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The Effect of Indian Contact and Glaswegian Contact on the Phonetic Backward Transfer of Glaswegian English (L2) on Hindi and Indian English (L1)

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Abstract: This study examined phonetic backward transfer in 'Glaswasians', the ethnolinguistic minority of first-generation bilingual immigrant Indians in Glasgow (Scotland), who present a situation of contact between their native languages of Hindi and Indian English (L1s) and the dominant host language and dialect, Glaswegian English (L2). This was examined in relation to the Revised Speech Learning Model (SLM-r) and Speech Accommodation Framework. These predict that the migrants' L1 sound categories can either shift to become more Glaswegian-like ('assimilation' or 'convergence') or exaggeratedly Indian-like ('dissimilation' or 'divergence') or remain unchanged. The effect of Indian and Glaswegian Contact on transfer was also investigated. Two control groups (Indians and Glaswegians) and the experimental group (Glaswasians) were recorded reading English and Hindi sentences containing multiple phones which were examined for multiple phonetic features (/t/—VOT, /l/—F2-F1 difference, /b d g/—Relative Burst Intensity). In both languages, Glaswasian /t/ and /g/ became more Glaswegian-like (assimilation), whereas F2-F1 difference in /l/ became exaggeratedly Indian-like (dissimilation). Higher Indian Contact was associated with more native-like values in /t/ and /l/ in Hindi but had no influence on /g/. Higher Glaswegian Contact was related to increased assimilation of /g/ in English but had no effect on /l/ and /t/.

Keywords: phonetic backward transfer; Indian English; Glaswegian English; Hindi; Indian Contact; Glaswegian Contact; speech accommodation; Glasgow-Indian; voiced stops; lateral

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1. Introduction

Languages in a bilingual mind are known to interact and influence each other (Barlow 2014; Flege 1995; Flege and Bohn 2021; Jarvis and Pavlenko 2008; Kroll et al. 2012; Pavlenko and Jarvis 2002; Weinreich 1953). This influence can be from the first language (L1) to the second language (L2) (*forward transfer*; Lado 1957) or from L2 to L1 (*backward transfer*; Cook 2003; Kartushina et al. 2016b). The present study is concerned with the unidirectional influence or 'backward transfer' of a second or new language on the L1 in bilingual speakers.

In previous research, among other approaches, changes in the phonology of the L1 due to the influence of another linguistic variety have been examined from two perspectives that are relevant to the present study. The first is phonetic backward transfer (Cook 2003; Kartushina et al. 2016b), which has also been recognised in the wider literature as L1 phonetic drift (Chang 2012, 2013) or L1 phonetic attrition (Bergmann et al. 2016; de Leeuw et al. 2007; Köpke 2007; Mayr et al. 2012; Schmid and Köpke 2019b; Seliger 1996) or drift (Chang 2012, 2013). The second perspective is L1 phonetic accommodation (Babel 2009; Giles and Powesland 1997; Kim et al. 2011; Kim 2012; MacLeod 2012; Olmstead et al. 2021; Pardo 2006; Sachdev et al. 2012), where the new linguistic variety acts as an ambient language, not necessarily learned by the speaker. This is usually the case when a monolingual is in contact with another dialect (or accent; D2), which influences their D1. However, a situation of language contact that has not been examined before is

when a speaker is native in two languages and is exposed to a new linguistic variety that simultaneously acts not only as a new language but also as a new dialect with respect to the bilinguals' previously acquired native varieties.

The above situation is depicted in Figure 1 with the help of the experimental group in this study. The ethnolinguistic immigrant minority of first-generation bilingual Indians in Glasgow 'Glaswasians' (Alam 2015) presents the perfect opportunity to compare backward transfer effects between languages and dialects. The term 'Glaswasian' was introduced by Alam (Alam 2015; Stuart-Smith et al. 2011) to refer to the South-Asian minority in Glasgow. Here, it has been extended to refer to the first-generation Indian immigrant population in Glasgow. These Glaswasians were bilingual in Hindi and English (Indian English; IE) prior to migrating to Glasgow (Scotland), where the host dominant variety is Glaswegian English (GE). Interestingly, Glaswasians' L1 Hindi is a different language to Glaswegian English and Glaswasians' L1 Indian English is a different dialect to Glaswegian English. This presents an interesting situation of simultaneous bilingual and bidialectal contact and allows for the examination of how a host dominant language (Glaswegian English), which is both a new dialect (with respect to Indian English) and a new language (with respect to Hindi), would influence these native varieties.

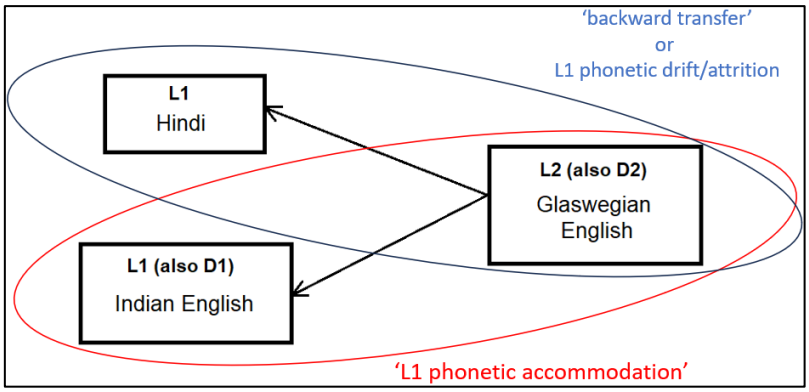

Figure 1. L1 phonetic shift towards L2 examined under the backward transfer or L1 attrition/drift framework and D1 phonetic accommodation to D2 studied under the 'speech accommodation' framework.

The abovementioned frameworks are further explained in detail in the sub-sections below.

1.1. Backward Transfer: Revised Speech Learning Model (SLM-r)

A strong theoretical account of the influence of L2 on L1 in speech production and speech perception comes from Flege and Bohn's SLM-r (Flege and Bohn 2021). SLM-r holds that L1 and L2 sounds exist in a shared phonetic space. The changes in the L1 are the result of the reorganisation of this space to accommodate the new L2 sounds. This reorganisation of the common phonetic space may happen in two ways: by forming new L2 categories, via the process of 'dissimilation', or by modifying existing L1 categories, via the process of 'assimilation'. A big contributor to determining which of these two processes will happen is the perceived cross-linguistic similarity between L1–L2 categories.

SLM-r argues that by the automatic and subconscious process of 'interlingual identification', L2 learners perceive the full range of L2 sounds as instances of one or more L1 phonetic categories (Bohn 2018). In this way, 'perceptual linkages' are formed between a specific L2 sound and the corresponding L1 category that it has mapped onto, at a position-sensitive allophonic level.

One way of reorganizing the phonetic space is through a process called *category dissimilation*. This occurs when an L2 learner identifies enough dissimilarity between perceptually linked L1–L2 categories ('diaphones'; Weinreich 1953), leading to a breakage of the link between these categories and the creation of a separate category for the corresponding L2 sound. In doing so, the L1 category, which specifies the language-specific features of that

category, may be deflected away from this newly formed L2 category in the common phonetic system to maintain a contrast between them. Due to this deflection, the features of that L1 category are exaggerated to highlight this contrast from the corresponding L2 category.

The evidence for dissimilation comes from multiple studies. Flege and Eefting (1987a) found that Dutch–English bilinguals with high proficiency in L2 English produced L1 Dutch /t/ with shorter VOT than what is found in Dutch. This means that the bilinguals exaggerated the shorter Dutch VOT characteristic of monolinguals to contrast it with the longer English VOT. Flege and Eefting (1987b) examined various groups of childhood Spanish–English bilinguals for VOT in /p t k/. Again, all bilingual groups produced their L1 Spanish VOT with significantly shorter VOT values than age-matched native Spanish monolinguals to maintain a contrast from the similar but longer English VOT patterns. Dissimilation has also been reported in vowels. Guion (2003) found that early Quichua-Spanish bilinguals successfully partitioned their vowel space to accommodate their L1 and L2 vowels, but at the cost of a systemic raising of the L1 vowels to maintain a perceptual distinction with the L2 vowels. Furthermore, Flege et al. (2003) reported dissimilation in early Italian–English bilinguals in Canada who contrasted English /e$^{\text{I}}$/with Italian /e/ indicating that they had formed a new category for the English vowel while also dissimilating the native Italian category.

Another way of organising the phonetic space is through a process called *L1 category assimilation*. That is, it is also possible that L2 learners are unable to distinguish between highly phonetically similar diaphones because of the *perceptual mechanism of equivalence classification*. When that happens, then instead of creating a new L2 category, the linked L1–L2 categories are merged such that the corresponding L1 category will be changed to reflect the characteristics of the linked L2 category.

Again, support for assimilation comes from multiple studies on consonants as well as vowels. Much research has found evidence of assimilation in relation to long-term immersion in L2 environments. Bergmann et al. (2016) found this in adult German–English bilinguals in America. They observed that formants for German /a:/ and /l/ had shifted towards the corresponding L2 values. de Leeuw et al. (2013) also examined a group of German–English bilinguals (in Canada) for the production of /l/. The results showed an influence of the darker Canadian English /l/ such that the L1 German /l/ became darker. Lev-Ari and Peperkamp (2013) also found evidence for assimilation in late English–French bilinguals in France. They found that the VOT for English voiceless stops had significantly reduced and become like the shorter VOT in French voiceless stops. Mayr et al. (2012) studied attrition in two L1 Dutch monozygotic twin sisters. The sister who had been immersed in an L2 English environment for more than 30 years showed longer VOT values for voiceless stops in L1 Dutch, influenced by the longer VOT for voiceless stops in English. Stoehr et al. (2017) found similar results for German–Dutch bilinguals for VOT for all three voiceless stops /p t k/. Instances of assimilation have also been reported by Major (1992) in English–Portuguese bilinguals, Harada (2003) in Japanese–English bilinguals, Kang and Guion (2006) in Korean–English bilinguals for VOT in voiceless stops, and de Leeuw et al. (2018) in Albanian–English bilinguals and Barlow (2014) in Spanish–American English bilinguals for /l/.

Another set of studies on phonetic drift informs us that such assimilatory shifts can be experienced not only by long-term immersed bilinguals but also by new learners of an L2. Chang (2012, 2013) found this in L1 English students who were in Korea for a six-week beginners' course in Korean for VOT in voiced and voiceless stops. Kartushina et al. (2016a) reported this in monolingual French speakers who were trained to produce two non-native Russian sounds for one hour for three days. By the end of the training, the acoustically closest French /o/ drifted towards Russian /ɨ/ along with French /y/.

Some studies have also found instances of assimilation in situations where the ambient host language kept changing. Sancier and Fowler (1997) examined a single speaker of L1 Brazilian Portuguese and L2 American English who went back and forth between the US and Brazil and resided in either country for months. They found that both L1 Portuguese

VOTs and L2 English VOTs became longer (like in American English) after a stay in the US and shorter after a stay in Brazil. These results indicate that a few months of exposure to the L2 could be profound in causing phonetic changes in the L1. Furthermore, assimilation has also been reported in L1 perception (de Leeuw et al. 2007; Lev-Ari and Peperkamp 2013; Mora and Nadeu 2012).

1.2. L1 Phonetic Accommodation

Simply put, speech accommodation is the tendency of speakers to align or adjust their speech to the patterns of their speech partner or partners (Kim et al. 2011; Solanki 2017; Wagner et al. 2021), which is reflective of the pervasive cognitive mechanisms that motivate us to acquire the ambient speech variety as infants (Babel 2012; Kuhl 1993). Instances of accommodation at the acoustic-phonetic level come under the term 'phonetic accommodation' (Babel 2009, 2012; Kim 2012; Kim et al. 2011; Olmstead et al. 2021; Pardo 2006; Wagner et al. 2021). This adjustment can be expressed in three ways: convergence, divergence, and maintenance (Giles and Powesland 1997). In *convergence*, the speaker adjusts their speech in the direction of their speech partner, whereas in *divergence*, the speaker adjusts their speech away from their speech partner. In *maintenance*, the speaker maintains their speech and does not adjust to the speech of their partner in either direction.

Several instances of phonetic accommodation towards other accents (native or non-native) in the form of convergence and divergence have previously been reported in monolingual speakers (Alshangiti and Evans 2011; Babel 2009, 2010; Biro et al. 2022; Evans and Iverson 2007; Giles 1973; Nielsen 2011; Nycz 2013, 2015; Ostrand and Chodroff 2021; Pardo 2006; Pardo et al. 2013; Simard et al. 1976; Solanki 2017; Soquet and Delvaux 2007). For example, Soquet and Delvaux (2007) examined accommodation in monolingual speakers of Belgian French across two regional dialects that are spoken in the Belgian cities of Mons and Liege. They found that upon exposure to the Liege regiolect, the vowels (/ɛ, o/) produced by Mons speakers had shifted acoustically in the direction of the Liege vowels, which is evidence of convergence towards the Liege dialect. Babel (2010) examined the accommodation of native speakers of New Zealand English (NZE) towards a male native speaker of Australian English (AusE). The vowels in *kit*, *dress*, *trap*, *start*, *strut*, and *thought* were examined for normalized F1 and F2. The results, in general, showed that NZE speakers converged to AusE. However, there were differences based on gender: female NZE speakers showed convergence for all vowels, whereas male speakers showed convergence for *dress*, *strut*, *thought*, and *start*, but divergence for *kit* and *trap*. Furthermore, NZE speakers with pro-AusE bias showed a higher degree of convergence towards the AusE speaker. Furthermore, Nycz (2016) examined changes in D1 in adult native speakers of Canadian English (D1) who moved to the New York City region. Their D1 speech was examined for (1) the quality of the diphthong /aʊ/ before voiceless stops, which is characterized by 'Canadian-Raising', and (2) the realisations of the vowels in the words COT and CAUGHT. In D1, there is a COT–CAUGHT merger, but not in the English spoken in the New York City region. The results showed convergence towards D2 for both features such that (1) more frequent words showed less raising, and (2) the participants maintained a distinction between COT–CAUGHT words.

Not only in monolinguals, previous research has also found evidence of accommodation in bilingual speakers' L2 English towards another English accent (Enzinna 2018; Kim 2012; Kim et al. 2011; Olmstead et al. 2021; Tobin 2022; Wagner et al. 2021). For instance, Enzinna (2018) examined VOT in voiceless stops in English in two types of speaker groups (Spanish–English bilinguals, and English monolinguals), who interacted with both a model English monolingual speaker and a model Spanish–English bilingual speaker. The participants were divided into four groups (English monolinguals from Ithaca, Spanish–English bilinguals from Ithaca, English monolinguals from Miami, and Spanish–English bilinguals from Miami) such that Ithaca represents a majority English-speaking monolingual community, whereas Miami represents a majority Spanish–English bilingual community. The results showed that all participant groups produced longer English-like VOTs with the

monolingual English talker and shorter Spanish-like VOTs with the Spanish-English bilingual talker. While this indicated that accommodation could have been automatic across all participants, this convergence was found to be modulated by the social factor of group affiliation. This was such that bilinguals in Ithaca converged more to the English monolingual model speaker, and the monolinguals in Miami converged more to the bilingual model speaker. This indicates their social motivation for higher convergence with the speech of the community in which they are linguistic outsiders.

In conclusion, while transfer and accommodation phenomena are quite different, they bear similarities in at least two ways that are of interest to the present study. First, their predicted outcomes of the interaction between two linguistic varieties (assimilation, dissimilation, no change in SLM-r versus convergence, divergence, maintenance in accommodation) appear to be somewhat functionally similar. Therefore, to avoid confusion, the terms assimilation, dissimilation, and no change are used in the present study to refer to the direction of phonetic change in Glaswasians' native varieties Hindi and Indian English due to the influence of the host dominant variety Glaswegian English. Second, both SLM-r and accommodation research acknowledge that transfer and accommodation processes may be modulated by various factors such as the individual's cognitive abilities (also Lev-Ari and Peperkamp 2013), linguistic similarity, language proficiency, and use, social affiliations, circumstances, and opinions (Enzinna 2018; Labov 1963; Simard et al. 1976). The present study examines the effect of one such factor, language contact.

1.3. The Effect of Contact on Backward Transfer

Relevant to examining backward transfer effects are also the kind of social experiences that the migrants have while living in the host country (de Leeuw et al. 2010; Giles 1973; Kerswill 2006; Matras 2009; Siegel 2018), especially with reference to the uneven power-dynamic between them and the host community (Fought 2013; Vertovec 2007). Such a transformation in their sociolinguistic and cultural reality might eventually affect their linguistic behaviour. For example, Sachdev et al. (2012) argue that immigrants may converge to the language of their host country as proof of their acculturation of the host values, but they can also diverge to maintain "intergroup distinctiveness" (p. 397).

In this study, the term 'contact' refers to 'interethnic contact', that is, the contact that Glaswasians have with members of their own ethnolinguistic community and with members of the host Glaswegian community, and by extension with the languages of the respective communities. The amount of interethnic contact may be influenced by the migrants' personal motivations. On the one hand, migrants who wish to improve their social mobility and economic standing as members of an ethnolinguistic minority may attempt more contact with the host community, and even adopt and converge to the host languages to signal their affiliation (Giles 1973; Kerswill 2006; Sachdev et al. 2012; Sharma and Sankaran 2011; Whaley and Samter 2006). On the other hand, migrants may be motivated by the fear of extinction of their minority ethnolinguistic group or to preserve their ethnolinguistic/cultural/religious identity (Kerswill 2006; Medvedeva 2010), leading them to attempt minimal contact with the host community, their culture, and language.

Much research has found evidence that the amount of contact with the host or heritage community also has implications for transfer, such that higher contact with the host community is associated with more transfer from the host language (de Leeuw 2009; Fox 2010; Stoehr et al. 2017; Torgersen et al. 2006). For instance, Fox (2010) investigated PRICE and FACE vowels in Bangladeshi, mixed-race, and British youth in the East End of London. They found that British males, who were in higher contact with Bangladeshi males, used more Bangladeshi variants, whereas British females, who were not in contact with Bangladeshi males, did not use Bangladeshi variants for these two vowels. Furthermore, in an acoustic investigation of /l/ in 2nd and 3rd generation Glaswasians (Pakistani heritage speakers of Punjabi and Urdu in Glasgow), Stuart-Smith et al. (2011) found that the Glaswasian speaker with the highest number of Asian friends had Asian-like clear /l/, whereas a Glaswasian speaker with the lowest number of Asian friends showed

Glaswegian-like darker /l/. Similarly, Stoehr et al. (2017) reported that late German–Dutch bilinguals who were in reduced contact with their L1 German showed backward transfer of Dutch on their L1, whereas late Dutch–German bilinguals who were in frequent and direct contact with their L1 showed no influence of L2 German on their L1. This led to Stoehr et al. (2017) concluding that contact with the native language is an important aspect of L1 maintenance. The effect of contact has also been found in accent perception. In her study, de Leeuw (2009) found that German migrants in Canada who had more contact with their native language were less likely to be perceived as having a foreign accent in their L1 by native speakers of German in Germany.

From a psycholinguistic perspective, the impact that interethnic contact has on language transfer can be understood using the *Activation Threshold Hypothesis* (Köpke 2002; Paradis 2007, 2001). Higher contact with one's ethnolinguistic community, here, represents higher contact with the native languages Hindi (and other cognate Indic languages like Urdu and Punjabi) and Indian English, which will ensure regular activation of units in these native languages, thus making them harder to be influenced by Glaswegian English. Similarly, higher contact with the host community represents higher and regular contact with the host variety, Glaswegian English, and a higher possibility of influence from it (Britain 2010).

With the help of advances in technology and the pre-existing long-term Indian Glaswasian community, it is not hard for the experimental group to maintain contact with members of their community both back in India and in Glasgow. Through contact with Indians in India, they are in contact with Indian English and Hindi as spoken in India and through contact with the long-term 2nd and 3rd generation Indian Glaswasian community, they are in contact with the hybrid Glaswasian English accent that represents an integration of Glaswegian and Asian features (Alam 2015; Alam and Stuart-Smith 2014; Stuart-Smith et al. 2011).

With respect to the role of contact in the present study then, two predictions are made. First, Glaswasians with higher Indian contact will show less assimilation to Glaswegian English. Second, Glaswasians with higher Glaswegian contact will show more assimilation to Glaswegian English.

2. Present Study

With respect to the above background, the present study seeks to better understand the nature of backward transfer across languages and dialects. It does so by examining the experimental group of Glaswasians who were bilingual in Hindi and Indian English prior to migrating to Glasgow. Post-migration, they have been in contact with the host dominant variety Glaswegian English, which acts as the host dominant language with respect to Glaswasians' L1 Hindi and as the host dominant dialect with respect to Glaswasians' L1 Indian English. These Glaswasians were examined in relation to two control groups, Glaswegians and Indians. The contact between these linguistic varieties has been examined under the attrition/drift/transfer (Chang 2019; Schmid and Köpke 2019a) and the speech accommodation (Giles 1973) frameworks. Simultaneous bilingual and bidialectal contact have not been examined before in the same population, which is the aim of the present study. It examines this by proposing the following three research questions:

2.1. Is There a Backward Transfer of Glaswegian English to Indian English and Hindi?

According to SLM-r, the interaction between L1–L2 categories can lead to assimilation or dissimilation of L1 categories. However, it is also possible that L1 categories exhibit no change. To answer this research question, three types of phone categories were examined for one phonetic feature, each of which is known to differ across the respective L1s and L2. These are (1) the lateral /l/ for F2-F1 difference, (2) the voiceless stop /t/ for voice onset time (VOT), and (3) the voiced stops /b d g/ for relative burst intensity (RBI).

2.2. Does Indian English (IE) Show More Influence from Glaswegian English (GE) than Hindi?

Previous research indicates that one can expect higher transfer between linguistic varieties that are mutually intelligible compared to those that are not (De Angelis 2007; Trudgill 1986), and also that in situations of third language acquisition, forward transfer to L3 would come from the more structurally similar L1 or L2 (Typological Primacy Model; Rothman 2010, 2013, 2015). Therefore, it is possible that because Indian English and Glaswegian English are dialects of the same language, Indian English may exhibit more transfer from Glaswegian English compared to Hindi, which is a separate language and exhibits higher familial distance from Glaswegian English. However, at the same time, even though Indian English is a dialect of English, it is still strongly influenced by the Indian indigenous and native languages in its phonology (Bansal 1990; Maxwell and Fletcher 2009). Therefore, Indian English may objectively be at a similar distance from Glaswegian English as Hindi on a phonological basis than what systemic typology may dictate and may not show higher transfer from Glaswegian English.

2.3. Do the Outcomes of Assimilation and Dissimilation Vary by the Amount of Contact That Glaswasians Have with the Indian and Glaswegian Communities?

This question addresses whether backward transfer effects are modulated by the amount of contact that immigrants have with their respective heritage and host communities (de Leeuw 2009; Stoehr et al. 2017). The effect of this sociolinguistic variable remains under-researched in backward transfer literature and will be very informative in understanding whether both Indian Contact and Glaswegian Contact are equally effective in predicting backward transfer effects across multiple sound categories.

3. Materials and Methods

3.1. Participants

Three groups of speakers (two control groups and one experimental group) of mixed sexes were recruited in 2022. The first control group, 'Glaswegians', comprised 34 adult speakers (10 M, 22 F, 2 non-binary) of Glasgow Standard English (GSE). These were Glaswegian locals and belonged to a large age range (*min.* = 18, *max.* = 69, *mean* = 32.3, *SD* = 14.4). The second control group, 'Indians', (12 M, 19 F; age: *min.* = 18, *max.* = 62, *mean* = 31.32, *SD* = 9.76) comprised 31 adult native speakers of Hindi and Indian English, the variety of English spoken in India (that is, they were exposed to these since birth to varying degrees and grew up speaking both at home in addition to instruction in school). These speakers reside in India, use Hindi and Indian English to communicate in their daily lives, and have never had any contact with Glaswegian English. The experimental group, 'Glaswasians', comprised 38 adult speakers (7 M, 31 F; age range: *min.* = 21, *max.* = 83, *mean* = 46.02, *SD* = 17.59). These Glaswasians are first-generation immigrant Indians in Glasgow. They are native speakers of Hindi and Indian English and acquired both before coming to Glasgow. They had been living in Glasgow for at least three years at the time of data collection (range of length of residence: *min.* = 3, *max.* = 63, *mean* = 18.98, *SD* = 20.89). Notably, the difference in mean age between the control and experimental groups has not been controlled for, which could have affected the results.

Unlike Indians, these Glaswasians in Glasgow are in contact with the host variety of Glaswegian English, Indian English spoken by other Indian immigrants in Glasgow, as well as the hybrid Glaswasian English spoken by the pre-established 2nd and 3rd generation Glaswasian population (Alam 2015; Alam and Stuart-Smith 2014; Stuart-Smith et al. 2011). However, like Indians, the experimental group also speaks Hindi and Indian Esnglish as their native languages. Additionally, both Glaswasians (prior to migration to Glasgow) and Indians resided in various parts of India. Furthermore, some of the members of both groups spoke another regional language as their native language in addition to Hindi and Indian English, which they acquired since birth. These languages were Punjabi, Haryanvi, Rajasthani, Malvi, Gujarati, Odia, Sindhi, Konkani, and Marathi in Indians, and Garhwali, Punjabi, Bhojpuri, Bengali, Rajasthani, Malvi, Gujarati, and Marathi in

Glaswasians. Moreover, both Glaswasians and Indians were very diverse with respect to how and at what age they acquired their native languages. Some participants were early simultaneous multilinguals, whereas some were early sequential multilinguals (where exposure to Hindi preceded exposure to English). However, it is important to note that all members of both groups had acquired all their languages before the age of nine and had studied in English-medium schools. Eventually, a limitation of this study is that the differences in age of acquisition, type of bilingualism, or the regional varieties spoken by the members of the Glaswasian and Indian groups have not been accounted for and may have affected the results.

Glaswasians are a linguistically diverse but minority population in Glasgow. Therefore, it was not possible to limit all Glaswasians to the same linguistic background. That is, it was not possible to recruit Glaswasians (and Indians) who all spoke the same dialect of Hindi and the same regional language as another L1. To control for this, at a minimum, those speakers were recruited as members of the Glaswasian and Indian groups, who spoke only Indo-Aryan varieties along with Hindi and Indian English. Since the sound categories examined here are similar across Indo-Aryan varieties, it was possible to limit transfer from more dissimilar languages such as the Dravidian languages spoken in South India.

3.2. Target Sounds

3.2.1. Word-Initial /l/

The two allophones of the alveolar lateral relevant to this study are 'clear' and 'dark' /l/. When the tip/blade of the tongue touches the alveolar ridge and the tongue body is also raised, the sound produced is a 'clear' or 'light' alveolar /l/ (Hayward 2000; Ladefoged and Johnson 2015; Recasens 2004). The lateral /l/ is 'dark' when for the same primary articulation, the tongue body is raised towards the velum, that is, it is velarized [ɫ] (Hayward 2000; Recasens 2004; Simonet 2010). Dark /l/ typically shows a lower second formant (F2) (Hayward 2000; Recasens 2004) and higher first formant (F1) compared to clear /l/, which has higher F2 and lower F1. In terms of F2-F1 difference then, darker /l/ should have smaller F2-F1 difference compared to clearer /l/, which should have larger F2-F1 difference.

In Glasgow Standard English (GSE), which is of interest in this study, the lateral is realised as [ɫ] in all word positions (Stuart-Smith 2004; Wells 1982) and has been shown to have a very low F2 (Stuart-Smith et al. 2011). A small F2-F1 difference of around 750 Hz has been reported in Glasgow Vernacular English, which is known to have darker /l/ than GSE (Macdonald and Stuart-Smith Forthcoming). However, Hindi and Indian English only have clear /l/ in all word positions (Gargesh 2008; Wells 1982), and therefore, both are expected to have larger F2-F1 difference than GSE.

Some previous research exists on the effect of L2 on L1 in /l/ in various bilingual groups. An assimilation of L1 /l/ towards darker L2 /l/ was reported by Bergmann et al. (2016), de Leeuw (2019), de Leeuw et al. (2013, 2018), de Leeuw and Bogulski (2016) and Barlow (2014). Another small-scale study on first-generation Glaswasians (drawn from the same community as the present study, Shaktawat (2018a), also examined the influence of the host variety of Glaswegian English on their native varieties of Indian English and Hindi. In English, Glaswasian /l/ became more Glaswegian-like or exhibited assimilation. However, in Hindi, Glaswasians developed clearer /l/ compared to Indians, which was consistent with dissimilation. The present study will allow to investigate if this pattern is repeated in a different and larger group of Glaswasians with different demographic and linguistic profiles. Additionally, it will compare Glaswasians' production with not one, but two control groups (Glaswegians and Indians) to help ascertain the direction of transfer.

In the current study, in the case of assimilation, for their Hindi and Indian English, Glaswasians will show darker /l/ than Indians (in the direction of Glaswegian English) in the form of smaller F2-F1 difference compared to Indians. In the case of dissimilation, Glaswasians will show clearer /l/ than Indians by exhibiting larger F2-F1 difference than Indians in order to dissimilate or contrast it from the darker /l/ in Glaswegian

English. Finally, if there is no backward transfer, then Glaswasians will have the same F2-F1 difference as Indians because the category will remain uninfluenced.

3.2.2. Word-Initial /t/

On the one hand, Glaswegian English has a two-way voicing contrast at three places of articulation: bilabial (/p b/), denti-alveolar (/t d/), and velar (/k g/) (Stuart-Smith 2004). On the other hand, Hindi has a four-way system of contrast at four places of articulation: bilabial (/p p^h b b^h/), dental (t t^h d d^h/), retroflex (/ʈ $ʈ^h$ ɖ $ɖ^h$/), and velar (/k k^h g g^h/) (Davis 1994; Ohala 2014; Singh and Tiwari 2016). Like Glaswegian English, Indian English also has a two-way voicing contrast at three places of articulation, but as it is influenced by Hindi (and other Indian regional languages), the denti-alveolar stops are replaced by retroflex stops (Gargesh 2008). Thus, what is recognised as a denti-alveolar voiced or voiceless stop in Glaswegian English is realised as a retroflex voiced or voiceless stop in Indian English ([ʈ] or [ɖ]). Ohala (1991) argued that retroflex stops are perceptually closer to alveolar stops than dental stops, which might be one of the reasons why Indian English uses the retroflex stop in place of the alveolar stop instead of a dental stop, even though Indian languages have both dental and retroflex stops.

The present study is concerned with possible transfer related to the fine phonetic detail in positive or 'long lag' VOT. This is characterised by a longer delay between burst release and the onset of voicing (as generally found in English voiceless aspirated stops). Table 1 presents the findings from previous research on VOT in /t/ across Glaswegian English, Indian English, and Hindi.

Table 1. Reported lag VOT across Glaswegian English, Indian English, and Hindi in /t/ and /p t k/ in previous research.

Study	Speech Type	Language	Stop/s	VOT (ms)
Stuart-Smith et al. (2015)	Spontaneous Speech	Glaswegian English	/p t k/ /t/	46.5 70–80 (approx.)
Sonderegger et al. (2020)	Spontaneous Speech	Glaswegian English	/p t k/	50
Lisker and Abramson (1964)	(Isolated Words/Within Sentences)	Hindi	/p t k/ /t/	13 9
Benguerel and Bhatia (1980)	CV Syllabic Utterance	Hindi	/t/	15.24
Ohala and Ohala (1992)	Word-list	Hindi	/t/	10 (approx.)
Hauser (2016)	Word-list	Hindi	/p t k/ /t/	20.43 11.25
Hussain et al. (2017)	Isolated Disyllabic Words	Punjabi	/t/	15
Das and Hansen (2004)	Isolated Monosyllabic Words	Indian English	/t/	28.58
Wiltshire and Harnsberger (2006)	Isolated Words	Gujarati English Tamil English	/t/	16 38
Awan and Stine (2011)	Continuous Speech	Indian English American English	/t/	36.02 86.63

In the word-initial position, Glaswegian English /t/ is aspirated, which is reflected in longer lag/positive VOT (Sonderegger et al. 2020; Stuart-Smith et al. 2015), as seen in Table 1. By contrast, in both Hindi and Indian English (Table 1), /t/ remains unaspirated and has short-lag positive VOT (Benguerel and Bhatia 1980; Hauser 2016; Lisker and Abramson 1964; Ohala and Ohala 1992).

Thus, when compared with VOT for /t/ in Glaswegian English, there is no denying that Hindi VOT for /t/ is much shorter than the VOT reported for Glaswegian English /t/ (Table 1). When compared to Hindi VOT for /t/, Indian English VOT seems longer (Awan and Stine 2011; Das and Hansen 2004; Wiltshire and Harnsberger 2006) (Table 1), but much shorter than the VOT for /t/ in Glaswegian English. So, the pattern for VOT for /t/ across Glaswegian English, Indian English, and Hindi appears to be Glaswegian English > Indian English > Hindi.

There is extensive previous research on backward transfer in VOT in voiceless stops. While instances of dissimilation (Flege 1987) and no change (Lord 2008; Stoehr et al. 2017) have been reported, there are many more instances of assimilation (Flege and Eefting 1987b; Lev-Ari and Peperkamp 2013; Major 1992; Mayr et al. 2012; Sancier and Fowler 1997; Stoehr et al. 2017).

For the current study, in the case of assimilation in both Hindi and Indian English, Glaswasians will show longer VOT than Indians (in the direction of Glaswegians). In case of dissimilation, Glaswasians will show shorter VOT than Indians in both Hindi and Indian English, to dissimilate or contrast it from the longer VOT in Glaswegians. Finally, if there is no backward transfer, then Glaswasians will have the same VOT as Indians.

3.2.3. Word-Initial /b d g/

The voiced stops /b d g/ are present in the phonological systems of all three varieties of concern here but differ substantially with respect to their role in the phonological stop series of each variety. While Glaswegian English has a denti-alveolar realisation of the coronal stop /d/, Hindi contrasts between retroflex and dental realisations (Davis 1994; Ohala 2014; Singh and Tiwari 2016), and this stop is realised as a retroflex stop in Indian English (Gargesh 2008). The present study is concerned with possible transfer related to fine phonetic detail of relative burst intensity (RBI). RBI is the spectral amplitude, or loudness, of the stop burst, calculated relative to the intensity of the following vowel (Sundara 2005; Sundara et al. 2006).

In a small-scale study on 2nd and 3rd generation Pakistani-heritage speakers of Punjabi and Urdu in Glasgow, Shaktawat (2018b) observed that native Glaswegian English speakers had less intense bursts than the heritage speakers whose English was influenced by the heritage languages Urdu/Punjabi. Based on Shaktawat's (2018b) observations, it is assumed that Glaswegian English-voiced stops have lower RBI than Hindi and Indian English-voiced stops.

Prior to Shaktawat (2018b), Kirkham (2011) examined RBI in British-Asians (in Sheffield), where the British-Asian /t/ but not /d/, was found to have greater burst intensity than the British English counterpart. However, in the wider literature on transfer, RBI has not been examined before. An instance of backward transfer in voiced stops comes from a small-scale study (Shaktawat 2018a), which examined RBI in voiced stops /b d g/ in the same population of 1st generation immigrant Indians in Glasgow. The results showed that all Glaswasians produced all three stops in Hindi with significantly lower RBI than the Indian control group. Thus, Glaswasian voiced stops in Hindi had developed more Glaswegian-like quieter stop bursts, which is indicative of assimilation. By contrast, in English, /b/ and /g/ had similar RBI as the Indian control group; /d/ however showed significantly lower RBI in Glaswasians compared to Indians. This was, again, indicative of assimilation. However, Shaktawat (2018a) did not compare these results with those of a Glaswegian control group. This is done in the present study to not only examine RBI in Glasgow Standard English for the first time but also to ascertain the direction of transfer in Glaswasians when compared with both control groups, Glaswegians and Indians.

Based on the research discussed above, Hindi and Indian English are expected to show higher RBI than Glaswegian English. In that case, in case of assimilation, Glaswasians will show lower RBI than Indians in Hindi and English (in the direction of Glaswegians). However, in case of dissimilation, Glaswasians will show higher RBI than Indians, to contrast it from the lower RBI in Glaswegian English. If there is no transfer, then Glaswasians will have the same RBI as Indians.

3.3. Materials

The target categories /l/, /t/, /b d g/ occurred in word-initial position in the target words. These target words were embedded in carrier sentences. In English, the carrier sentence was *Say* ____ *again* and in Hindi, it was /*kəha* ___ *apne?*/, which can be translated as "Did you say____?". The participants were recorded reading these sentence-lists in

English and Hindi. When in disyllabic words, these target sounds always occurred in the stressed syllable. There were ten words per target sound in each language.

3.4. Procedure

The University of Glasgow College of Arts Ethics Committee granted the ethical clearance for data collection, which was conducted entirely online.

All three groups participated in the speech production task, which was designed and hosted online using the LaBB-CAT Speech Elicitation Tool (Fromont and Hay 2012). In recent years, there has been much discussion around the quality of speech data collected remotely over various online platforms using various recording devices, particularly in relation to the reliability of acoustic measures for comparison across speakers. Sanker et al. (2021) summarise two different sources of variation in remotely recorded audio. First is acoustic signal manipulation. This includes compressing audio files for space-effective storage, the presence of non-speech artifacts in the recordings, and differences in sampling rate. Sanker et al. (2021) reported that audio compression influenced duration and formant measures. Other research has also reported the effects of file compression on spectral properties (De Decker and Nycz 2011; Rozborski 2007; Van Son 2005), and F1 and F2 measures in vowels (De Decker and Nycz 2011) in video and audio recordings. LaBB-CAT's Elicit Speech Tool records all audio as 16 kHz mono WAV files. Therefore, all recordings have the same sampling rate, and all remain uncompressed. Thus, compression is unlikely to be a big issue in the present study.

The second source of variation involves differences in types of recording devices or conditions related to issues of shielding, ambient noise, and microphone placement. Extensive research has shown that increased noise levels can make the formants appear less clearly defined or faint and also interfere with spectral characteristics (De Decker and Nycz 2011; Rathcke et al. 2017; Sanker et al. 2021; Svec and Granqvist 2010). LaBB-CAT itself does not control for such factors, and no special processing has been carried out to try to rectify these. Therefore, there may be variability in the quality of recordings as participants in this study have used their own devices and microphones, which have different frequency responses, and were placed at varying distances, and recordings were made in different setups for each participant. Such interference can ultimately lead to discrepancies in formant extraction (Rathcke et al. 2017). To a certain extent, some of this extra variation will be taken care of in the statistical modelling (by adding a random intercept for Speaker). There were also multiple instances of non-speech click-like artifacts that could have been caused by equipment noise or poor shielding. These were especially problematic when directly imposed on the part of the audio signal that was being measured, for example, on the burst of the stop that was used to measure burst intensity. Such tokens were discarded from the analysis.

Additionally, although their results suggest relatively little overall differences between recording devices (such as Zoom H4N recorder, Mac computer, iPad, iPhone, and Android phone) for most measurements, Sanker et al. (2021) reported that the F2 measures, especially for /u/, were very high for some devices. This may not be a big concern, however, in the present study, because the majority of Glaswasian participants used a computer equipped with an external audio recording device (n = 35). Though all Indians and Glaswegians were also advised to use their computers, there is no way to quantify how many participants used which device in these two control groups. Furthermore, as Sanker et al. (2021) only examined vowels, it is not clear if F2 measures of other types of segments such as laterals may also be susceptible to this device-related variability. Another measure that is susceptible to these effects is burst intensity. Even though the burst intensity of the stop in this study is calculated relative to the following vowel, this does not resolve across-speaker differences that may be caused by differing noise levels. In such cases, all tokens with high noise levels were discarded from the analysis. Approximately 4% of tokens of /l/, approximately 5% of tokens of /t/, and approximately 7% of tokens for the voiced stops were removed from analysis.

In conclusion, while there is a possibility of remote audio recording affecting the quality of speech data, it was taken care of to a certain extent using the means discussed above. Additionally, tokens with suspiciously high or low formant values, as provided by the PRAAT script, were hand-corrected for F1 and F2 in /l/.

All groups also completed a questionnaire to provide more information on their demographics. The questionnaire for Glaswasians was based on Berry's (2001) acculturation questionnaire to elicit data on Indian Contact and Glaswegian Contact. Out of the 38 Glaswasians who participated in the speech production task, only 25 Glaswasians provided data on the two predictors, Indian Contact and Glaswegian Contact as they either did not have the time, energy, or a stable internet connection to finish the extended questionnaire. Therefore, the results of the speech production experiment (Section 4.1) are based on data from 38 Glaswasians, whereas the results of the effect of Indian Contact and Glaswegian Contact on transfer in production (Section 4.2) are based on data from only 25 Glaswasians.

Indian Contact represents the amount of contact with the participants' own ethnic group in Glasgow (inclusive of other 1st generation immigrants and long-term 2nd and 3rd generation Glaswasians) and India. There were a total of 11 questions such as "How often do you spend free time with your close Indian friends?". Participants responded on a scale ranging from 'never' (1) to 'almost always' (5). Individual scores on each question were summed up to form a final score for the predictor of Indian Contact (IC). A higher value represents higher contact with Indians (*min*. = 20, *max*. 50, *mean* = 37.16, *SD* = 7.35; score out of 57). *Glaswegian Contact* (GC) represents the amount of contact with the local Glaswegian host population. There was a total of five questions, such as "How often do you spend free time with your close Glaswegian friends?". A higher value represents higher contact with Glaswegians (*min*. = 5, *max*. 20, *mean* = 11.2, *SD* = 4.97; score out of 27). Data were also collected on Glaswasians' Age of Entry in Glasgow (AoE; *min*. = 12, *max*. 36, *mean* = 26.19, *SD* = 6.38).

3.5. Data Analysis

The data was analysed in two steps. First, the data from the speech production task was acoustically analysed and compared across the three groups separately for each phonetic feature. Second, backward transfer outcomes of assimilation or dissimilation (where present) were then analysed as a function of Indian Contact and Glaswegian Contact. These steps are described in detail in the sub-sections below.

3.5.1. Acoustic Analysis

The recorded speech data from the speech production task was acoustically analysed. The audio files were annotated in PRAAT (Boersma and Weenink 2024) with segment boundaries positioned according to acoustic landmarks on both waveform and spectrogram (described in detail in Supplementary Materials). A PRAAT script was run on these annotations to extract the following measures: mean values of the first two formants for /l/ and the difference between them (F2-F1), and VOT, and RBI for /t/ and /g/, respectively.

The data was then subjected to linear mixed effects modelling using the lmer() function in the lme4 package (Version 1.1.29; Bates et al. 2015) in R (Version 3.6.3; R Core Team 2020). The model summary and *p*-values were generated using the summary() function in the lmerTest package (Version 3.1.3; Kuznetsova et al. 2017). Separate analyses were conducted for each of the three phone categories and respective phonetic features: (1) lateral /l/ (F2-F1 difference), (2) voiceless stop /t/ (VOT), and (3) voiced stop /b d g/ (RBI).

The random effects included Speaker and Word. Fixed effects included Vowel Height (the height of the vowel following the target sound: high/non high), Language (English/Hindi), Phone (b/d/g—applicable to the voiced stops only), Phone Duration (specified duration of the target phone), and Group (Glaswegian/Glaswasian/Indian). The analysis of each phone category and corresponding feature was carried out in two stages using two separate mixed effects models. In stage 1, only the two control groups (Glaswe-

gian/Indian) were compared for production in English only. This model provided the baselines for the two control groups in English (since Glaswegians do not speak Hindi). In this model, the fixed effect of Group was effect-coded, with weights of 0.5 for Glaswegian and −0.5 for Indian. These control baseline values were used to assess the direction of transfer in Glaswasians in stage 2. In stage 2, the experimental group (Glaswasians) was compared with the Indians for English and Hindi. This analysis examined whether there was transfer in either language in Glaswasians. In this model, the fixed effect of Group was effect-coded, with weights of 0.5 for Glaswasian and −0.5 for Indian.

A Group effect indicated that there was a difference between the relevant groups, and specifically, in stage 2 analysis of Glaswasians and Indians, this effect indicated backward transfer. An interaction between Group and Language indicated if one language was more susceptible to transfer than the other. In the analysis of voiced stops, interactions between Group and Phone indicated that different places of articulation were differentially sensitive to transfer effects.

3.5.2. Analysing for the Effects of Indian Contact and Glaswegian Contact

If backward transfer was found for any of the sound categories and corresponding features, it was then analysed as a function of the predictors Indian Contact and Glaswegian Contact. The data was also subjected to linear mixed effects modelling, which analysed the given phonetic feature (that is, (1) F2-F1 difference in Hz for /l/, (2) log VOT for /t/, and (3) RBI in dB for /g/) as a function of the fixed effects of Indian Contact and Glaswegian Contact. Other variables such as the length of residence in Glasgow, Hindi and English dominance, Glaswegian and Indian identity, gender, inhibitory skill scores, and language switching costs were also included in these models, but the results of these are not reported in the present study. However, even without these additional sociolinguistic and psycholinguistic variables, the effects of Indian Contact and Glaswegian Contact presented in the current study were significant (the associated data files for this analysis can be accessed at osf.io/dc34w). It was ensured that none of the above predictors were correlated using the corrplot() function in the corrplot package (Wei and Simko 2021; version 0.92) in R.

All the above continuous variables (Age of Entry in Glasgow, Indian Contact and Glaswegian Contact) were converted to z-scores using the scale() function in R. The models were created by manually adding linguistic control and subject variables, interactions one by one. If adding a variable significantly improved the fit of the model, as determined by a loglikelihood ratio test, then that variable was retained, otherwise, it was not. All variables were tested in this manner until a final model was created.

4. Results

4.1. Acoustic Analysis

4.1.1. Word-Initial /l/

For /l/, the dependent variable was F2-F1 difference. Figure 2 visualises F2-F1 difference in /l/ for Glaswasians, Glaswegians and Indians across English and Hindi.

In stage 1, the linear mixed model predicted F2-F1 difference in English by fixed effects of Group (Glaswegian/Indian), Vowel Height (High/Non-High) and scaled Log Duration of /l/. The model included a random intercept for Speaker. A significant effect of Group ($\beta = -568.97$, $t(604) = -39.11$, $p < 0.001$) indicated that as expected, Glaswegians had smaller F2-F1 difference than Indians in English (Gargesh 2008; Stuart-Smith 2004; Wells 1982). Therefore, in English, Indian /l/ is clearer than Glaswegian /l/. This is important for stage 2: if Glaswasian /l/ in English has smaller F2-F1 difference than Indian /l/ in English (in direction of Glaswegian English /l/), then it would indicate assimilation in Glaswasians; if Glaswasian /l/ in English has higher F2-F1 difference than Indian /l/ in English, then it would indicate dissimilation in Glaswasians.

In stage 2, another linear mixed model predicted F2-F1 difference by fixed factors of Language (English/Hindi), Group (Glaswasian/Indian), Vowel Height (High/Non-

High) and scaled Log Duration of /l/. The model included a random intercept for Speaker and interaction between Language and Group. Significant effects emerged for Vowel Height ($\beta = -44.73$, $t(1341) = -4.18$, $p < 0.001$) and scaled Log Phone Duration ($\beta = 37.82$, $t(1341) = 6.15$, $p < 0.001$). More importantly, the effects of Language ($\beta = -47.96$, $t(1341) = -4.46$, $p < 0.001$) and Group ($\beta = 52.25$, $t(1341) = 3.33$, $p < 0.001$) emerged as significant, along with an interaction between them ($\beta = 86.34$, $t(1341) = 4.01$, $p < 0.001$). The nature of the Language effect was that in general (across Glaswasians and Indians), Hindi /l/ had smaller F2-F1 difference (darker /l/) than English /l/. Additionally, in English, Glaswasians had significantly higher F2-F1 difference (clearer /l/) than Indians, who had smaller F2-F1 difference. Finally, the interaction indicates that the Group Effect was significantly larger in Hindi than in English, as seen in Figure 1.

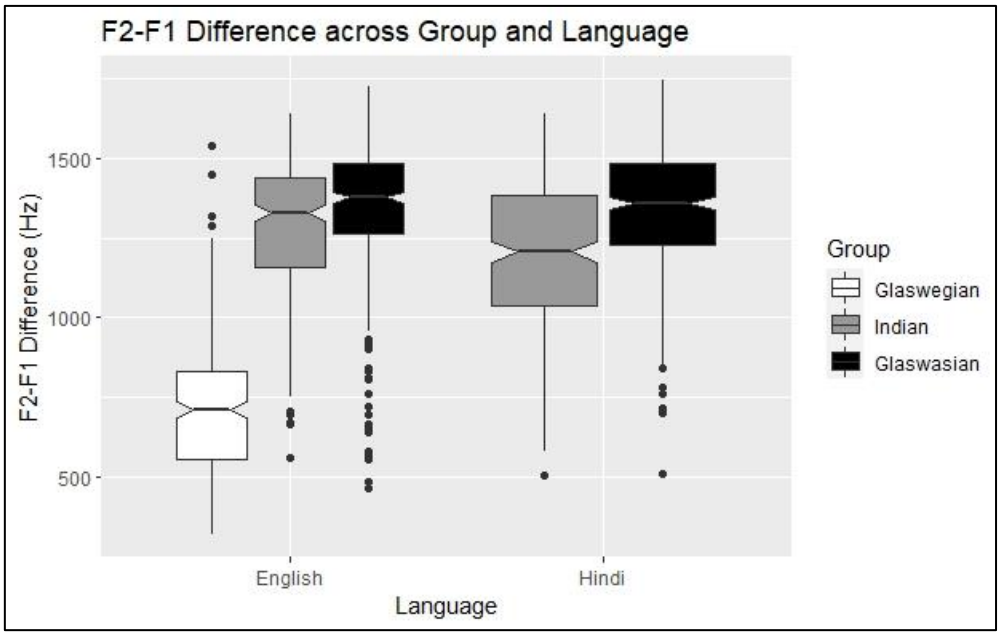

Figure 2. F2-F1 difference for Glaswasians, Glaswegians and Indians for word-initial /l/ in English and Hindi.

These results indicate that Glaswasians' English and Hindi /l/ exhibited backward transfer in the form of dissimilation to maintain a contrast with Glaswegian English darker /l/ by exaggerating the larger F2-F1 difference in the L1s.

4.1.2. Word-Initial /t/

For /t/, the dependent variable was VOT, and this data was converted to log for normalisation. Figure 3 depicts log VOT for /t/ across English and Hindi for Glaswasians, Glaswegians and Indians. In this graph, the more negative the log VOT value, the shorter the VOT duration.

In stage 1, the linear mixed model predicted log VOT in English as a function of Group (Glaswegian/Indian) and Vowel Height (High/Non-High). The model included a random intercept for Speaker but no interactions. A significant effect emerged for Non High Vowel Height ($\beta = -0.06$, $t(589) = -2.09$, $p = 0.037$) and Group ($\beta = 2.05$, $t(589) = 76.31$, $p < 0.001$). Glaswegians had less negative log VOT (longer VOT) than Indians in English. This is important for stage 2: if Glaswasian /t/ has longer VOT than Indians (in the direction of Glaswegians), then it would be indicative of assimilation; if Glaswasian /t/ has shorter VOT than Indians, then it would indicate dissimilation in Glaswasians. However, if Glaswasian /t/ has similar VOT as Indians, then that would indicate no change in Glaswasians.

In stage 2, another linear mixed model was fitted to predict log VOT by Language, Group (Glaswasian/Indian) and Vowel Height (High/Non-High). This model included

a random intercept for Speaker and an interaction between Language and Group. The effect of Vowel Height again emerged as significant ($\beta = -0.117$, $t(1272) = -4.69$, $p < 0.001$). Significant effects emerged for Language ($\beta = -0.22$, $t(1272) = -9.01$, $p < 0.001$) and Group ($\beta = 0.35$, $t(1272) = 9.58$, $p < 0.001$), along with an interaction between them ($\beta = -0.18$, $t(1272) = -3.57$, $p < 0.001$). The nature of the effect of Language was that Hindi had more negative log VOT (shorter VOT) than English in general. The nature of the significant Group Effect was that in English, Glaswasians had less negative log VOT (longer VOT) than Indians. Finally, the significant interaction between Language and Group indicated that the difference in VOT between the two groups was significantly bigger in English than in Hindi.

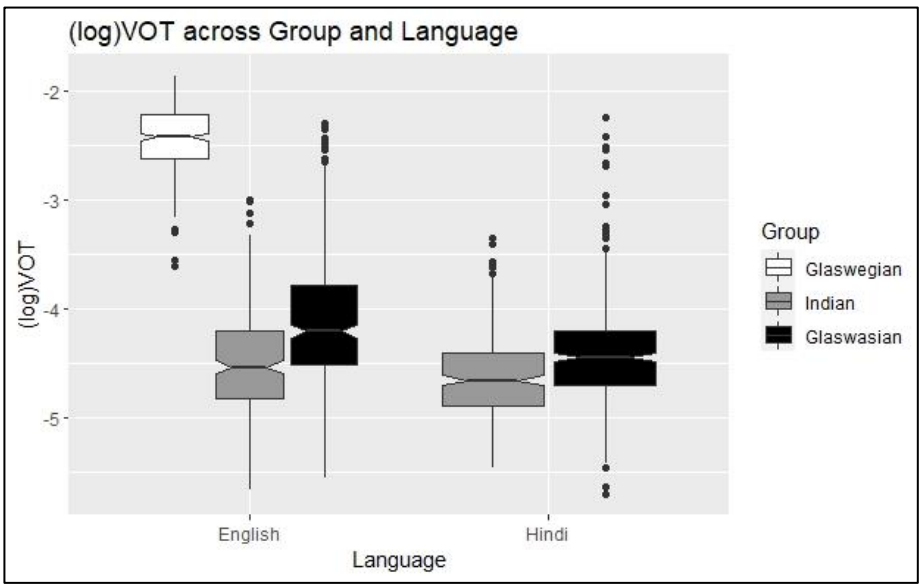

Figure 3. Log VOT across Group and Language.

These results indicate that in English and Hindi, Glaswasians had longer VOT than Indians (in direction of Glaswegians). This is evidence of assimilation in both L1 towards Glaswegian English.

4.1.3. Word-Initial /b d g/

For these voiced stops, the dependent variable was Relative Burst Intensity (RBI). A smaller value represents a louder burst. Figure 4 visualises RBI in /b d g/ for Glaswasians, Glaswegians, and Indians across English and Hindi.

In stage 1, a linear mixed model was fitted to predict Relative Burst Intensity (RBI) as a function of Phone (b/d/g), Group (Glaswegian/Indian) and Vowel Height. The model included a random intercept for Speaker and an interaction term was specified between Phone and Group.

Significant effects of Vowel Height ($\beta = -1.23$, $t(1814) = -8.806$, $p < 0.001$) and Phone /d/ and /g/ emerged (/d/ ($\beta = 0.88$, $t(1814) = 5.25$, $p < 0.001$); /g/ ($\beta = 3.88$, $t(1814) = 23.11$, $p < 0.001$)). These latter effects indicated that different places of articulation had different RBI values. As expected, both phones /d/ and /g/ had lower RBI compared to /b/ (Ogden 2017). Finally, significant Group Effects emerged in English. For /b/ in English, the Group Effect was significant ($\beta = 1.82$, $t(1814) = 7.59$, $p < 0.001$). However, for /d/ in English, the Group Effect was not significantly larger than for /b/ ($\beta = 0.59$, $t(1814) = 1.75$, $p = 0.081$). However, for /g/ in English, there was a significant difference in Group Effect relative to /b/ ($\beta = -3.33$, $t(1814) = -9.91$, $p < 0.001$). Therefore, Glaswegians had lower RBI than Indians for /b/ and /d/, but higher RBI than Indians for /g/.

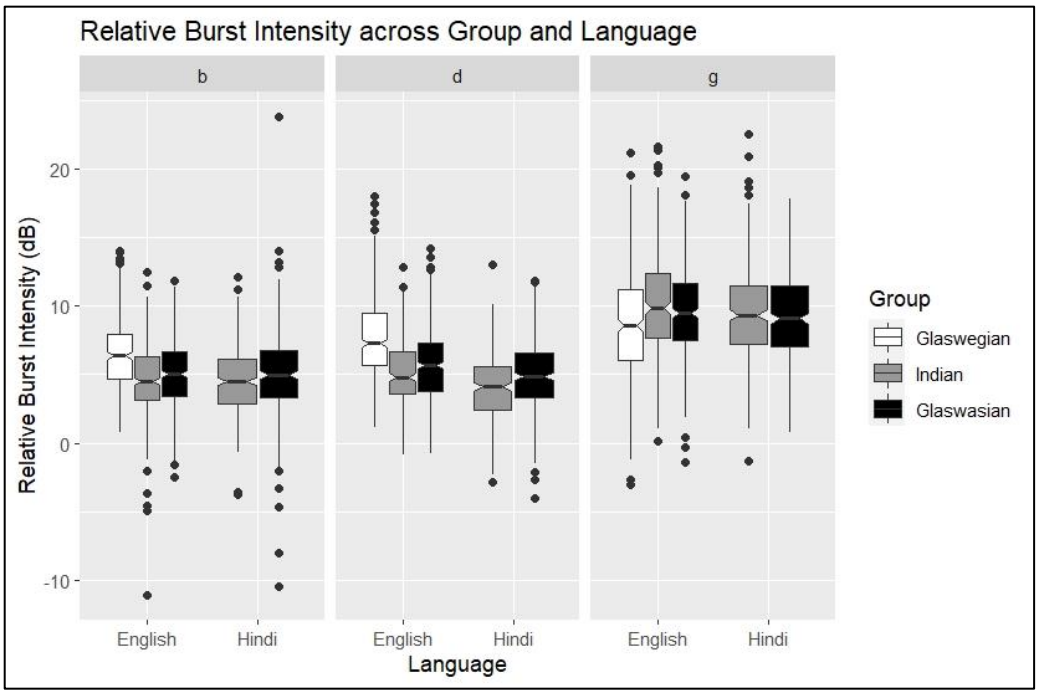

Figure 4. RBI for /b d g/ across Language and Group.

Therefore, in the following analysis, if Glaswasians have lower RBI for /b/ and /d/ and higher RBI for /g/ (in the direction of Glaswegians) as compared to Indians, it would indicate assimilation. If compared to Indians, Glaswasians have higher RBI for /b/ and /d/ and lower RBI for /g/, it would indicate dissimilation, whereas similar RBI for Glaswasians and Indians for any of the stops would indicate no transfer for that stop.

In stage 2, another linear mixed model was fitted to predict RBI by Language, Phone, Vowel Height and Group (Glaswasian/Indian). Interactions were specified between Language, Group and Phone along with all the lower-level interactions. A significant effect of Vowel Height ($\beta = -1.34$ $t(3817) = -15.29$, $p < 0.001$) (Koffi 2020; Ladefoged and Johnson 2015) and Phone (/d/ ($\beta = 0.59$, $t(3817) = 3.97$, $p < 0.001$); /g/ ($\beta = 5$, $t(3817) = 33.38$, $p < 0.001$); Ogden (2017) emerged. The Group Effect was not significant for English or Hindi /b/ (English: ($\beta = 0.30$, $t(3817) = 1.39$, $p = 0.164$); Hindi: ($\beta = -0.07$, $t(3817) = -0.25$, $p = 0.806$)). Therefore, Glaswasians and Indians had similar RBI for /b/ in English and Hindi. Similarly, the Group Effect was not significant for English or Hindi /d/ (English: ($\beta = 0.08$, $t(3817) = 0.28$, $p = 0.777$); Hindi: ($\beta = 0.41$, $t(3817) = 0.98$, $p = 0.328$)). Thus, Glaswasians and Indians had similar RBI in English and Hindi for /d/. For /g/, however, there was a significant Group Effect in English ($\beta = -1.04$, $t(3817) = -3.46$, $p < 0.001$). This meant that Glaswasians had higher RBI compared to Indians. In Hindi, the Group Effect was not significantly different from the Group Effect in English ($\beta = 0.38$, $t(3817) = 0.88$, $p = 0.377$). These indicate that Glaswasians had higher RBI for English and Hindi /g/ compared to Indians.

These results are consistent with no backward transfer in Glaswasians for /b/ and /d/ in English or Hindi, but assimilation to higher Glaswegian English RBI in English and Hindi /g/ by an equal amount.

4.2. The Effect of Indian Contact and Glaswegian Contact

4.2.1. Word-Initial /l/

For /l/, the dependent variable was F2-F1 difference (Hz). The acoustic analysis showed that Glaswasians' English and Hindi exhibited dissimilation, that is, in both languages, Glaswasian /l/ had developed exaggerated characteristics leading to a significantly clearer /l/ than the native Indian /l/. For the present analysis, higher F2-F1 difference indicates higher dissimilation, lower F2-F1 difference indicates lower dissimilation.

For word-initial /l/, the final linear mixed effects model contained a simple effect of Indian Contact and its interaction with Language. The predictor Glaswegian Contact was not included as it did not improve the fit of the model. Importantly, a significant interaction effect between Indian Contact and Language ($\beta = -81.20$, $t(437) = -6.31$, $p < 0.001$). This was such that higher Indian Contact correlated with lower F2-F1 difference (less dissimilation) in Hindi, but no effect in English (Figure 5).

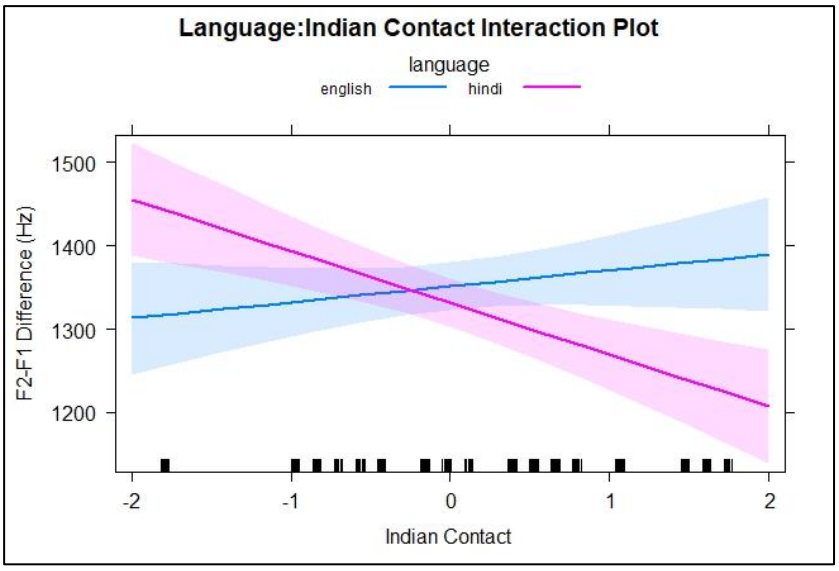

Figure 5. Model interaction effect between Language and Indian Contact on F2-F1 Difference.

In conclusion, Indian Contact was associated with decreased dissimilation (more Indian-like values in /l/) in Hindi /l/ only.

4.2.2. Word-Initial /t/

For /t/, the dependent variable was log VOT. Acoustic analysis showed that Glaswasian /t/ in English and Hindi exhibited assimilation. Additionally, English showed more assimilation than Hindi. For the present analysis, shorter VOT indicates lower assimilation, while longer VOT indicates higher assimilation.

Among other variables, the linear mixed model of the best fit contained the fixed effects of Vowel Height, Language and the interactions between Language and Indian Contact, and Language, Age of Entry in Glasgow (AoE), and Indian Contact. The results showed significant effects of Vowel Height and Language (Vowel Height: ($\beta = -0.13$, $t(410) = -3.72$, $p < 0.001$); Language: ($\beta = -0.70$, $t(410) = -10.28$, $p < 0.001$)). A two-way interaction emerged between Indian Contact and Language ($\beta = -0.64$, $t(410) = -9.60$, $p < 0.001$). This indicated that higher Indian Contact had no effect on VOT in English, whereas it was associated with less assimilation or more Indian-like values in Hindi. This was qualified by a three-way interaction with Age of Entry in Glasgow ($\beta = 0.64$, $t(410) = 7.52$, $p < 0.001$). This was such that with increasing Indian Contact, Hindi VOT was increasingly Indian-like (less assimilation)—more so for early Age of Entry in Glasgow than late Age of Entry in Glasgow. English VOT, on the other hand, was longer (more assimilation), with greater Indian Contact—an effect that subsided with higher Age of Entry in Glasgow. This is depicted in Figure 6.

In conclusion, Indian Contact was associated with decreased assimilation (more Indian-like values) in VOT in /t/ in Hindi.

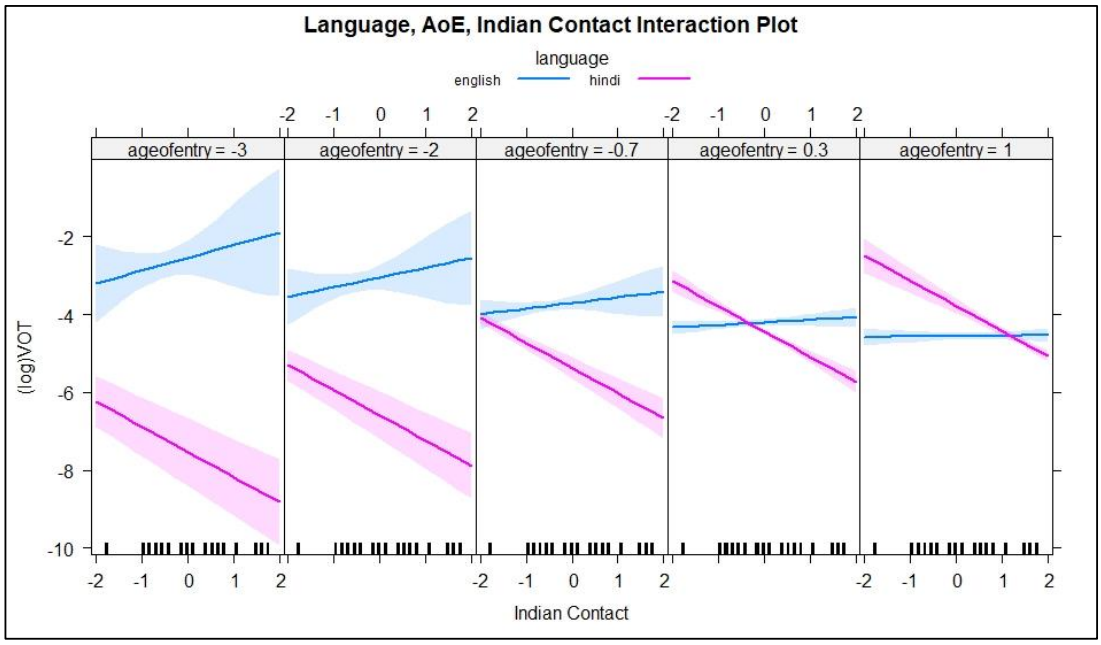

Figure 6. Model interaction effect between Language, Age of Entry and Indian Contact on log VOT.

4.2.3. Word-Initial /g/

Acoustic analysis showed that for RBI, Glaswasian /g/ showed higher RBI than Indians in English and Hindi in the direction of Glaswegians (that is, assimilation). For the present analysis, lower RBI indicates higher assimilation, whereas higher RBI indicates lower assimilation.

For word-initial /g/, the linear mixed model of the best fit included the fixed effect of Vowel Height and the interaction between Age of Entry in Glasgow (AoE) and Glaswegian Contact (GC). A significant effect emerged for Non-High Vowel Height ($\beta = -1.85$, $t(387) = -5.83$, $p < 0.001$), along with a significant two-way interaction between Glaswegian Contact and Age of Entry in Glasgow ($\beta = 2.13$, $t(387) = 3.52$, $p < 0.001$), as shown in Figure 7. This indicates that an increase in Glaswegian Contact was associated with higher RBI (more assimilation) in English, but this effect flattens and reverses with higher Age of Entry in Glasgow.

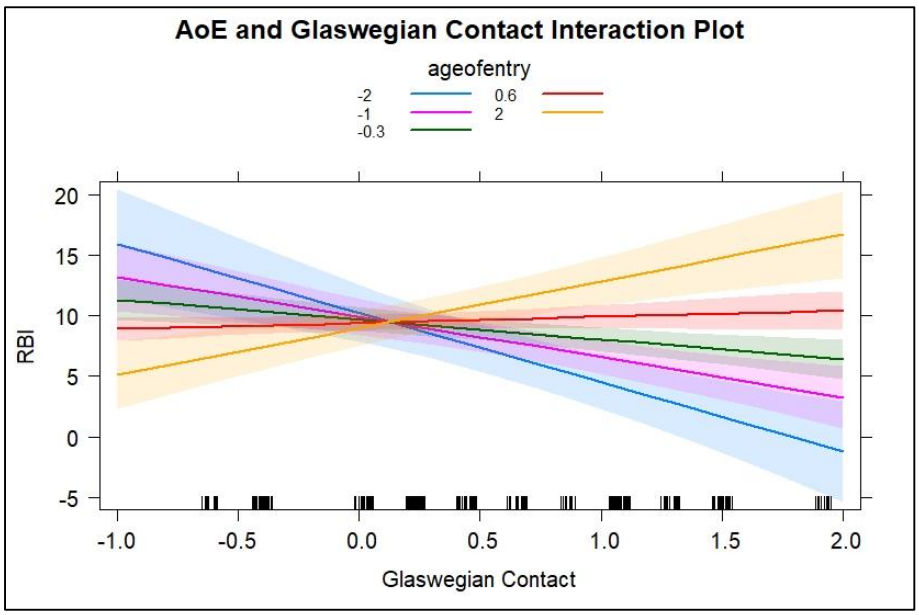

Figure 7. AoE and Glaswegian Contact interaction effect on RBI in /g/.

In conclusion, Glaswegian Contact was associated with increased assimilation in early arrivals in Glasgow (more Glaswegian-like values) in RBI in /g/.

5. Discussion

Table 2 presents the findings of the acoustic analysis across phone categories and respective measures. This influence from GE to the native varieties is summarised in terms of assimilation or dissimilation, and the amount of transfer to each native variety. The features that became more Glaswegian-like in their realization are categorised under 'Assimilation', those that became more unlike the Glaswegian and Indian realization are categorised under 'Dissimilation', whereas those that retained their original features and have not been influenced are categorised under 'No Change'.

Table 2. Direction and degree of backward transfer summarised across sounds for Glaswasians' English and Hindi. Assimilation indicates phonetically more Glaswegian-like, while dissimilation indicates less Glaswegian-like.

Sound	Measure/Feature	Assimilation	Dissimilation	No Change	Amount of Transfer
/l/	F2-F1 Difference	-	Hindi, English	-	Higher dissimilation in Hindi than in English
/t/	VOT	Hindi, English	-	-	Higher assimilation in English than in Hindi
/b/	RBI	-	-	Hindi, English	
/d/		-	-	Hindi, English	
/g/		Hindi, English	-	-	Equal amount in both

5.1. Was There a Backward Transfer of Glaswegian English to Hindi and Indian English?

There was a backward transfer of Glaswegian English to Glaswasians' native varieties, Hindi and Indian English. Three key patterns were observed in the findings regarding backward transfer.

First, in line with SLM-r's predictions, transfer manifested as assimilation and dissimilation (Flege and Bohn 2021), and there were cases of no change as well (Table 2). According to SLM-r (Flege 1995; Flege and Bohn 2021), assimilation represents the merging of perceptually linked L1 and L2 categories, where the L1 category shifts in the direction of the L2 category in the common phonetic space. This 'composite' L1–L2 category is based on the combined distribution of the respective L1 and L2 sound category tokens that the speaker has encountered. Consistent with this, all instances of assimilation in the present study (/t/ for VOT and /g/ for RBI in English and Hindi) indicate merged host and native category cues such that the assimilated values are intermediate between Glaswegian and native realisations. Dissimilation, or the exaggeration of the characteristics of the native varieties (here, Indian English and Hindi) to maintain a contrast between perceptually similar L1–L2 categories was found for /l/ in English and Hindi. However, /b/ and /d/ showed no difference in RBI.

Second, findings also revealed equivalent behaviour of sound categories for features in both languages. That is, /t/ exhibited assimilation for VOT in both native languages (was more aspirated like Glaswegian English /t/). Similarly, for both native varieties, /g/ for RBI also exhibited assimilation (assimilated to Glaswegian louder bursts). Even for /l/, both Hindi and English exhibited dissimilation for F2-F1 difference (became clearer). The implications of these findings are discussed in Section 5.2.

Finally, even for the same cue (RBI), not all members of the given 'natural class' or subsegmental level (Chang 2012) of voiced stops exhibited transfer and of the same kind. That is, the voiced stops /b d g/ behaved differently with respect to the influence exhibited: /g/ showed an assimilatory shift in both L1s, whereas /b/ and /d/ showed no difference in either L1. While RBI has not been extensively examined in backward transfer research, previous research on VOT in voiceless stops has shown generalisation in backward transfer effects across all three voiceless stops /p t k/ (Flege and Eefting 1987a; Harada 2003;

Lev-Ari and Peperkamp 2013; Major 1992; Mayr et al. 2012; Stoehr et al. 2017). However, there are also studies where there is either a difference in the transfer processes found across these three voiceless stops (Lord 2008) or a difference in the amount of transfer found across them (Chang 2012). Similar to the results for voiced stops in the present study, Lord (2008) did not find transfer effects to be generalised across the subsegmental class of voiceless stops: while there was an assimilatory shift in L1 /k/, no shift was found in /p/ and /t/. In Chang (2012), however, while there was an assimilatory shift across all three voiceless stops, the shift was found to be bigger in /p/ and /k/ than in /t/. Based on this, Chang (2012) concluded that depending upon the level at which the L1–L2 linkages are formed, transfer can be specific or general. That is, it may occur between specific L1–L2 segments (at the segmental level), across members of a given natural class like voiceless stops (at the sub-segmental level), or even at a global level. The results for RBI in this study seem to support that backward transfer effects may not be generalized across members of a given subsegmental class even for the same cue in either direction (assimilation or dissimilation) or amount (Bergmann et al. 2016; Chang 2012). This goes against previous findings, suggesting that the L1 and L2 sounds are linked at the system-wide level (Schmid and Köpke 2017). Therefore, the finding of assimilation in Glaswasian Hindi and English /t/ for VOT does not ensure the same direction and amount of transfer for this feature for Glaswasian /p/ and /k/. Moreover, it is possible that other factors, such as salience of a given segment or feature, play a role in modulating transfer effects.

Such diverse transfer effects of assimilation, dissimilation, and no change across the three types of phone categories prompt an interesting question: are different phone categories susceptible to different transfer effects? According to Bergmann et al. (2016), the most widely examined feature in L1 attrition/drift research is VOT, which has also been found to be particularly susceptible to assimilation in findings from many studies on the subject. The findings on VOT in /t/ in the present study seem to confirm this observation. With respect to RBI in /g/, only rarely has this cue been examined in backward transfer research to be able to draw a pattern about it here. Shaktawat (2018a) found instances of assimilation and no difference in Glaswasians. On the one hand, the stop /d/ exhibited assimilation in both Hindi and English, and /b/ and /g/ exhibited assimilation in Hindi only. On the other hand, both /b/ and /g/ remained unchanged for this cue in English. In any case, in both Shaktawat (2018a) and the present study, RBI did not exhibit dissimilation, and as a cue seems to be more likely to show evidence of assimilation than dissimilation. This indicates a trend towards quieter bursts in Glaswasians' voiced stops for both Hindi and English. However, what is interesting here is that even though Shaktawat (2018a) and the present study recruited speakers from the same Glaswasian population, backward transfer effects were different across the same phone categories and feature of RBI. This seems to suggest that factors such as language contact and exposure, age of entry, length of residence in L2 country, etc. may play a crucial role in modulating backward transfer effects in immigrant populations, which are especially quite linguistically diverse. This also presents a good opportunity for examining possible effects of Glaswasians' regional native language on backward transfer outcomes. In this case, Shaktawat (2018a) did not report any results on the effects of language contact or other predictors in order to make a comparison with the present study.

While the examination of /l/ in previous research on backward transfer is not as extensive as that of VOT, some work has examined /l/ in this regard (Barlow 2014; Bergmann et al. 2016; de Leeuw et al. 2013; Shaktawat 2018a). An assimilatory shift of L1 /l/ in the direction of the L2 was reported in three of these studies (Barlow 2014; Bergmann et al. 2016; de Leeuw et al. 2013). By contrast, the present study observed dissimilation of /l/, with larger F2-F1 differences in both Indian English and Hindi produced by Glaswasians. Moreover, in the same population, Shaktawat (2018a) reported dissimilation in Hindi but assimilation in Indian English. It is important to note that though recruited from the same population, the members of the Glaswasian group in Shaktawat (2018a) and the present study were different. It is possible that it is the differences in their individual linguistic and

social profiles (for example, quality and quantity of L1–L2 use and contact) that contributed to these differences in results across these two studies even in the same population. This highlights the need to examine the effect of various psycholinguistic and sociolinguistic factors on backward transfer outcomes.

There is a possible explanation for the dissimilatory shift found in Glaswasian /l/ in the present study and in Shaktawat (2018a), which has to do with the 'Cross-Sectional Methodology Criticism in Determining L1 Attrition Argument' (E. de Leeuw et al. 2013) and diachronic language change. This criticism argues that shifts in the L1 may be found not because of L1 attrition or backward transfer, but because the language of the monolingual controls has undergone a change since the bilinguals moved out of the country (de Leeuw et al. 2013). Therefore, in the case of /l/, it can be argued that the dissimilatory effects (the lighter /l/ observed among Glaswasians than Indian speakers of Hindi) are observed here because the control Indian Hindi /l/ got darker after Glaswasians left for Glasgow. Therefore, when compared with the Indian control group, it could be because of this changing nature of /l/ in India that the Glaswasian /l/ appears clearer and is taken to be indicative of dissimilation. However, first, there is no research to indicate that Indian /l/ has got darker over recent years, and second, the results also indicate that there are Glaswasians who have values similar to Indians. Therefore, it appears that this influence is indeed due to interaction with Glaswegian English.

5.2. Did Indian English Receive More Transfer than Hindi?

It was assumed that the structural proximity between Glaswegian English and Indian English would lead to higher, more substantial transfer effects in the latter, as compared to Hindi, which is a separate language with respect to Glaswegian English. The findings are interesting. In the two cases of assimilation, English either showed a quantitatively bigger assimilatory shift than Hindi (for VOT in /t/) or showed a similar assimilatory shift as Hindi (for RBI in /g/). In the one case of dissimilation, Hindi showed a bigger dissimilatory shift than English (for F2-F1 difference in /l/). Therefore, while there does not appear to be a clear-cut pattern here, what is immediately clear is that in the event of becoming more Glaswegian-like, Glaswasian's English was affected more than their Hindi, and in the event of becoming exaggeratedly unlike Glaswegian, Glaswasian's Hindi was affected more. This seems to indicate that transfer effects may indeed be somehow modulated by the typological proximity between the linguistic varieties.

5.3. An Effect of Indian Contact (IC) and Glaswegian Contact (GC)?

The results also showed significant effects of Indian Contact and Glaswegian Contact which support previous research (de Leeuw 2009; Stoehr et al. 2017) and the proposed predictions of this study.

The effect of Indian Contact was interesting as it was different across English and Hindi. In English, the effect of Indian Contact was either absent (for F2-F1 difference in /l/) or correlated with more assimilation (for VOT in /t/ in early arrivals). But in Hindi, higher Indian Contact was related to either increasingly Indian-like values, that is, no transfer (as in F2-F1 difference in /l/ and VOT in /t/ in later arrivals) or increasingly exaggerated Indian-like values, that is, dissimilation (for VOT in /t/ in early arrivals). Importantly, higher Indian Contact was certainly not associated with an increase in Glaswegianness or assimilation in Hindi. It appears that higher Indian Contact represents higher influence of the heritage language, Hindi (as spoken by Indians or by long-term Indian Glaswasians), which ensured the maintenance of Hindi, instead of its assimilation, in Glaswasians.

However, higher Indian Contact also had an unexpected effect in the form of increased assimilation of VOT in English /t/ in early arrivals. It is possible that this assimilation represents a stronger attempt to integrate or assimilate (Berry 2001) to the host community by adapting their native accent of English to Glaswegian English in the face of higher Indian Contact. It is also possible that it only showed in /t/ (as compared to other categories) because Glaswasians are possibly more perceptually sensitive to the difference in short-

lag and long-lag VOT because aspiration is phonemic in Hindi, which is one of their native languages.

With respect to the effect of Glaswegian Contact (GC), higher Glaswegian Contact was found to be associated with higher assimilation to Glaswegian English, but only for RBI in /g/. However, this influence subsided with an increase in the age of entry in Glasgow, which was also the case for the assimilatory shift found for VOT in /t/. This can be related to SLM-r's 'L1 category-precision' hypothesis. It argues that "the more precisely defined L1 categories are at the time of first exposure to an L2, the more readily the phonetic difference between an L1 sound and the closest L2 sound will be discerned" (Flege and Bohn 2021, p. 33). Based on this, it is possible that Glaswasians who arrived in Glasgow later in life had more precisely defined L1 categories that prevented assimilatory shift to the Glaswegian RBI in /g/ as well as VOT in /t/.

What the above discussion also highlights is that the effects of these predictors varied across English and Hindi. Indian Contact represented increased contact with the Indian community and by extension with the Indian English and Hindi that they speak, based on which it was possible that the effect of this predictor could have had a similar effect across both languages. However, Indian Contact seemed to affect Hindi more than English. This suggests that Indian Contact represents increased influence from the heritage language Hindi, which affected Glaswasians' Hindi more than their English, and ensured its maintenance. Moreover, Glaswegian Contact represented influence from Glaswegian English only, which was expected to affect Indian English more than Hindi. However, the effect of Glaswegian Contact was not variable across Hindi and English. Glaswasian RBI showed the same amount of assimilation for Hindi and English /g/ and the effect of Glaswegian Contact did not differ across English and Hindi. At the very least, these findings highlight the need for a deeper examination of the impact of various sociolinguistic and psycholinguistic predictors to better understand the nature of backward transfer.

With reference to the number of categories affected by Indian Contact and Glaswegian Contact, it appears that an immigrants' contact with their respective heritage community and languages is more important in native language maintenance than their contact with the host community and language is at causing an assimilatory shift of L1 categories towards the L2. Yes, Glaswegian Contact modulated backward transfer effects, but this effect was far more limited than the effect of Indian Contact. While Indian Contact affected two out of the three phone categories for the same sample size (/l/ and /t/), Glaswegian Contact affected only one phone category (/g/).

6. Conclusions

By examining the interaction between Glaswegian English (L2) and Hindi and IE (L1s) in Glaswasians, this study found evidence of backward transfer in the form of assimilation, dissimilation, and no change. More importantly, it offered a comparison of phonetic backward transfer across languages and dialects in a situation of simultaneous bilingual and bidialectal contact and argued that backward transfer effects are possibly modulated by the degree of structural similarity between the involved linguistic varieties. Not only this, but it also adds to the sparse evidence of the role of contact with various speech communities in affecting phonetic backward transfer effects. By examining not one but two contact variables, this study informs us that contact with migrants' heritage community may be more influential in affecting transfer outcomes. In terms of future research, more evidence is needed to understand the nature of transfer in this situation of simultaneous bilingual and bidialectal contact, and compared to a cross-sectional study, a longitudinal study would be better suited at capturing such transfer processes taking place across time.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/languages9040118/s1, Figure S1: Annotation of word-initial /l/ in the word 'lust' as spoken by a female speaker from the 'Indian' control group. Figure S2: Annotation of word-initial /t/ in the word 'tub' as spoken by a male speaker from the control group 'Indian'. Figure S3: Annotation of word-initial /b/ in the Hindi word 'bel' (meaning 'vine') as spoken

by a male speaker from the control group 'Indian'. Figure S4: English word-list stimuli. Figure S5: Hindi word-list stimuli.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data associated with this study are available at osf.io/dc34w.

Conflicts of Interest: The author declares no conflict of interest.

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