some degree of lip-rounding. For dark-l, the main auditory cues were those indicating apical contact and velarisation/pharyngealisation. Most sociolinguistic studies on l-vocalisation have employed perceptual coding techniques, which have been found to be reliable, especially for laterals that are most consonantal or most vocalised (Hall-Lew & Fix, 2012). Finally, in a token where /l/ was deleted, there was no change in quality in the nucleus that would indicate any kind of residual consonantal gesture aurally, as can also be seen acoustically in (d). Coda /l/ of these tokens was found to be preceded by a back vowel or schwa, as reported by Deterding (2007). A second rater who was a sociophonologist was trained in the coding and asked to rate about 10% of all coda /l/ tokens (n=120). As very clear-l is easy to identify, tokens that were coded as consonantal and had an F2 of above 1000 were excluded from the random selection of the 120 tokens. The rater was asked to rate whether tokens were consonantal or l-less. 80% of all tokens were in agreement. Of the 120 tokens, 48 were coded as consonantal, and 87.5% of them were in agreement.

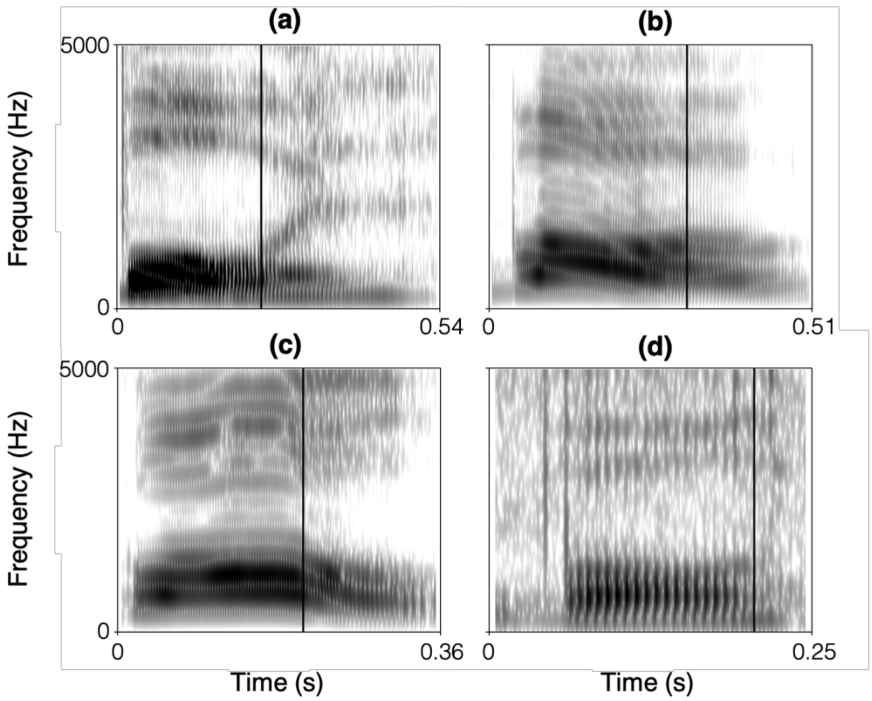


**Figure 1** Representative spectrograms for the word *ball*. (a) clear-l, (b) dark-l, (c) vocalised-l, (d) deleted-l by the mothers of M9 and M10. Vertical black line represents end of the vowel interval.

In the second part of the analysis, only consonantal laterals (in both onset and coda positions) were further analysed. Figure 2 shows how the laterals were further hand-segmented for landmarks indicating the onsets and offsets of the (i) laterals and (ii) vowels for word-initial /l/ (left) and word-final /l/ (right). The onset and offset of the lateral was 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; Carter & Local, 2007; Simonet, 2015).

The primary acoustic correlate of velarisation or pharyngealisation is regarded to be F2, though F1 has also been shown to vary between the two variants. Clear-l has a relatively high F2 and low F1, whereas dark-l has a low F2 and higher F1. Many studies have used the F2–F1 metric to capture the relationship between the two formants; clearer /l/ has a higher F2–F1 (e.g. Amengual, 2018; Clothier, 2019; Holmes-Elliott & Smith, 2018), which was also used in this study. Formant tracks were calculated with the built-in Burg algorithm in Praat. All tokens were measured manually. The effective window length was set at 25 ms, and the maximum number of formants was kept at five (1.0 mm dot size, 5.5 kHz ceiling) as default. However, adjustments to the number of formants and formant ceiling were made according to the speaker and to rectify tracking errors. Formant measurements were taken at the midpoint of the lateral steady state, in order to minimise effects of coarticulation. Following previous studies (e.g. Amengual, 2018; Clothier, 2019; Kirkham, 2017), formant values were extracted in Hertz and were converted to Bark, a psychoacoustic scale, to reflect darkness of /l/ as a perceptual phenomenon. Outliers were detected using the interquartile range method. 18 coda /l/ tokens had an F1 (Bark) or F2 (Bark) that fell below the first quartile or above the third quartile of 1.5 times the interquartile range of all tokens. 14 of these tokens were produced in the formal contexts. Many of these outliers were a result of exaggerated speech that is characteristic of CDS. Others were due to stronger coarticulatory effects with the neighbouring consonants that is typical of fast spontaneous speech, and a few were spoken much slowly and in isolation which resulted in a 'canonical' dark- or clear-l. As none of these tokens were deviant from what would be expected of spontaneous speech or CDS, nor due to mismeasurement, they were not excluded from the analyses.

Several linguistics factors were considered to account for the variability in phonetic contexts in spontaneous speech data and the potential inter-speaker variability that may exist. The duration of the lateral defined by the temporal-acoustic 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). Neighbouring vowels have also been shown to influence darkness of /l/; studies of a few language varieties including but not limited to American English (Oxley et al., 2007), African American English (van Hofwegen, 2010), Majorcan Spanish and Catalan (Simonet, 2015), and Welsh and Welsh English (Morris, 2017) have found that /l/ tended to be lighter with fronter vowels and darker with backer vowels, but dark-l was strongly resistant to coarticulation. The potential coarticulation effects of vowels were considered by taking into account the F2 of the neighbouring vowel, as indicated by (iii) in Figure 2. To achieve this, Morris (2017) and van Hofwegen (2010) used the arithmetic difference between F2 (Bark) of the /l/ midpoint and the F2 (Bark) of the 30 ms into the offset or onset of the preceding or following vowel respectively; 30 ms was an arbitrary value that allowed for some transition into the next segment. However, as this study is concerned with within-speaker variation that involved the use of both allophones syllable-finally, only the F2 (Bark) of the vowel was used in the analysis. Finally, adjacent consonants may also affect /l/-darkening, although these effects may be language or variety specific. For instance, Davidson (2012) reported that in Catalan, velarisation is stronger when the lateral consonant precedes a velar or bilabial consonant. Morris (2017), who examined /l/ in Welsh and Welsh English, did not find a difference in darkness between /l/ before coronals and those before other consonant types, but found that word-final /l/ that preceded coronal consonants were lighter than those before a pause. The phonetic contexts that follow the laterals may also condition l-vocalisation. Scobbie and Wrench (2003) examined the word-final /l/ of English speakers of non-vernacular varieties of British English, Scottish English and American English, and found that word-final /l/ was vocalised more often in prelabial context than in prepausal context, and more often in these two contexts than prevocalically. In prepausal /l/, vocalisation occurred more often if the /l/ was in a metrically weak syllable, although some of these patterns were highly speaker-specific. Therefore, the place of articulation or type of neighbouring consonant (or stated as pause, in the case of an /l/ at utterance boundary) and whether the lateral consonant was in a lexically stressed or unstressed syllable were also recorded. Following Davidson (2012) and Morris (2017), the types of consonant included coronal (/t, d, tʃ, dʒ, s, z, ʃ, n, r, ð, θ/), glottal (/h/), labial (/m, f, v, p, b/), velar (/k, g/), and also glides (/w, j/).

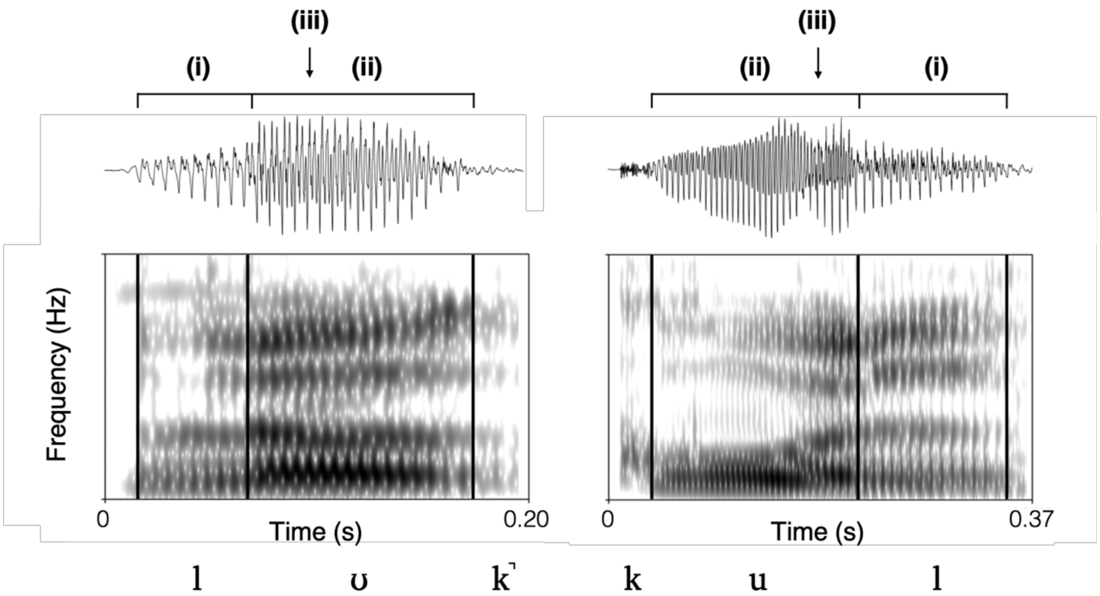


**Figure 2** Representative waveforms and spectrograms of *look* (left, word-initial /l/) and *cool* (right, word-final /l/). (i) lateral, (ii) vowel, (iii) 30 ms mark into onset (left spectrogram) or offset (right spectrogram) of vowel.

### 2.5. *Statistical analyses*

Mixed-effects regression analyses were conducted using the R statistical software (R Core Team, 2020), the lme4 package (Bates et al., 2015), and the lmerTest package (Kuznetsova et al., 2017). For all models, the random effect structure included random intercepts for subject and word, and for variables of interest only, by-subject and by-word random slopes, as justified by the data. Random effects structures were simplified (but random slopes of variables of interest were not removed) when they were of a significantly worse fit than a simpler model and/or when convergence issues could not be resolved. Interactions between variables were further investigated using the emmeans package (Lenth, 2020). For ease of reference, the specific linear models used for each part of the analysis, variables that were included in the full models, and the model selection technique are described in the results section.

## 3. Results

### 3.1. *L-less versus retained coda laterals*

The proportions of coda /l/ tokens that were l-less (i.e. vocalised/deleted) and retained according to parent and formality of situational context are shown in Figure 3. By visual inspection of the figure, overall, both fathers and mothers share the same production patterns: the proportions of retained /l/ were greater in informal contexts, but in formal contexts, more /l/

tokens were l-less. Mixed-effects generalised linear regression was run to model the binary outcome of a coda lateral being l-less or retained for mothers and fathers separately. In the full models, the random effects structures included random intercepts for subject and word and by-subject and by-word slopes for formality. Fixed effects that were linguistic factors included the neighbouring consonant (coronal, glottal, labial, velar, glide or pause), lexical stress (stressed/unstressed), and the categorical variables of vowel height and vowel advancement of the preceding vowel. Vowels were categorised according to the vowel system of SgE (see Deterding [2007] and Leimgruber [2013, pp. 64-65]). Compared to Standard Southern British English, the vowel inventory of SgE is much reduced; there is an absence of phonemic length and quantity distinctions between tense-lax pairs (e.g. *beat* and *bit* are homophones), /æ/ is merged with /ɛ/, and /eɪ/ and /oʊ/ are monophthongised to [e] and [o] respectively. Diphthongs were categorised according to their offset (e.g. /aɪ/ was grouped with /i/). Therefore, the vowel height categories were close [i, u], close-mid [e, ə, o], open-mid [ɛ, ɔ], and open [ʌ], and the vowel advancement categories were front [i, e, ɛ], central [ə, ʌ], and back [u, o, ɔ]. Non-linguistic or social factors that were included as fixed effects were formality (formal/informal), gender of child (male/female), age of child (in months), SES score, and BLP score. Continuous independent variables were mean centred. Finally, two-way interactions between formality and SES, BLP, age of child and gender of child were added as fixed effects. To evaluate the contribution of each predictor, pairwise model comparisons between the 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.

The results for the full model and further information about the reduced model for mothers and fathers can be found in Appendix A and Appendix B, respectively. In the reduced model for mothers, neighbouring labials, $B = -0.99$, OR = 0.37, $p = 0.01$, 95% CI [0.17, 0.81], and formality, $B = -0.84$, OR = 0.43, $p = 0.04$, 95% CI [0.20, 0.96] were significant predictors. That is, laterals that preceded labials were significantly more likely to be l-less compared to those before a pause, and coda laterals of mothers in formal contexts were more likely to be l-less. In the reduced model for fathers, by-subject slope of the interaction between formality and age of child, and by-word slope of age of child were added, as the interaction term as a fixed effect was found to significantly improve model fit in the modelling. The effects of the neighbouring consonant, specifically labials, $B = -1.35$, OR = 0.26, $p = 0.001$, 95% CI [0.12, 0.58], and velars, $B = -1.47$, OR = 0.23, $p = 0.02$, 95% CI [0.07, 0.79], were significant; coda laterals that preceded these two consonant types were significantly more likely to be l-less compared to those before a pause. The advancement of preceding vowel was also a significant predictor; laterals after front vowels, $B = -1.57$, OR = 0.21, $p < 0.001$, 95% CI [0.09, 0.46], and after central vowels, $B = -1.63$, OR = 0.20, $p < 0.001$, 95% CI [0.09, 0.42], were more likely to be l-less compared to those after back vowels. Inspection of tokens by individual vowels revealed that the high occurrence of three specific words that shared the rime /ɔl/ – *ball, all* and *small*, which were almost always pronounced with a retained /l/ by fathers, could have contributed to the significant differences. Finally, the interaction between formality and age of child was a significant predictor, $B = 0.07$, OR = 1.07, $p$ = 0.02, 95% CI [1.01, 1.14]. Spotlight analysis was performed to examine how formality and position varied by three levels of age of child: at the mean level, +1 SD of the mean, and a third at -1 SD of the mean. Based on plots of marginal means and estimates of simple effects, as age decreases, more l-less tokens were produced in formal contexts than informal contexts, and only for the younger group, the contrast was significant (OR = 0.31, $p = 0.02$). Pairwise comparisons (with Tukey adjustments) for age levels by situational contexts (e.g. older versus younger in informal context) revealed that differences between age levels were not significant (*ps* > 0.1). Inspection of individual raw data indeed revealed that the fathers of two youngest children, M9 (3;1) and M10 (3;2) produced a considerably higher proportion of l-less tokens in formal situations, but the increase in the use of l-less tokens by the father of the next youngest child, Mi1 (3;8) was only marginal. In short, with linguistic factors considered, mothers overall produced significantly more l-less tokens in formal contexts, while only some fathers of very young children did so.

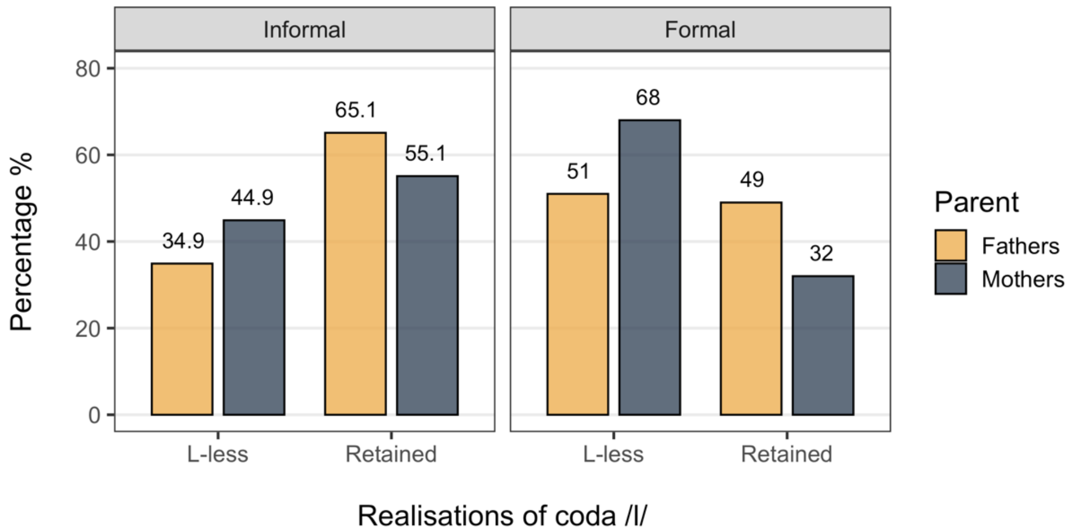


**Figure 3** Percentages of realisations of coda /l/ as a function of formality of situational context and parent

## 3.2. *Darkness of consonantal laterals*

Only onset laterals and coda laterals marked as retained ($n = 1096$) were included in the following analyses. Variation in the darkness of the laterals was first investigated by plotting the Bark-transformed F1 values of the laterals against their F2 values (Figure 4). To reiterate, clearer /l/ is associated with higher F2 and lower F1 values. Individual observations, which were grouped by context according to the formality and syllable position, are included in the plot, together with ellipses that show their spread at ±1 standard deviation. The laterals of the fathers and mothers were also plotted separately, in order to uncover potential gender differences.

The figure shows that fathers and mothers exhibited different production patterns. The ellipses of the laterals of fathers (top row) in all four contexts coalesced, suggesting that little distinction was made if at all in the allophones of /l/ according to situational or positional context. Contrastingly, for mothers (bottom row), many tokens of coda /l/ in the formal context were comparatively darker than all other /l/. This suggests that in informal contexts, mothers exhibited the same /l/ pattern as fathers, but in formal contexts, many tokens of coda /l/ were made darker, reflecting the clearer onset and darker coda pattern that speakers of more established standard varieties of English exhibit. However, the relatively larger ellipse also suggests that not all tokens of /l/ were made darker in the formal contexts or that there was some interspeaker variation, but this could also be due to more general linguistic factors, such as coarticulatory effects. Possible interspeaker variation in mothers was further explored by conducting a visual inspection of individual scatterplots. Six of the mothers clearly distinguished onset and coda /l/ in the formal context, M10, M17 only partially, and M6 and Mi1, who had two of the lowest BLP scores, hardly distinguished all laterals in their darkness, which suggests that BLP may have an effect on their lateral production. However, M21, despite being the most Malay dominant of all mothers, had clearly distinguished the laterals in formal contexts, but she had only retained 13.8% of /l/ in the formal context as the rest were vocalised (86.3%). Although mothers M6 and Mi1 did not differentiate the darkness of their laterals, individual production patterns revealed that in formal contexts, they still produced more l-less tokens than in informal contexts (M6 produced 30.5% more l-less tokens and Mi1, 30%). Interestingly, the increase in the use of l-less tokens in formal contexts by M21, M6 and Mi1 was greater than that of most mothers.

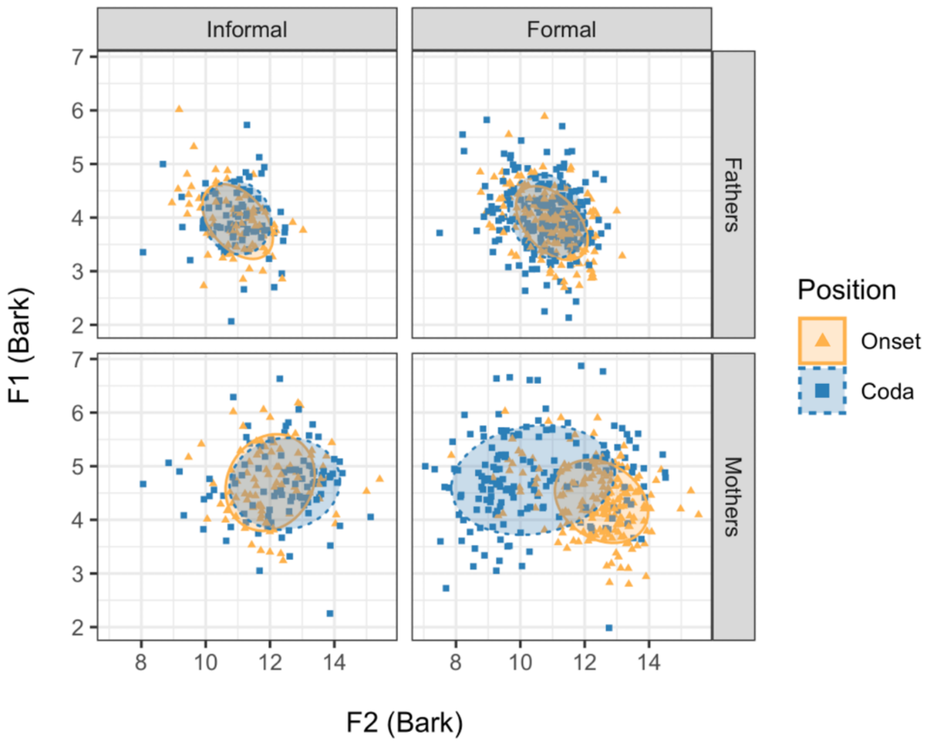


**Figure 4** Scatterplot of formant values of laterals as a function of formality of situational context, syllable position and parent with ellipses of ±1 standard deviation

The darkness of the laterals was further examined visually using mean F2–F1 (Bark) values (recall that a higher difference indicates a clearer /l/), plotted according to formality, parent and syllable position (Figure 5). For fathers, in the informal contexts, there was little difference in the mean F2–F1 (Bark) values of onset and coda /l/. The mean of onset /l/ in the informal context was 6.97 ($SD$ = 1.21, $n$ = 81) compared to 6.95 ($SD$ = 1.06, $n$ = 82) for coda /l/. In the formal context, coda /l/ was slightly darker; the mean was 6.76 ($SD$ = 1.22, $n$ = 200), compared to 7.03 ($SD$ = 1.19, $n$ = 194) for those in the onset, with a very small mean difference of 0.27 Bark. In contrast, mothers used a much darker /l/ in the formal context. The mean of onset /l/ was 8.02 ($SD$ = 1.50, $n$ = 197) compared with 5.78 ($SD$ = 1.93, $n$ = 163) for coda /l/—a mean difference of 2.24 Bark. Interestingly, the figure shows that in the informal context, mothers' onset /l/ was darker than those in the formal context, and coda /l/ was slightly clearer than onset /l/. The mean of onset /l/ was 7.35 ($SD$ = 1.22, $n$ = 87) and the mean of coda /l/ was 7.64 ($SD$ = 1.51, $n$ = 92). These differences suggest a three-way interaction between formality, parent, and syllable-position, and this was considered in the regression models.

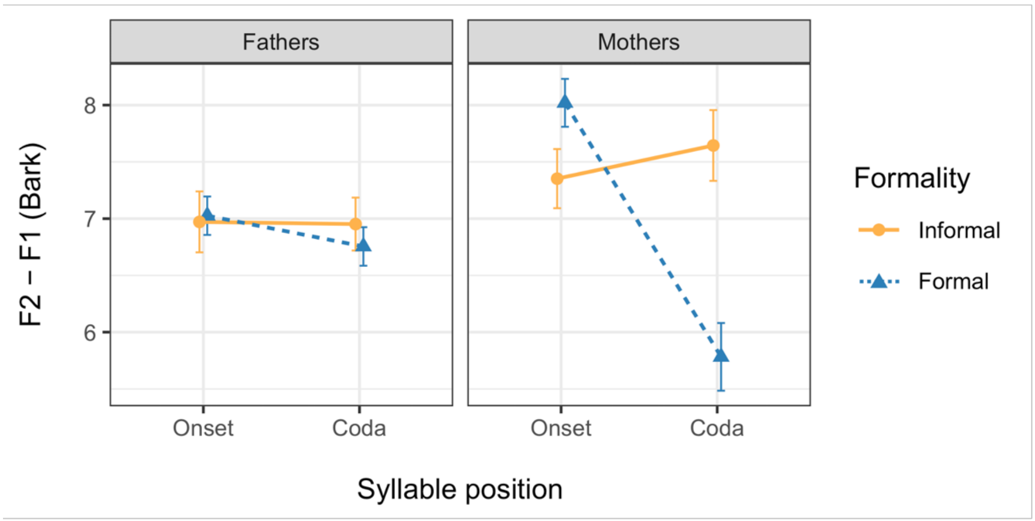


**Figure 5** Means (+95% CIs) of F2–F1 Bark of laterals as a function of formality of situational context, syllable position and parent

Mixed-effects linear regression analysis was conducted to examine the relationship between the darkness of the laterals and various potential predictors. The response variable was the Bark-transformed F2–F1 values. The random effects included random intercepts for subject and word as well as by-subject and by-word slopes for formality, position and parent. The fixed effects in the full model that were categorical included formality of situational context (formal/informal), parent (mother/father), syllable position (onset/coda), lexical stress (stressed/unstressed), neighbouring consonant (coronal, glottal, labial, velar, glide, or pause) and gender of child (male/female). The fixed effects that were continuous included F2 (Bark) of the 30 ms mark of the neighbouring vowel, duration of the lateral, BLP scores, SES scores, and the age of the child. Finally, a three-way interaction term between formality, parent, and syllable position was added. The duration of the lateral was log-transformed to resolve the skewness of the data. The age of acquisition of the parents was measured in the BLP survey, and so it was not added as a separate variable, in order to avoid issues with multicollinearity. Continuous independent variables were mean centred. A series of models was fitted for model selection using the process outlined in Zuur (2009, pp. 121–122). All the explanatory variables above were included in a full model initially. The optimal random effects structure was first explored with the full model using the likelihood ratio test with restricted maximum likelihood tests (REML) estimation. The optimal fixed effects structure with the selected random effects was then evaluated by maximum likelihood (ML) estimation by removing fixed factors one by one, while using the Akaike Information Criteria as measure of model fit. The reduced model is then presented using REML estimation.

The results of the reduced model are presented in Table 3, while the results for the full model can be found in Appendix C. The optimal random effect structure of the reduced model included subject and word as random intercepts, by-subject random slopes for parent and the two-way interaction between formality and position, and by-word slopes for formality, position and parent. The results show that coarticulatory effects of neighbouring vowels and consonants that were found in previous studies were also significant in predicting the darkness of the laterals in this study. For vowel context, the fronter the neighbouring vowel, the clearer the /l/ was. The neighbouring consonant also had an effect on the laterals. Laterals next to labials were significantly darker than those next to pauses. Finally, the three-way interaction between parent, formality and syllable position was a significant predictor. The non-significance of all two-way interaction terms reflects the considerable variability in the levels of the factors without the moderation of the levels of the third term. Inspection of plots of marginal means and pairwise comparisons of simple effects (with Tukey adjustments) reflect the observations in Figure 5; in informal contexts, the darkness of onset and coda laterals did not significantly differ within and between mothers and fathers ($ps > 0.05$). In formal contexts, there was no significant change in darkness of onset laterals of mothers ($B = 0.29$, $t = 1.39$, $p = 0.52$), but their coda laterals were significantly much darker than informal codas ($B = -1.12$, $t = -3.74$, $p = 0.006$), and therefore also significantly darker than formal onset laterals ($B = -1.73$, $t = -6.00$, $p < 0.001$). In contrast, for fathers, there was no significant change in darkness of both onset and coda laterals, and the positional contrast in both situational contexts remained insignificant; unlike mothers, fathers' codas were not significantly darker than onsets in formal contexts ($B = -0.28$, $t = -1.13$, $p = 0.68$). The main effects of age and gender of the children, BLP and SES did not significantly influence the darkness of the laterals.

**Table 3.** Regression coefficients of a reduced mixed-effects linear regression model fit to the consonantal laterals across entire dataset with F2–F1 (Bark) as response

| Fixed factors | Level | *β* | *B* | SE | *t* | *p* |
|---|---|---|---|---|---|---|
| (Intercept) | | 0.12 | 7.22 | 0.18 | 40.01 | **<0.001** |
| Formality | Formal | 0.02 | 0.03 | 0.19 | 0.14 | 0.89 |
| Position | Coda | 0.02 | 0.03 | 0.24 | 0.12 | 0.90 |
| Vowel context | | 0.48 | 0.39 | 0.03 | 15.29 | **<0.001** |
| Neighbouring consonant | Coronal | 0.04 | 0.06 | 0.10 | 0.60 | 0.55 |
| | Glottal | 0.01 | 0.01 | 0.22 | 0.05 | 0.96 |
| | Labial | -0.30 | -0.46 | 0.13 | -3.60 | **<0.001** |
| | Glides | 0.19 | 0.30 | 0.21 | 1.43 | 0.15 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Velar | -0.15 | -0.24 | 0.17 | -1.43 | 0.15 |
| Parent | Mothers | 0.09 | 0.14 | 0.24 | 0.60 | 0.55 |
| Formality × Parent | | 0.17 | 0.27 | 0.28 | 0.99 | 0.32 |
| Formality × Position | | -0.20 | -0.31 | 0.34 | -0.89 | 0.37 |
| Parent × Position | | -0.22 | -0.34 | 0.34 | -0.98 | 0.33 |
| Formality × Parent × Position | | -0.72 | -1.13 | 0.50 | -2.22 | **0.03** |

Note: Reference category for formality is informal, syllable position is onset, neighbouring consonant is pause, and parent is fathers. Model: lmer(f2_f1_bark ~ formality*position*parent + vowel context + neighbouring consonant + (1 + formality*position + parent|subject) + (1 + formality + position + parent|word)). Observations = 1096, marginal $R^2$ = 0.37, conditional $R^2$ = 0.70, AIC = 3385.19.

To further understand how the interaction between formality and position differed across the levels of parent, as well as their three-way interactions with the other external factors, two separate linear mixed-effects models, one for fathers and one for mothers, were run. In addition to their main effects, the two-way interaction between formality and syllable-position, as well as their three-way interactions with SES, BLP, and age and gender of child, were added as fixed effects. The same linguistic factors, namely neighbouring consonant, lexical stress, vowel context (F2 of the neighbouring vowel at the 30 ms mark) and (log) duration of the lateral were also added as fixed effects in the full model. The results for the full model and further information on the reduced model for mothers and fathers can be found in Appendix D and Appendix E, respectively.

In the reduced model for mothers, the random effects structure included random intercepts for subject and word, by-subject random slopes for the interaction between formality and position, and by-word slopes for formality and position. The main effects of vowel context ($\beta$ = 0.45, $t$ = 11.38, $p < 0.001$) and (log-transformed) lateral duration ($\beta$ = 0.08, $t$ = 2.61, $p$ = 0.01), and the two-way interactions between formality and syllable position ($\beta$ = -0.91, $t$ = -3.03, $p$ = 0.002) were significant predictors; that is, longer laterals were (marginally) clearer, and the fronter the neighbouring vowel, the clearer the /l/ was. Inspection of plot of marginal means and pairwise comparisons of simple effects (with Tukey adjustments) of the interaction term again revealed that onset and coda laterals were not significantly different in darkness in informal contexts ($B$ = -0.03, $t$ = -0.06, $p$ = 0.99), but coda laterals were significantly darker than onset laterals in formal contexts ($B$ = -1.72, $t$ = -5.14, $p < 0.001$). In the reduced model for fathers, the random effects structure included random intercepts for subject and word, and by-subject random slopes for the interaction between formality and position. Only the main effects of vowel context ($\beta$ = 0.48, $t$ = 10.11, $p < 0.001$) and neighbouring labials ($\beta$ = -0.37, $t$ = -2.99, $p$ = 0.003) were significant predictors; that is, the fronter the neighbouring vowel, the clearer the /l/ was, and laterals next to labials were significantly darker than those next to pauses. The main effects of formality ($\beta$ = -0.01, $t$ = -0.08, $p$ = 0.94), position ($\beta$ = 0.02, $t$ = 0.13, $p$ = 0.90) and their interactions

($\beta$ = -0.26, $t$ = -1.51, $p$ = 0.13) were not significant predictors. Language-external factors also did not significantly modulate the darkness of the laterals of fathers.

In sum, with linguistic factors considered, the darkness between onset and coda laterals of mothers in informal contexts was not significantly different, but in formal contexts, coda laterals were significantly darker than onset laterals. By contrast, the darkness of laterals of fathers did not significantly differ across formality, nor was it modulated by other language-external factors.

## 4. Discussion

This study set out to find out whether and how Singaporean English-Malay bilingual caregivers vary their use of variants of /l/ in their CDS towards their preschoolers according to situational context, and the possible socio-indexical reasons that could explain the phonetic variability. To remind the reader, there are three forms of syllable-final /l/ that have been described in previous SgE studies: l-lessness (vocalised-l or deleted-l, the predominant local forms), dark-l (the variant associated with exonormative standards), and clear-l (a Malay-derived variant used by some English-Malay bilinguals). The findings revealed that in informal contexts that involved unstructured play and casual conversation with their child, both mothers and fathers used a relatively clearer /l/, in all syllable positions. Contrastingly, in formal contexts that involved teaching and learning, mothers used a significantly darker coda, reflecting the clear-l onset and dark-l coda pattern that speakers of more established standard varieties of English exhibit. In addition, mothers used significantly more l-less tokens in the formal contexts. For fathers, there was no significant differentiation in the darkness of the laterals according to situational context, and positional contrast remained insignificant. Some fathers of younger children, however, did produce considerably more l-less tokens in the formal contexts. In addition to these findings, two linguistic factors were found to significantly predict the likelihood of l-vocalisation. First, coda /l/ that preceded labials (and also velars for fathers) was significantly more likely to be l-less compared to those before pauses, which supports previous findings that preconsonantal /l/was more likely to be vocalised than prepausal /l/ (e.g. Scobbie & Wrench, 2003). Second, for fathers, laterals after back vowels were more likely to be retained, but as previously explained, the effect may be attributed to the high occurrence of specific lexical items with the rime /ɔl/ that were almost always pronounced with a retained /l/ by the fathers. Two main linguistic factors also predicted the darkness of the retained laterals. First, /l/ was found to be significantly lighter when neighbouring fronter vowels, as also has been found in previous studies (e.g. Oxley et al., 2007; Recasens & Espinosa, 2005). Second, especially for fathers, /l/ was darker when neighbouring a labial consonant, supporting other studies that reported effects of adjacent consonants on l-darkening (e.g. Davidson, 2012; Morris, 2017).

The use of a clearer variant of English coda /l/ that is as clear as onset /l/ by the Malay caregivers contrasts with the norms of Chinese Singaporeans, whose laterals, if not l-less, typically show positional differences due to a relatively darker coda /l/. This can be attributed to their bilingual experiences. Participants in this study might have been raised in a more Malay-dominant environments, by significant adults who spoke little English or were late learners, and/or were a part of more Malay-dominant social circles. This is considering that the bilingualism policy was still in development in the 1960s, and for many Singaporeans then and even today, English is not acquired as their first language (see Bao, 2015, pp. 15–36, for an overview of Singapore's linguistic ecology, and Cavallaro & Serwe, 2010, for a description of the Malay speech community in Singapore). The use of clear-l, however, is unlikely the result of cross-linguistic influence. The participants in this study were early if not simultaneous bilinguals, having been exposed to both languages by five (with the exception of the father of family M11 who acquired Malay later, as mentioned previously), and should have formed separate phonetic categories for clear- and dark-l (e.g. Barlow et al., 2013; Khattab, 2002, 2011). Further, there is some evidence that even those who learnt the L2 later in school had maintained two separate acoustic distributions for the laterals in their two languages, despite showing evidence of phonetic assimilation to their dominant language (Simonet, 2010a). Those who have been raised in environments where more Malay is used, however, may have had more influence of Malay on their English phonology (En et al., 2014). The primary source of influence is likely to be the phonetic details in the input. It has been shown that children are sensitive to even non-contrastive phonetic information in the input, and further these properties are reflected in their production (e.g. Mayr & Montanari, 2015; Sim & Post, 2021; Stoehr et al., 2019). Similar to second generation British Asians (e.g. Kirkham, 2017; Sharma, 2011), the use of clearer coda /l/ by participants of this study, who were mostly English-dominant at the time of the study, could have been a result of the acquisition of accented English L2 from their parents or peers, or ethnic features in the repertoire of L1 speakers in their community.

The maintenance and use of a clearer variant of coda /l/ by the English-Malay caregivers is therefore similar to the use of local or nonstandard forms by bilectal monolinguals in their CDS, or the use of exogenous forms by ethnolect speakers with family members or with peers who share the same ethnic affiliation, in that although they may not be standard nor mainstream forms, they are used in informal CDS and with family members because it indexes group membership. As mentioned, the use of local features or a more ethnically distinctive repertoire for their sociocultural capital is not uncommon among Singaporeans (Alsagoff, 2007). Preliminary findings of a perception study by Sim (2021) that involved a matched-guise test revealed that guises with clear-l were 'stereotyped' (Labov, 1991) by Singaporeans and perceived to be the most ethnic-accented of all three variants, but were regarded as the friendliest and used variably by Malay non-users to signal group membership. An appreciation of the significance of the Malay ethnic repertoire requires an understanding of the Malay community. The Malays[3] constitute an ethnic minority in Singapore (about 15% of the population). They are especially close-knit and have, by and large, strong, dense ties with other members. Almost all Malays in Singapore are Muslims, and so their shared customs, traditions and values are extensively shaped by the Islamic religion. Their identity is further strengthened by speaking a common ethnic mother tongue, the Malay language, which is strongly associated with and forms an integral part of the Malay ethnic, cultural and religious identity in Singapore (Kassim, 2008). Being in a multicultural society and one that is increasingly English dominant did not erode their Malay identity. In a survey involving over 400 Malay Singaporeans, Mathews & Selvarajan (2020) found that while the participants had a strong multicultural identity, they still held a strong sense of Malay ethnic and cultural identity; 96.9% of the participants identified with Malay culture and 95.7% indicated a strong affinity to the Malay language. Even young people who are becoming more English dominant still showed a strong sense of ethnic group-belonging as well as a sense of inheritance and affiliation for the Malay language (Chong & Seilhamer, 2014). Most of the participants in this study can be said to be archetypal Malay families who were closely affiliated to the ethnic community. They observed Malay traditions and customs and practised the Muslim faith. Many of them also sent their children to Islamic preschools and kindergartens that offered Islamic studies and the Malay language in addition to the mainstream curriculum. As Mathews & Selvarajan (2020) highlighted, "intangible boundaries carved out to demarcate Malayness do exist (p. 732)", and it is argued here that a distinctly Malay-influenced English repertoire, with coda clear-l being one of the many distinctive features, is maintained and may be used variably by members of the Malay community for such an endeavour. Its use in CDS is essential in helping children construct a full sociolinguistic repertoire (Foulkes et al., 2005).

Mothers' use of darker coda /l/ and/or producing more l-less tokens in formal contexts is not unexpected. It was previously mentioned that Singaporeans have in their English repertoire alternative forms associated with standard and local varieties. Standard forms are often regarded as prescriptively correct in Singapore, and there is public awareness of their social value; they are accorded social prestige and their use evokes semiotic connections to education, high social status, formality, and 'correctness' (e.g. Cavallaro et al., 2014; Sim, 2021). The shift from using a clearer variant of coda /l/ to other variants in contexts of teaching and reading, therefore, can be interpreted as the adoption of a more mainstream/standard repertoire, a style that mothers deemed as most appropriate for teaching and learning, which also coincides with the style that is preferred in formal language classrooms. Although mothers M6 and Mi1, who were more Malay dominant, did not show positional contrasts in their laterals by producing darker /l/, they showed the highest percentage increase of l-less tokens in formal contexts, and therefore it seems

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

that mothers were using different strategies for the same aim, based on their individual linguistic repertoire. This perspective is supported by findings from previous studies in which more standard forms were used by mothers with children in formal contexts (e.g. Smith et al., 2007) and/or for pedagogical reasons (e.g. Roberts, 1999; 2013), and also mirrors the shift from a more ethnic to a more mainstream repertoire by some ethnolect speakers when speaking to their children (e.g. 'Anwar' in Sharma, 2011). Further, this shift in style was not limited to segmental modifications. Perceptually, mothers in this present study, and sometimes fathers, approximated a hybrid accent that was not purely colloquial when teaching or reading, with the differences most noticeable in its prosody.

Fathers in this study were found to make little adjustments to their use of /l/ in their CDS relative to mothers. The findings tie well with what was previously reported in Foulkes et al. (2005) based on the limited data of three male adults, and provide further insights into the grossly understudied area of socially-conditioned phonetic variation in paternal CDS. Social forces such as cultural or societal norms that constrain or influence language choices may offer a more satisfactory account, since the language-external/social factors that were considered in this study failed to correlate with gender. One explanation could be the differentiation of gender roles. The traditional Malay family is patriarchal; the husband is the breadwinner, while the wife manages the household and takes on the primary role of the caregiver. Despite the rise in Malay women's participation in the workforce, such rigid gender roles remained dominant (Sumartono & Sumartono, 2017). In her qualitative study of ten dual-income Malay families in Singapore, Suratman (2011) found that while there was more sharing of child care and household tasks between husbands and wives, women 'gate-keep' by managing the delegation of family work based on their evaluation of the ability or efficiency of their husbands in performing these tasks. Such segregation of roles was also observed in the husbands, as they delegated child caring responsibilities to their wives. In the Malay community, gender roles such as women's duty in child-rearing do not only have a cultural underpinning, but also a religious one. Mothers therefore take on the mantle of role model and teacher of language at home. The use of a darker variant of /l/ by mothers but not fathers is consistent with the 'gender pattern' that has been widely reported across different cultural and linguistic contexts, in which women generally use more standard variants and conform more closely than men to sociolinguistic norms that are overtly associated with prestige (Labov, 2006). This suggests that the gendered differences observed could have been a result of and enabled by mothers having a wider overall repertoire range compared to fathers. In her study of second generation British-born Asians, Sharma (2011) found that gender was not directly correlated with how varied her subjects' repertoires were, but a more varied repertoire was in part due to the need for such differentiation. She postulated that older British Asian men had a more complex repertoire range because of a need to maintain strong transnational ties to India and also the need to pass as British because of the pervasive hostility toward migrant families. In the same way, Malay women might have a more differentiated repertoire because of a need to do so. Due to the predominantly patriarchal Malay community, coupled with the socio-economic disadvantages of and relatively poorer access to social resources such as higher education by the ethnic Malay minority (see Mutalib, 2012, chapter 4), Malay women may need to do more to be successful and adapt/conform in order to gain greater social mobility, and therefore show a more nuanced use of linguistic resources, especially prestige forms and standard varieties. Therefore, in addition to the maintenance and use of ethnically-distinct variants for their sociocultural capital, young Malay women also have in their repertoire prestige forms possibly for their symbolic expressions of status or to access social, political or economic power (Schilling, 2011; Queen, 2013). This perspective is aligned with the findings of Cavallaro and Serwe (2010). In a study of the language use patterns of 233 Malay Singaporeans in various domains and towards family, relatives and close Malay friends, they found that their female participants in the 18–24 year old group, which coincides with the age of the caregivers in this study, used more English than their male counterparts. They drew parallels between these young Malay women and women of other societies who used the language variety of prestige in a bid to move up the social ladder, and commented that the higher use of English by the younger Malay women in their study reflected their higher educational and career aspirations. Based on their BLP results, mothers in this study also had a more positive attitude towards the use of English and were more strongly affiliated to an English-speaking culture than most fathers, and so did the two fathers who had used more l-less tokens with their very young children in formal contexts. Interestingly, the father of the next youngest child, who did not produce more l-less tokens in formal contexts, did not identify with the English-speaking culture at all (i.e. a rating of '0'). Finally, the findings can be explained by the observed general differences between maternal and paternal CDS. Studies in paternal infant-directed speech have found that fathers do indeed modify acoustic properties in CDS, but not to the same extent as mothers, and they also accommodate less. The way fathers modify their speech also differs across societies and cultures (Broesch & Bryant, 2018). Moreover, some studies found that fathers play a special role in facilitating language learning by using more complex speech than mothers, and this contributes significantly to the child's later language development (e.g. Pancsofar & Vernon-Feagans, 2006). These suggest that both mothers and fathers play a role in the language development of their children, but in different ways. In addition, age-correlated effects in CDS could also be different for mothers and fathers. Warren-Leubecker & Bohannon (1984) studied the intonational patterns in CDS between mothers and fathers in their dyadic interactions with their 2-year-old children or 5-year-old children. They found that mothers raised their pitch equally for both ages of child listeners but used a greater pitch range when speaking with the younger children. In contrast, fathers increased their pitch and ranges even more than mothers when addressing younger children, but did not differentiate between 5-year-old and adult listeners. Thus, the older children in this study could also be a contributing factor to why there was no variation in paternal CDS for most fathers.

Some age effects were observed in the fathers; as mentioned, in formal contexts, fathers of younger children used more l-less tokens. However, due to a lack of a balanced sample, these effects should be interpreted with caution. Other social factors like gender of the children and social class of the families did not significantly modulate the darkness of the laterals in CDS in this study. Previous studies have shown that more standard forms were used with girls, but the same effect was not found. Again, one reason could be the unbalanced sample, given that there were only three girls. If there were indeed gender effects, however, we should expect to see little variation in mothers' use of /l/ with the seven boys, but this was not the case. Foulkes et al. (2005) and Foulkes and Docherty (2006) explained that the variation in CDS was a result of mothers tailoring their speech in line with the emerging gender of their children and community norms. No gender differentiation in the use of clear-l by Malay Singaporeans was reported in Sim (2015, 2019), and perhaps this could also explain the lack of variation in CDS according to the gender of child in this study. A study with a cross-sectional design that includes more children could be conducted in the future to examine these effects further. That the use of a clearer coda /l/ by these participants was not differentiated by social class is also expected, given that ethnically distinct features can be used by any member of the community. Social class, however, can be associated with predictors of ethnic accentedness, such as social networks and language background, but participants in this study did not differ much in these aspects.

The variation in CDS that has been described reveals the complexity of phonological acquisition in the bilingual children of these caregivers, and this also applies to heritage speakers or speakers of contact languages. Not only is there a mixed representation of two or even three allophones of /l/ in their English input, which may appear to the child as probabilistic, but clearer coda /l/ is also shared with their other language, Malay. Further, this variation is only present in maternal CDS, but not paternal CDS. The frequency of clearer coda /l/ in the ambient language environment is therefore considerably higher than that of the darker or l-less variant. In this case, we might expect them to show a preference to the most frequently encountered variant, as also observed in the studies previously described (e.g. Khattab, 2002; Kirkham, 2017). Preliminary analysis of the children's production in casual interactions indeed revealed that they used relatively clearer-l in all syllable positions, regardless of which parent the children were speaking to. Two questions remain to be explored. The first is with regard to the acquisition of darker /l/ and its stylistic constraints of use. As previously discussed, not only do monolingual children acquire sociolinguistic variation at an early age (Nardy et al., 2013), but bilinguals may also use different variants for various purposes (e.g. Khattab, 2002; Sharma, 2011). However, the linguistic and social salience of a feature can affect when it is acquired (Foulkes & Hay, 2015). In the Singapore context, the prominence of dark-l may only increase as the children are exposed to other situations where dark-l is used, such as in mass media or in schools, and during which will they have greater access to and a better understanding of its indexical associations. The second question is whether Malay adults and children phonetically distinguish between the clearer variant of coda /l/ in their Malay and English. A few studies have consistently shown cross-linguistic influence between the lateral systems of both languages, showing evidence of similar categories merging, or darker laterals being clearer than those of their monolingual counterparts (Barlow et al., 2013; Khattab, 2011; Simonet, 2010a). The case is slightly different here, because clear-l is found in both lateral systems instead of one, and bilinguals may show 'deflecting effects' (Kehoe, 2015), in order to maximise the contrast between the two language systems.

This study set out to better understand whether, how and why Singaporean English-Malay bilingual caregivers vary their use of syllable-final /l/ in the child-directed speech towards their preschoolers. Consistent with previous studies on bilectal monolinguals and ethnolect speakers that involved socially-conditioned segmental modifications, this study has shown how mothers but less so fathers varied their production of /l/ in their CDS according to the communicative intent and their potential socio-indexical associations, and also explored how CDS patterns may be shaped by cultural norms and expectations. More importantly, it illustrates the linguistic and sociolinguistic complexity in language acquisition by children in similar multilingual and multicultural contexts, and stresses that external factors play an integral role in the acquisition process. Given that the input they receive is highly varied but not necessarily probabilistic, an area in language acquisition that is worth further exploration is thus how these children negotiate such complexity in their input, and the effects it has on their language development.

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### Appendix A

Regression coefficients of a full mixed-effects logistic regression model fit to the realisation of coda laterals of mothers with realisation (l-less or retained) as response

| **Fixed factors** | **Level** | ***n*** | ***B*** | ***SE*** | **Odds Ratio** | **[95% CI]** | ***p*** |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (Intercept) | | | 1.45 | 0.89 | 4.25 | 0.74 – 24.37 | 0.10 |
| Formality | Formal | 509 | -0.69 | 0.39 | 0.50 | 0.24 – 1.08 | 0.08 |
| Neighbouring consonant | Coronal | 263 | 0.40 | 0.33 | 1.49 | 0.78 – 2.85 | 0.23 |
| | Glottal | 14 | 1.13 | 0.77 | 3.08 | 0.69 – 13.87 | 0.14 |
| | Labial | 134 | -1.11 | 0.41 | 0.33 | 0.15 – 0.74 | **0.008** |
| | Glide | 30 | 0.26 | 0.57 | 1.30 | 0.43 – 3.97 | 0.64 |
| | Velar | 25 | -0.78 | 0.79 | 0.46 | 0.10 – 2.17 | 0.33 |
| Lexical stress | Stressed | 440 | -0.89 | 0.70 | 0.41 | 0.10 – 1.62 | 0.20 |
| Vowel height | Close-mid | 274 | 0.36 | 0.72 | 1.43 | 0.35 – 5.90 | 0.62 |
| | Open | 17 | 1.50 | 1.35 | 4.48 | 0.32 – 63.15 | 0.27 |
| | Open-mid | 263 | -0.26 | 0.54 | 0.77 | 0.27 – 2.22 | 0.63 |
| Vowel advancement | Central | 232 | -2.13 | 0.90 | 0.12 | 0.02 – 0.69 | **0.02** |
| | Front | 221 | -0.39 | 0.53 | 0.67 | 0.24 – 1.91 | 0.46 |
| BLP | | | -0.01 | 0.01 | 0.99 | 0.97 – 1.02 | 0.64 |
| SES | | | 0.37 | 0.22 | 1.44 | 0.95 – 2.20 | 0.09 |
| Age of child | | | 0.04 | 0.04 | 1.05 | 0.96 – 1.13 | 0.28 |
| Gender of child | Female | 199 | 0.55 | 1.29 | 1.73 | 0.14 – 21.72 | 0.67 |
| Formality × SES | | | -0.31 | 0.20 | 0.74 | 0.49 – 1.09 | 0.13 |
| Formality × BLP | | | 0.01 | 0.01 | 1.01 | 0.99 – 1.04 | 0.16 |
| Formality × Age of child | | | -0.01 | 0.04 | 0.99 | 0.92 – 1.07 | 0.83 |
| Formality × Gender of child | | | -1.61 | 1.22 | 0.20 | 0.02 – 2.16 | 0.18 |

Note: CI = confidence interval. Response variable is l-less (0) or retained (1). Reference category for formality is informal (*n* = 167), neighbouring consonant is pause (*n* = 210), lexical stress is unstressed (*n* = 236), vowel height is close (*n* = 122), vowel advancement is back (*n* = 223), gender of child is male (*n* = 477). **Full model**: glmer(realisation ~ formality + neighbouring consonant + lexical stress + vowel height + vowel advancement + BLP + SES + age of child + gender of child + formality:SES + formality:BLP + formality:age of child + formality:gender of child + (1 + formality|subject) + (1 + formality|word)). Observations = 676, marginal $R^2$ = 0.20, conditional $R^2$ = 0.57, AIC = 750.08. **Reduced model**: glmer(realisation ~ formality + neighbouring consonant + (1 + formality|subject) + (1 + formality|word)). Observations = 676, marginal $R^2$ = 0.06, conditional $R^2$ = 0.56, AIC = 744.45.

**Appendix B**

Regression coefficients of a full mixed-effects logistic regression model fit to the realisation of coda laterals of fathers with realisation (l-less or retained) as response

| **Fixed factors** | **Level** | ***n*** | ***B*** | ***SE*** | **Odds Ratio** | **[95% CI]** | ***p*** |
|---|---|---|---|---|---|---|---|
| (Intercept) | | | 1.31 | 0.75 | 3.70 | 0.85 – 16.05 | 0.08 |
| Formality | Formal | 408 | -0.42 | 0.46 | 0.66 | 0.26 – 1.64 | 0.37 |
| Neighbouring consonant | Coronal | 160 | -0.55 | 0.32 | 0.58 | 0.31 – 1.08 | 0.09 |
| | Glottal | 22 | 0.40 | 0.66 | 1.48 | 0.41 – 5.37 | 0.55 |
| | Labial | 87 | -1.30 | 0.43 | 0.27 | 0.12 – 0.63 | **0.003** |
| | Glide | 25 | 0.30 | 0.62 | 1.35 | 0.40 – 4.59 | 0.63 |
| | Velar | 28 | -1.60 | 0.65 | 0.20 | 0.06 – 0.71 | **0.01** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lexical stress | Stressed | 322 | 0.63 | 0.53 | 1.88 | 0.66 – 5.34 | 0.24 |
| Vowel height | Close-mid | 266 | 0.01 | 0.58 | 1.01 | 0.32 – 3.15 | 0.99 |
| | Open | 9 | 0.77 | 1.21 | 2.15 | 0.20 – 23.06 | 0.53 |
| | Open-mid | 164 | -0.77 | 0.49 | 0.46 | 0.18 – 1.20 | 0.11 |
| Vowel advancement | Central | 208 | -1.40 | 0.68 | 0.25 | 0.07 – 0.93 | **0.04** |
| | Front | 165 | -1.52 | 0.44 | 0.22 | 0.09 – 0.52 | **< 0.001** |
| BLP | | | 0.0003 | 0.01 | 1.00 | 0.99 – 1.01 | 0.96 |
| SES | | | 0.005 | 0.15 | 1.00 | 0.75 – 1.34 | 0.98 |
| Age of child | | | -0.05 | 0.04 | 0.95 | 0.89 – 1.02 | 0.19 |
| Gender of child | Female | 179 | 1.11 | 0.80 | 3.03 | 0.63 – 14.53 | 0.17 |
| Formality × SES | | | -0.13 | 0.15 | 0.88 | 0.65 – 1.18 | 0.38 |
| Formality × BLP | | | 0.001 | 0.01 | 1.00 | 0.99 – 1.01 | 0.82 |
| Formality × Age of child | | | 0.09 | 0.04 | 1.09 | 1.02 – 1.17 | **0.01** |
| Formality × Gender of child | | | 0.38 | 0.78 | 1.46 | 0.32 – 6.77 | 0.63 |

Note: CI = confidence interval. Response variable is l-less (0) or retained (1). Reference category for formality is informal (*n* = 126), neighbouring consonant is pause (*n* = 212), lexical stress is unstressed (*n* = 212), vowel height is close (*n* = 95), vowel advancement is back (*n* = 161), gender of child is male (*n* = 355). **Full model**: glmer(realisation ~ formality + neighbouring consonant + lexical stress + vowel height + vowel advancement + BLP + SES + age of child + gender of child + formality:SES + formality:BLP + formality:age of child + formality:gender of child + (1 + formality|subject) + (1 + formality|word)). Observations = 534, marginal $R^2$ = 0.25, conditional $R^2$ = 0.54, AIC = 620.36. **Reduced model**: glmer(realisation ~ formality*age of child + neighbouring consonant + vowel advancement + (1 + formality*age of child|subject) + (1 + formality+age of child|word)). Observations = 534, marginal $R^2$ = 0.15, conditional $R^2$ = 0.60, AIC = 621.57.

**Appendix C**

Regression coefficients of a full mixed-effects linear regression model fit to the consonantal laterals across entire dataset with F2–F1 (Bark) as response

| **Fixed factors** | **Level** | ***n*** | ***β*** | ***B*** | **SE** | ***t*** | ***p*** |
|---|---|---|---|---|---|---|---|
| (Intercept) | | | 0.05 | 7.43 | 0.31 | 24.38 | **< 0.001** |
| Formality | Formal | 754 | 0.01 | 0.01 | 0.19 | 0.06 | 0.95 |
| Position | Coda | 537 | 0.01 | 0.02 | 0.25 | 0.06 | 0.95 |
| Vowel context | | | 0.47 | 0.39 | 0.03 | 15.09 | **< 0.001** |
| Neighbouring consonant | Coronal | 369 | 0.05 | 0.08 | 0.10 | 0.82 | 0.42 |
| | Glottal | 26 | 0.03 | 0.05 | 0.22 | 0.22 | 0.83 |
| | Labial | 310 | -0.27 | -0.43 | 0.13 | -3.24 | **0.001** |
| | Glide | 31 | 0.21 | 0.33 | 0.21 | 1.57 | 0.12 |
| | Velar | 60 | -0.14 | -0.22 | 0.17 | -1.29 | 0.20 |
| Lexical stress | Stressed | 905 | 0.02 | 0.032 | 0.14 | 0.22 | 0.82 |
| Lateral duration (log) | | | 0.04 | 0.11 | 0.07 | 1.58 | 0.11 |
| Parent | Mothers | 539 | 0.08 | 0.12 | 0.25 | 0.47 | 0.64 |
| BLP | | | 0.03 | 0.001 | 0.002 | 0.54 | 0.59 |
| SES | | | 0.05 | 0.03 | 0.04 | 0.81 | 0.42 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Age of child | | | -0.01 | -0.001 | 0.01 | -0.09 | 0.93 |
| Gender of child | Female | 321 | 0.15 | 0.24 | 0.21 | 1.17 | 0.24 |
| Formality × Parent | | | 0.17 | 0.27 | 0.27 | 1.01 | 0.31 |
| Formality × Position | | | -0.20 | -0.31 | 0.35 | -0.90 | 0.37 |
| Parent × Position | | | -0.21 | -0.33 | 0.35 | -0.95 | 0.34 |
| Formality × Parent × Position | | | -0.70 | -1.10 | 0.50 | -2.17 | **0.03** |

Note: Reference category for formality is informal (*n* = 342), syllable position is onset (*n* = 559), neighbouring consonant is pause (*n* = 300), lexical stress is unstressed (*n* = 191), parent is fathers (*n* = 557), and gender of child is male (*n* = 775). Model: lmer(f2_f1_bark ~ formality*position*parent + vowel context + neighbouring consonant + lexical stress + lateral duration (log) + BLP + SES + age of child + gender of child + (1 + formality*position + parent|subject) + (1 + formality + position + parent|word)). Observations = 1096, marginal $R^2$ = 0.37, conditional $R^2$ = 0.70, AIC = 3425.02.

**Appendix D**

Regression coefficients of a full mixed-effects linear regression model fit to the consonantal laterals produced by mothers with F2–F1 (Bark) as response

| **Fixed factors** | | ***n*** | ***β*** | ***B*** | **SE** | ***t*** | ***p*** |
|---|---|---|---|---|---|---|---|
| (Intercept) | | | 0.26 | 8.32 | 0.53 | 15.72 | **< 0.001** |
| Formality | Formal | 360 | 0.15 | 0.28 | 0.35 | 0.81 | 0.42 |
| Position | Coda | 255 | -0.18 | -0.28 | 0.56 | -0.50 | 0.62 |
| Vowel context | | | 0.44 | 0.39 | 0.04 | 10.50 | **< 0.001** |
| Neighbouring consonant | Coronal | 208 | -0.05 | -0.10 | 0.17 | -0.60 | 0.55 |
| | Glottal | 9 | -0.02 | -0.04 | 0.45 | -0.10 | 0.92 |
| | Labial | 144 | -0.20 | -0.38 | 0.22 | -1.75 | 0.08 |
| | Glide | 13 | 0.26 | 0.49 | 0.37 | 1.32 | 0.19 |
| | Velar | 26 | -0.23 | -0.42 | 0.30 | -1.42 | 0.15 |
| Lateral duration (log) | | | 0.07 | 0.23 | 0.11 | 2.19 | **0.03** |
| Lexical stress | Stressed | 458 | -0.05 | -0.09 | 0.26 | -0.35 | 0.73 |
| BLP | | | -0.18 | -0.01 | 0.01 | -1.22 | 0.22 |
| SES | | | 0.05 | 0.03 | 0.11 | 0.31 | 0.75 |
| Age of child | | | -0.19 | -0.03 | 0.02 | -1.34 | 0.18 |
| Gender of child | Female | 129 | -0.24 | -0.45 | 0.66 | -0.67 | 0.50 |
| Formality × Position | | | -0.77 | -1.45 | 0.77 | -1.89 | 0.06 |
| Formality × BLP | | | -0.001 | 0.00 | 0.01 | -0.01 | 1.00 |
| Formality × SES | | | 0.04 | 0.03 | 0.10 | 0.25 | 0.80 |
| Formality × Age of child | | | 0.15 | 0.03 | 0.02 | 1.08 | 0.28 |
| Formality × Gender of child | | | 0.23 | 0.42 | 0.66 | 0.63 | 0.53 |
| Position × BLP | | | -0.08 | -0.003 | 0.01 | -0.32 | 0.75 |
| Position × SES | | | 0.01 | 0.01 | 0.19 | 0.04 | 0.97 |
| Position × Age of child | | | 0.29 | 0.05 | 0.04 | 1.21 | 0.23 |
| Position × Gender | | | 0.23 | 0.42 | 1.15 | 0.37 | 0.71 |
| Formality × Position × BLP | | | -0.01 | -0.001 | 0.02 | -0.03 | 0.98 |
| Formality × Position × SES | | | 0.09 | 0.06 | 0.25 | 0.25 | 0.80 |
| Formality × Position × Age of child | | | -0.58 | -0.10 | 0.05 | -1.79 | 0.07 |

| | | | | | |
|---|---|---|---|---|---|
| Formality × Position × Gender of child | -0.55 | -1.02 | 1.51 | -0.67 | 0.50 |

Note: Reference category for formality is informal (*n* = 179), syllable position is onset (*n* = 284), neighbouring consonant is pause (*n* = 139), lexical stress is unstressed (*n* = 81), and gender of child is male (*n* = 410). **Full model**: lmer(f2_f1_bark ~ formality + position + vowel context + neighbouring consonant + lateral duration (log) + lexical stress + BLP + SES + age of child + gender of child + formality*position + formality*position*BLP + formality*position*SES + formality*position*age of child + formality*position*gender of child + (1 + formality*position|subject) + (1 + formality + position|word)). Observations = 539, marginal $R^2$ = 0.47, conditional $R^2$ = 0.76, AIC = 1918.67. **Reduced model**: lmer(f2_f1_bark ~ formality*position + vowel context + lateral duration (log) + (1 + formality*position|subject) + (1 + formality + position|word)). Observations = 539, marginal $R^2$ = 0.42, conditional $R^2$ = 0.75, AIC = 1820.74.

**Appendix E**

Regression coefficients of a full mixed-effects linear regression model fit to the consonantal laterals produced by fathers with F2–F1 (Bark) as response

| **Fixed factors** | | ***n*** | ***β*** | ***B*** | **SE** | ***t*** | ***p*** |
|---|---|---|---|---|---|---|---|
| (Intercept) | | | -0.05 | 7.08 | 0.37 | 19.36 | **< 0.001** |
| Formality | Formal | 394 | -0.07 | -0.15 | 0.18 | -0.83 | 0.41 |
| Position | Coda | 282 | 0.07 | 0.04 | 0.25 | 0.17 | 0.86 |
| Vowel context | | | 0.47 | 0.35 | 0.04 | 9.85 | **< 0.001** |
| Neighbouring consonant | Coronal | 161 | 0.14 | 0.16 | 0.12 | 1.40 | 0.16 |
| | Glottal | 17 | 0.05 | 0.07 | 0.24 | 0.27 | 0.78 |
| | Labial | 166 | -0.37 | -0.44 | 0.15 | -2.87 | **< 0.01** |
| | Glide | 18 | 0.17 | 0.21 | 0.24 | 0.87 | 0.38 |
| | Velar | 34 | -0.12 | -0.14 | 0.20 | -0.69 | 0.49 |
| Lateral duration (log) | | | 0.01 | 0.02 | 0.08 | 0.25 | 0.81 |
| Lexical stress | Stressed | 447 | 0.16 | 0.19 | 0.16 | 1.14 | 0.26 |
| BLP | | | 0.10 | 0.003 | 0.003 | 0.84 | 0.40 |
| SES | | | 0.26 | 0.10 | 0.07 | 1.42 | 0.16 |
| Age of child | | | -0.05 | -0.01 | 0.02 | -0.30 | 0.77 |
| Gender of child | Female | 192 | 0.19 | 0.22 | 0.39 | 0.58 | 0.56 |
| Formality × Position | | | -0.20 | -0.18 | 0.29 | -0.63 | 0.53 |
| Formality × BLP | | | -0.12 | -0.003 | 0.003 | -1.07 | 0.28 |
| Formality × SES | | | -0.21 | -0.08 | 0.07 | -1.24 | 0.22 |
| Formality × Age of child | | | -0.01 | -0.001 | 0.02 | -0.05 | 0.96 |
| Formality × Gender of child | | | 0.20 | 0.24 | 0.35 | 0.69 | 0.49 |
| Position × BLP | | | -0.03 | -0.001 | 0.003 | -0.28 | 0.78 |
| Position × SES | | | -0.19 | -0.07 | 0.06 | -1.10 | 0.27 |
| Position × Age of child | | | 0.04 | 0.004 | 0.02 | 0.27 | 0.79 |
| Position × Gender | | | 0.06 | 0.07 | 0.39 | 0.18 | 0.86 |
| Formality × Position × BLP | | | 0.15 | 0.004 | 0.004 | 0.90 | 0.37 |
| Formality × Position × SES | | | 0.04 | 0.02 | 0.10 | 0.16 | 0.87 |
| Formality × Position × Age of child | | | 0.02 | 0.002 | 0.02 | 0.08 | 0.94 |

| | | | | | |
|---|---|---|---|---|---|
| Formality × Position × Gender of child | -0.19 | -0.22 | 0.54 | -0.41 | 0.68 |

Note: Reference category for formality is informal (*n* = 163), syllable position is onset (*n* = 275), neighbouring consonant is pause (*n* = 161), lexical stress is unstressed (*n* = 110), and gender of child is male (*n* = 365). **Full model**: lmer(f2_f1_bark ~ formality + position + vowel context + neighbouring consonant + lateral duration (log) + lexical stress + BLP + SES + age of child + gender of child + formality*position + formality*position*BLP + formality*position*SES + formality*position*age of child + formality*position*gender of child + (1 + formality*position|subject) + (1|word)). Observations = 557, marginal $R^2$ = 0.26, conditional $R^2$ = 0.60, AIC = 1670.76. **Reduced model**: lmer(f2_f1_bark ~ formality*position + vowel context + neighbouring consonant + (1 + formality*position|subject) + (1|word)). Observations = 557, marginal $R^2$ = 0.25, conditional $R^2$ = 0.59, AIC = 1552.50.

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