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## Phonetic and Phonological L1 Attrition and Drift in Bilingual Speech

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### 32.1 Introduction

#### 32.1.1 Why Is Change in the First Language (L1) Important?

Even the most seemingly monolingual places are shaped in space and time by different languages meeting. Most often, when languages meet, they are brought together by humans who *speak* with one another. This section of the handbook is devoted to the variables and outcomes of bilingual speech, and within this chapter the authors target how an individual's native language (used synonymously here with "first language," L1) is impacted when a new language (used synonymously here with "second language," L2) is acquired post-pubescently.

Most of our knowledge about the speech of bilinguals relates to the potential for humans to acquire a new language. It is indeed a fascinating endeavor to understand the extent to which an L2 can be acquired once an L1 is already – even if only partly – in place. In comparison, much less bilingualism research has examined whether and how the L1 changes upon L2 acquisition and immersion. It is these changes in the L1 which are discussed here as *outcomes* of bilingual speech. We consider these outcomes (i.e., attrition and drift) to be *inevitable* outcomes of bilingual speech, although individual bilinguals are impacted differently, to greater or lesser degrees, and not necessarily across all aspects of their L1.

Research into L1 attrition and L1 drift aims to investigate how the native language changes when a new language is acquired, and – as discussed in more detail shortly – the two terms are closely related. They are, however, different in terms of the type of L1 change they describe. What underlies both terms is the understanding that a person's L1 is malleable and can – and *does* – change in adulthood once fully acquired. In this chapter, the focus will be on L1 attrition and L1 drift (henceforth, simply "attrition" and "drift" although we only refer to changes in the L1) in bilingual *speech*.

As bilingualism impacts all of us, either directly through our own personal experiences or indirectly through those around us, attrition and drift have an extensive scope. Indeed, individuals from diverse backgrounds may be impacted by attrition and drift. For example, in the case of the first author, she grew up in Northern British Columbia, so her L1 is Canadian English, but, as she also spent decades in Germany and the UK (as well as time in the Netherlands and Switzerland), her English has undergone changes in comparison to the language she spoke when she moved to Europe as a teenager. As her father spoke Dutch as an L1, she was also exposed to Dutch as a child, but, after living in the Netherlands, she discovered that her father's Dutch was quite different from the language spoken in the Netherlands (for one, he did not use English words in his Dutch, as many Dutch speakers do today). These personal experiences influenced her understanding of language change early on before she set about researching attrition and drift.

In the case of the second author, who grew up in New York, his L1 is US English, although he heard Korean often from family and community members throughout childhood. He started to perceive changes in his L1 during his first extended stay in Korea in his early twenties, when he was studying and speaking Korean daily. These changes were unexpected, as he was, at the same time, working as a teacher of his L1 and speaking English daily. Upon returning to the US, he became increasingly interested in the phenomenon of L1 change in adulthood, and noticed how his parents, L1 speakers of Korean who immigrated to the US in their thirties, would speak Korean differently from homeland speakers in Korea – using native Korean words where homeland speakers would use English borrowings, and vice versa – although his parents' pronunciation of Korean was not noticeably different from homeland speakers'.

Although there are parallels between the experiences of both authors – both are second-generation immigrants to North America, who returned to their family's country of origin as adults, and became interested in research into attrition and drift in part due to their own backgrounds – their experiences are also unique. For example, their regional origins are different: the first author grew up in a sparsely populated environment, the second in an urban environment. As such, there was no extensive Dutch community where the first author grew up, whereas there was a large Korean community where the second author grew up. This difference in environment resulted in different bilingual experiences for both authors as the quality and quantity of their Dutch and Korean input varied. Such unique, yet similar, backgrounds exemplify the diversity of bilingual experiences.

Despite the difference in the authors' regional origins, there is a commonality here as well: both authors grew up on land that was colonized by settlers. In Northwestern British Columbia, the first author saw and learned as a young girl about Canadian residential schools, where, among other atrocities, First Nation children were sent after being taken from their families

and forbidden to speak their languages (Greenwood & de Leeuw, 2012). Today, many indigenous languages, which have been profoundly impacted by the effects of colonialism, are undergoing revitalization initiatives (Sterud Miller, 2019). Here, too, we see the impact of bilingualism and the potential impact of attrition and drift. It is not only through personal choice and planned immigration, as in the cases of the authors of this chapter, that an individual acquires an L2; nor is it necessarily personal choice if this L2 changes the speech patterns of an individual's L1. Colonialism has given rise to large portions of the world's population that have been forced to acquire the language of colonizers, and, in doing so, colonialism may have changed not only the amount of speakers of colonial and indigenous languages but also the colonized and colonizing languages themselves.

These examples illuminate how different – and yet how similar – personal bilingual experiences can be. Many people come from immigrant backgrounds or have been personally impacted by colonialism, and are thus in a position to experience attrition and drift, directly or indirectly. This is why investigating change in the L1 is important from a personal perspective, although, as will be discussed in the rest of the chapter, investigating change in the L1 is also important from a theoretical perspective.

### 32.1.2 Terminology

As already exemplified, both attrition and drift refer to changes in the L1 of an individual, rather than the societal loss of a language (de Bot & Clyne, 1994; Schmid, 2011). In this chapter, we discuss attrition and drift as they occur in bilingual speech (i.e., at a phonetic and phonological level), in contrast to how, for example, the L1 syntax or lexical semantics might change due to L2 acquisition.

#### 32.1.2.1 What Is Bilingual Speech?

We use the term bilingual speech to refer broadly to speech which is produced by an individual who speaks more than one language variety. This could be someone who speaks two or more dialects (bidialectal) or two or more languages (bilingual).

The inclusion of dialects into a definition of attrition and drift is relevant when one considers that the terms “language” and “dialect” represent a continuum and that their “edges are extremely ragged and uncertain” (Haugen, 1966, p. 922). There are many examples of dialect continua which show that the distinction between languages and dialects is fuzzy (Chambers & Trudgill, 1998). Therefore, we believe that when investigating potential attrition and drift, both bilingualism and bidialectalism should be considered. Multiple dialects in a bilingual's repertoire can be referred to as D1, D2, etc., along the same lines as multiple languages (L1, L2, etc.).

Bilingual speech can be speech in L1/D1 or L2/D2, or speech in an additional variety such as a third language or dialect (L3/D3), and so on. It is

simply the speech produced by an individual who speaks two or more languages or dialects. In the study of attrition and drift, bilingual speech is the object of investigation; most commonly, the focus is on L1 speech specifically, but, as an additional language is required per definition, L2 speech, L3 speech, and so on may also enter the investigation. Additional languages may be investigated to see how the bilingual's different languages interact phonetically and/or phonologically, if at all, throughout the bilingual/bidialectal experience.

### 32.1.2.2 What Is L1 Attrition and What Is L1 Drift?

We consider the terms attrition and drift to characterize outcomes of bilingual speech on a continuum (see Figure 32.1). At the extreme ends of attrition and drift, the outcomes might look very different, but toward the middle of the continuum, the outcomes might overlap greatly. In the following sections, after considering the similarities between attrition and drift, we discuss differences between the two terms.

### 32.1.2.3 Similarities between Attrition and Drift

#### 32.1.2.3.1 L1 Change in Speech

Although attrition and drift might also occur in other linguistic domains, our definition of these terms focuses on L1 changes in *speech*. These changes can occur within the segmental and prosodic levels of speech in the phonetic domain. That is, both attrition and drift involve phonetic changes in the L1, which could include changes in L1 perception and/or L1 production. However, phonetic change in the L1 does not necessarily imply phonological change (see Section 32.1.2.4).

#### 32.1.2.3.2 Context of Late Bilingualism

Research into both attrition and drift aims to describe changes in pronunciation or listening that occur within an individual's L1 when an L2 is acquired post-pubescently, as well as to explain why such changes occur. Crucially, both

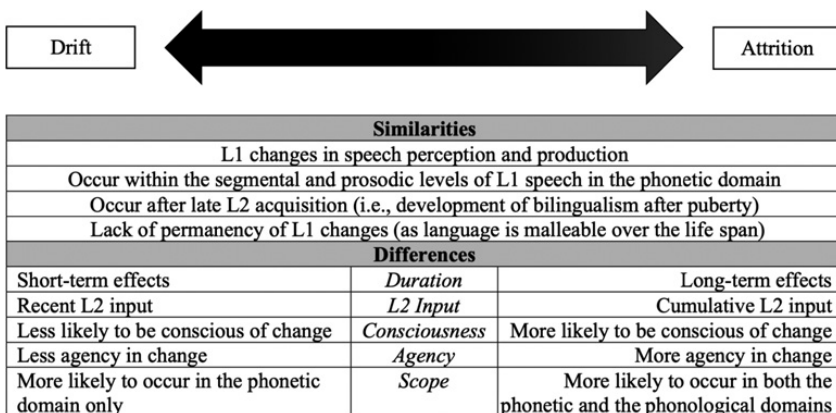


Figure 32.1 Theoretical similarities and differences between drift and attrition.

processes show that L1 change is possible after childhood (see also Flege, 1995; Flege & Bohn, 2021). In contrast, psycholinguistic models of language acquisition (e.g., the critical period hypothesis; Lenneberg, 1969) have advanced the idea that the L1 stabilizes in adolescence (i.e., after the closing of a proposed critical period). This idea, however, is challenged by research showing attrition (in the long term) and drift (in the short term) in late sequential bilinguals (see Chang, 2019b and de Leeuw & Celata, 2019 for a review). Such studies augment research on effects of new dialect exposure in monolinguals, which likewise reveal that, post-pubescently, the L1/D1 changes over time when in contact with new varieties of the same language (Evans & Iverson, 2007; Harrington, 2006; Munro, Derwing, & Flege, 1999; Sankoff, 2004; Shockey, 1984). In short, both attrition and drift refer to processes occurring in the context of late sequential bilingualism, broadly construed to include the very beginnings of L2 acquisition.

### 32.1.2.3.3 *Lack of Permanency*

We propose that the term “attrition,” like the term “drift,” characterizes changes in the L1 that are not necessarily permanent. In this respect, we conceive of attrition as similar to drift in being, in principle, reversible. In fact, we consider the term “permanent” to be a misnomer, and a straw man, in this context: since studies of L1 change glimpse only a part of an individual bilingual’s life, how can one ever know whether any observed change is truly permanent? Instead, we regard attrition as the summation of relatively durable changes in the L1 of bilingual speech which have occurred over time, without excluding the possibility that such changes could be reversed at a later point in life. By comparison, we use the term “drift” to refer to L1 changes that are intrinsically less durable, due to their source in recent L2 experience specifically (see Section 32.1.2.4).

Related to lack of permanency, we do not use the terms “attrition” and “drift” to imply language “loss,” which in our view carries the implication of permanency and, in certain contexts, clinical implications and associated value judgments. On the contrary, we consider both attrition and drift to be normal, inevitable, and reversible processes in late sequential bilingualism. Furthermore, because neither attrition nor drift involves an irrecoverable “loss” of any aspect of the L1, we would not expect the process of reversing attrition/drift (i.e., reacquiring or retuning the L1) to look the same as acquiring the L1 from scratch.

### 32.1.2.4 Differences between Attrition and Drift

#### 32.1.2.4.1 *Duration of L1 Change*

The terms “attrition” and “phonetic drift” (or “drift” for short) refer to L1 changes that differ in durability. We describe long-term, more enduring effects of the L2 on the L1 with the term “attrition” (Bergmann et al., 2016; de Leeuw, 2019b; de Leeuw, Mennen, & Scobbie, 2012; de Leeuw, Opitz, & Lubinska,

2013; de Leeuw, Schmid, & Mennen, 2010; de Leeuw, Tusha, & Schmid, 2018; Hopp & Schmid, 2013; Major, 1992; Mayr, Price, & Mennen, 2012; Mennen, 2004; Ulbrich & Ordin, 2014), but shorter-term, potentially more superficial effects of the L2 on the L1 with the term “drift” (Chang, 2012, 2013; Sancier & Fowler, 1997; Tobin, Nam, & Fowler, 2017). As in Section 32.1.2.3.3, however, both types of L1 change are in principle reversible.

#### 32.1.2.4.2 *L2 Input*

Attrition and drift differ in terms of their presumed source in L2 input and experience. The term “drift” refers to phonetic (i.e., subphonemic) changes in the L1 that can be attributed to the influence of *recent* L2 experience (Chang, 2019b). Given this presumed source, research on drift as distinct from attrition often focuses on the earliest stages of L2 immersion, such as the first weeks of a study-abroad experience (Chang, 2012, 2013, 2019a; Lang & Davidson, 2019), or on laboratory-based L2 exposure, which can be controlled and directly observed (Kartushina et al., 2016); however, the study of drift extends to L2 learning in L1-dominant environments (Herd et al., 2015) as well. In the case of drift, we are generally concerned with the effects of comparatively little and/or introductory L2 experience, not advanced L2 proficiency or long-term immigration to an L2-dominant environment. On the other hand, attrition is most often investigated within the scope of long-term immigration (Köpke & Schmid, 2004). Therefore, we conceive of attrition as being due to the cumulative totality of L2 experiences (e.g., de Leeuw et al., 2010), which may or may not be recent or ongoing, whereas drift is due precisely to recent or ongoing L2 experience (e.g., Chang, 2012; Dmitrieva, Jongman, & Sereno, 2020).

#### 32.1.2.4.3 *Consciousness of L1 Change*

The difference between drift and attrition in the extent and timescale of L2 experience is expected to affect how conscious or aware bilinguals are of the fact that their L1 has changed. In short, bilinguals appear more likely to be conscious of attrition than of drift. This stands to reason as attrition is a long-(er)-term process, so the bilingual experiencing attrition has more opportunity to notice changes in their L1 (which may be pointed out to them by others) than the bilingual experiencing drift. To our knowledge, there is no research that has systematically examined consciousness of change in L1 speech at different stages of late sequential bilingualism. However, anecdotally, many bilingual study participants in attrition contexts have revealed to the first author during experimental debriefing sessions that they “know” they have a foreign accent in their L1 and/or that other people have commented on the “way they say things,” whereas this level of consciousness of L1 change is not very common in the second author’s experience with study participants showing drift.

#### 32.1.2.4.4 Agency in L1 Change

Related to the difference in consciousness of change, we expect attrition and drift to differ in terms of potential effects of the bilingual's agency as a language user. Although all bilinguals have some degree of agency in their speech development and use (e.g., through choosing environments in which their L1 is practiced and/or their L2 is promoted), the bilingual undergoing attrition is more likely to be conscious of changes in their L1 speech than the bilingual undergoing drift, and is therefore more likely to be able to express their agency about these L1 changes. Agency could be expressed in a variety of ways, such as monitoring and inhibition of noncanonical L1 production patterns, choosing different language environments, talking with different interlocutors, or selecting languages differently by interlocutor and/or topic.

#### 32.1.2.4.5 Scope of L1 Change

Both attrition and drift involve phonetic changes in L1 speech – that is, changes that do not alter abstract phonological structure (e.g., phonemic contrast between two sounds) – but only attrition may additionally involve changes at a phonological level. Because drift follows from relatively little, albeit recent, L2 experience, the L1 changes in drift are expected to be phonetic, not phonological. Any L1 changes that are phonological (e.g., merging phonemes) are more likely to be found in contexts of attrition – and can be described precisely as “phonological attrition” (Celata, 2019; de Leeuw et al., 2018) – because such changes ostensibly result from the more extensive L2 experience characteristic of attrition contexts. Whether “phonological drift” is possible is an empirical question, but to our knowledge such a phenomenon has not been observed and we do not predict this to be possible.

An additional note about attrition and drift related to scope concerns the language versus dialect continuum. Although the term “attrition” has been used to refer to L1/D1 change in the context of both bilingualism and bidialectalism, the term “drift” has, up to now, mostly been applied to L1 change in the context of bilingualism per se (i.e., not bidialectalism). This is because the changes in L1 speech observed to follow from acquisition of a new dialect (see Nycz, 2015) have generally only been studied long after migration to a new dialect region (meaning that it is not possible to tease apart effects of the most recent exposure to the new dialect from those of extensive cumulative exposure), while changes in L1 speech found after recent exposure to a same-language talker, who may or may not speak a different dialect, have been described with a different term (namely, “accommodation”; e.g., Coupland, 1984; Giles, Coupland, & Coupland, 1991; Hay, Jannedy, & Mendoza-Denton, 1999; Kim, 2009). In our view, if one were to investigate effects of recent D2 exposure specifically, and in particular outside of interactional contexts, it would be appropriate to describe these effects as “drift” of the D1.

### 32.1.3 Core Findings of Attrition and Drift

Research on attrition and drift in bilingual speech is relatively young, but there are several recurring themes that have emerged from the literature. In this section, we briefly discuss each of six themes. More in-depth reviews of the literature in this area can be found in Chang (2019a, 2019b) for (phonetic) drift, de Leeuw (2019a) for phonetic attrition, and Celata (2019) for phonological attrition.

First, virtually all aspects of L1 speech are subject to attrition and drift. Attrition has been documented in both segmental (de Leeuw et al., 2018) and suprasegmental features (de Leeuw et al., 2012; Mennen, 2004) and in both perception (Ahn et al., 2017; de Leeuw, Kapia, & Lewis, 2023) and production (de Leeuw, 2019b; de Leeuw et al., 2010). Similarly, drift has been found in both segmental and suprasegmental features (Chang, 2012, 2013) and in both perception (Kellogg & Chang, 2023; Tice & Woodley, 2012) and production (Chang, 2019a; Sancier & Fowler, 1997). In short, there do not appear to be any aspects of L1 speech that are, by nature, impervious to change in late sequential bilinguals.

Second, there is variation in how susceptible different aspects of the L1 are to attrition and drift, and at least some of this variation may be principled. For example, in contexts of drift, the voice onset time (VOT) of L1 stops has been found to change faster than spectral qualities of L1 vowels such as formants (Chang, 2012; see also Lang & Davidson, 2019). This disparity has been attributed to the different nature of these features: VOT is timing-based, but vowel formants are posture-based (and, therefore, potentially more anchored in proprioceptive feedback).

Third, attrition and drift can generally be linked to a developing or well-established L2. In all the examples cited earlier, the L1 changes were observed in bilinguals in the broadest sense, including both novice L2 learners and proficient L2 users. Thus, despite our acknowledgment that attrition has been theorized to be possible without L2 acquisition (see, e.g., Köpke, 2004), in practice, both attrition and drift are typically attributable to the influence of an L2, influence that may be specific (e.g., due to particular L2 sounds) or more general (e.g., due to the presence of an additional language in the bilingual's repertoire that "competes" with the L1). Furthermore, specific L2 influence may not necessarily result in assimilation toward L2 norms, as dissimilatory attrition/drift is also attested (e.g., Chang, 2019b; de Leeuw et al., 2012; Flege & Eefting, 1987).

Fourth, both attrition and drift are influenced by cross-linguistic similarities between the L1 and the L2 at multiple levels (e.g., between individual phones, between natural classes, etc.), but the effects of L1–L2 similarity vary according to the aspect of the L1 under consideration. In the case of *contrasts*, similarity to L2 contrasts appears to counteract attrition by reinforcing the contrastiveness of the L1 contrast; thus, L1 contrasts paralleled by similar contrasts in the L2 tend to resist attrition (Ahn et al., 2017), while contrasts unique to the L1 are more vulnerable



(de Leeuw et al., 2018). In the case of *sounds*, however, there seems to be a “sweet spot” of cross-linguistic acoustic similarity that results in L1 change: enough similarity to an L2 sound is needed to cause the L1 sound to be cognitively linked to, and thus able to be influenced by, the L2 sound, but too much similarity (such that any L1–L2 acoustic disparity is so small as to be unnoticeable) may remove any trigger for L1 change (Chang, 2012), just as a lack of phonological similarity appears to do (see, e.g., /y/ in Chang et al., 2011; Flege, 1987). Recent work on drift has further argued that drift is not only triggered by L1–L2 similarities but also shaped directly by L2 development, such that the L1 and the L2 change together (“tandem drift”; see Turner, 2023).

Fifth, apart from L2 influence, attrition and drift are influenced by individual differences in L1-specific as well as nonlinguistic factors. Factors that are specific to L1 include quality of L1 use, including amount of code mixing and language switching (de Leeuw et al., 2010; Kartushina & Martin, 2019); amount of L1 education (Ahn et al., 2017); amount of L1 contacts (Hulsen, 2000); and sociolinguistic variables (Nodari, Celata, & Nagy, 2019). Nonlinguistic factors include inhibitory control (Lev-Ari & Peperkamp, 2013). Although many L1-specific factors could be construed as indirectly related to the L2 for bilinguals, cognitive constructs such as inhibitory control are generally understood to be domain-general (i.e., not specific to language). Crucially, this means that an individual bilingual’s manifestation of attrition and/or drift cannot be reduced completely to L2 influence.

Finally, attrition and drift can be reversed, although their reversal may differ depending on the feature under consideration. For example, drift in both VOT and vowel formants is reversed substantially after L1 reimmersion (Kartushina & Martin, 2019; Sancier & Fowler, 1997). Within an L2 environment as well, drift in VOT is reversed significantly in the absence of frequent active L2 use, whereas drift in fundamental frequency ( $f_0$ ) is more resistant to reversal even without frequent active L2 use (Chang, 2019a). In addition, there is evidence that traces of drift as well as attrition may remain in the L1 as long as ten months after L1 reimmersion (Turner, 2023), suggesting that full reversal of these processes may be difficult, at least as long as the L2 continues to be used within the L1 environment.

In summary, the current body of work on attrition and drift in bilingual speech does not point to any single condition as sufficient for triggering attrition or drift, but rather indicates that these are complex, multifaceted processes influenced by myriad factors, both linguistic and nonlinguistic, and about which much remains unknown. In the next sections, we contextualize a new theory of bilingual speech, one that devotes special attention to attrition and drift, within the landscape of existing theories of L2 speech, and then present the principles of this new theory as a testable framework for future work in this area.

## 32.2 Links to L2 Speech Theories

Current theories of bilingual speech focus on speech production and perception of individual sounds and sound contrasts in the L2. Three prominent theories – the Perceptual Assimilation Model (PAM; Best, 1995) and its extension to L2 learning (PAM-L2; Best & Tyler, 2007), the Speech Learning Model (SLM; Flege, 1995) and its revised version (SLM-r; Flege & Bohn, 2021), and the Second Language Linguistic Perception model (L2LP; Escudero, 2005, 2009) – explain how L1 experience influences L2 speech learning in different learning scenarios (Tyler et al., 2014). Special attention is given to L2 prosody in other theories, such as PAM for Suprasegmentals (PAM-S; So & Best, 2010) and the L2 Intonation Learning theory (LILT; Mennen, 2015). In this section, we discuss points of convergence and divergence between our proposed theory – Attrition & Drift in Access, Production, and Perception Theory (ADAPPT) – and the most widely tested bilingual speech theories, namely, the SLM-r, the PAM-L2, and the L2LP.

A major similarity among the SLM-r, the PAM-L2, and the L2LP is that none attempts to provide a detailed account of the effects that L2 acquisition has on L1 speech. Although the SLM-r admits the possibility of L2 effects on the L1 by positing that cross-language interactions are bidirectional, its focus remains on accounting for the acquisition of L2 speech, similar to the PAM-L2. The L2LP goes one step further in explicitly not allowing for perceptual attrition: “The L2LP model predicts that advanced L2 learners in an L2 monolingual mode will exhibit an L2 perception similar to that of monolingual native listeners. This means that no fossilization in L2 sound perception and no attrition in L1 sound perception will be attested” (Escudero, 2005, p. 121). We consider the general lack of attention to L2 effects on the L1 to be a significant shortcoming of these models as theories of bilingual speech, given the mounting evidence that the L1 is indeed impacted upon L2 acquisition (see references in Sections 32.1.2.3, 32.1.2.4, and 32.1.3). Our model, ADAPPT, attempts to address this shortcoming by devoting special attention to L1 change.

A second similarity among the PAM-L2, the L2LP, and the SLM (although not the SLM-r) is their stipulation that accurate perception needs to be in place *before* accurate production is possible, and that difficulties producing L2 sounds have a perceptual basis. The SLM-r, by contrast, adopts the view that “L2 segmental perception and production coevolve without precedence” (Flege & Bohn, 2021, pp. 28–29). In ADAPPT, we take a similar view as the SLM-r as to the timing of changes in perception versus production (i.e., they are not coordinated in any particular way), which leads us to predict disparities in attrition/drift between perception and production (see Section 32.4).

Note that ADAPPT’s view on the lack of coordination between L1 changes in perception versus production reflects a core hypothesis of separation between these modalities, which are presumed to rely on divergent, albeit

connected, representations. This hypothesis is supported by a growing body of research showing dissociations between perception and production of L2 sounds (Baker & Trofimovich, 2005; Barrientos, 2023; Beach, Burnham, & Kitamura, 2001; de Leeuw et al., 2021; Gorba Masip & Cebrian, 2021; Kartushina & Frauenfelder, 2014; Sheldon & Strange, 1982; Zampini, 1998). Indeed, of the experimental studies explicitly targeting the relationship between L2 perception and production, most have not found that accurate perception clearly precedes production. For example, results from Sheldon and Strange (1982) revealed that L1 Japanese speakers who produced L2 English /l/ and /r/ in a target-like fashion still made errors in perceiving the contrast, which led them to conclude that “perceptual mastery of a foreign contrast does not necessarily precede adult learners’ ability to produce acceptable tokens of the contrasting phonemes” (p. 254). Recent studies that have carefully controlled for methodological factors to measure L2 perception and production using more comparable metrics have also not found especially consistent and/or strong perception–production correlations (e.g., Baese-Berk, 2019; Melnik-Leroy, Turnbull, & Peperkamp, 2021; Turner, 2022; see also Cheng et al. [2021] on the L1 perception–production link). Such empirical evidence directly challenges the view that L2 perception and L2 production are tightly linked; it also opens up the possibility that change in L1 perceptual capacities may occur separately from change in L1 production capacities.

A third similarity among the SLM-r, the PAM-L2, and the L2LP is their incorporation of a central role for the construct of “similarity.” The SLM-r views cross-linguistic phonetic similarity between nonidentical L1 and L2 sounds as ultimately challenging for developing target-like L2 categories, whereas the L2LP views similarity as facilitative for developing target-like L2 perception. Focusing on L2 contrasts, the PAM-L2 proposes a typology of similarity relationships between L2 contrasts and L1 sounds, with the least challenging case being an L2 contrast resembling an L1 contrast (i.e., two different L1 sounds) and the most challenging case being an L2 contrast resembling one and the same L1 sound. Regarding attrition and drift of L1 speech, ADAPPT views cross-linguistic similarity as playing a significant, but variable, role; in particular, similarity can either prevent L1 change (compare with the SLM-r on L2 development) or facilitate L1 change (compare with the L2LP on L2 development), depending on the aspect of L1 speech at issue (see Section 32.1.3).

Finally, a further similarity among the SLM-r, the PAM-L2, and the L2LP is their focus on segments, such as phonemes and allophones (compare with the PAM-S and L1Lt). However, languages differ not only in their phoneme inventories but also in their realization of prosody and phonotactic constraints. Moreover, speech itself is holistic: prosodic dimensions are produced in tandem with segments, and segments are constrained by phonotactic rules. In fact, speech is not easily separable into individual sounds at all. This is to say that a theory explaining speech primarily at the segmental level is inherently

limited because it does not account for many other important contributors to the speech signal. Thus, in ADAPPT, we propose a theory of bilingual speech which encapsulates segmental and suprasegmental changes in both the L1 and the L2 as the next step forward for research into bilingual speech.

### 32.3 Attrition and Drift in Access, Production, and Perception Theory (ADAPPT)

Very generally, ADAPPT stipulates that the speech systems of different languages which a bilingual perceives and produces are inherently connected to one another because they are produced by the same person in the same vocal tract with the same ears. As these languages are intrinsically connected, changes which occur in one language (e.g., in an L2 as it is newly acquired and develops) will have effects on the other language (i.e., the L1). There are ten main principles of ADAPPT which differentiate it from other theories of bilingual speech. These are outlined below.

1. **L1 and L2 speech are intrinsically linked.** As mentioned already, ADAPPT predicts that when a person newly acquires or further develops an L2, this will have an impact on the L1. In its most minimal form, the impact on the L1 could be reduced accessibility, causing, for example, slower reaction times in the L1 (e.g., de Leeuw et al., 2023; Linck, Kroll, & Sunderman, 2009), but in some cases (e.g., extended L2 immersion) extensive structural changes in the L1 could occur (e.g., de Leeuw et al., 2018; Dmitrieva, Jongman, & Sereno, 2010; Yao & Chang, 2016). Future research could examine how these different forms of mutual interaction proceed over a bilingual's life span. Crucially, in contrast to the aforementioned theories, ADAPPT stipulates that the L1 will *always* be impacted in some way by L2 exposure and acquisition and that this is a normal outcome of bilingual speech. This does not mean that the L1 will be impacted in the same way across all bilinguals (on the contrary, there is great variation in the extent to which bilinguals display attrition and drift; Chang, 2012; de Leeuw, 2019b); rather, it means that, among the various dimensions of L1 speech, L2 development will necessarily impact an individual's L1 in one or more of these dimensions.
2. **All dimensions of L1 and L2 speech can be affected in a bilingual's language repertoire.** According to ADAPPT, any process related to speech, including access (i.e., retrieval of information in long-term memory representations), production, and perception, and any linguistic representation related to speech, such as of individual sounds, prosodic patterns, and phonotactic constraints, is a candidate for change in attrition and drift. We see these various dimensions of speech as interconnected and do not believe that it is generally possible for L1 and L2 sounds, for example, to influence one another without this affecting other dimensions because attrition and drift are at least in part systemic (Chang, 2012, 2013; Mayr et al., 2012; Turner, 2023). In the

future, it could be interesting to jointly investigate numerous dimensions of bilingual speech within individuals to see the extent to which there is systematicity in how these dimensions influence one another throughout attrition and drift.

3. **Changes in bilingual speech tend to occur hierarchically.** Closely related to principle 2, ADAPPT stipulates that what happens initially at the “lower” levels of speech (e.g., acoustic dimensions) impacts “higher” levels (e.g., phonemes, syllables, tones, etc.). Thus, we would predict, for example, that phonological attrition (de Leeuw et al., 2018) would not occur without phonetic attrition (de Leeuw, Mennen, & Scobbie, 2013). That is, lower-level phonetic change is necessary, but not sufficient, for higher-level changes in the L1. Future research might test this prediction by examining numerous levels of bilingual speech (e.g., vowel formants and vowel contrasts) within the same bilingual participants.
4. **There is no straightforward link between speech perception and production.** While acknowledging that there may be mechanisms of mapping between speech perception and production, ADAPPT does not predict a straightforward link between perception and production in either the L1 or the L2 (i.e., accurate speech perception is neither sufficient nor necessary for accurate speech production, and vice versa). Instead, ADAPPT suggests that speech perception and production recruit different executive control mechanisms (see Rubinstein, Meyer, & Evans, 2001 for examples of different possible mechanisms), are based on qualitatively different representations (see, e.g., Schuerman, Meyer, & McQueen, 2015; compare with Best, 1995), and are acquired at least partly independently in both L1 and L2 acquisition (de Leeuw et al., 2021; Wode, 1999). By the same token, perception and production are influenced at least partly independently in attrition and drift (for related findings from international adoptees, see Oh, Au, & Jun, 2010). To test this fourth principle, the design of future experiments needs to incorporate both perception and production tasks testing and measuring the same variables.
5. **Short- and long-term changes are possible in the L1.** As discussed previously, ADAPPT differentiates between short- and long-term changes in the L1 (respectively, drift and attrition). By hypothesis, these two levels of durability of L1 change differ in their source: in the case of drift, it is exclusively recent/ongoing L2 experience, whereas in the case of attrition, it is not, as we consider attrition to be due to the totality of L2 experiences, which are not necessarily recent or ongoing. Although recent L2 experience is often confounded with extensive L2 experience in bilingualism research, in those instances where they are not, the evidence suggests that there are indeed L1 changes that are due to the totality of L2 experience rather than recent L2 experience specifically (e.g., Turner, 2023). Future work could focus on recency effects in more detail to determine the extent to which drift and attrition interact to determine changes in the L1 and the L2 of bilinguals over their life span.

6. **The L1 and the L2 can change and adapt at any time in a person's life.** According to ADAPPT, the speech of bilinguals is dynamic (de Bot, Lowie, & Verspoor, 2007; de Leeuw, Opitz, et al., 2013) and the languages of a bilingual are constantly interacting throughout life (Chang, 2019a; Sancier & Fowler, 1997). Therefore, there is no language fossilization (see also Larsen-Freeman, 2005), and attrition can never be permanent because the languages of a bilingual continue to change as they interact. Here, future research could conduct short- and long-term longitudinal studies with numerous testing points to examine how linguistic variables change over time in different situations (see further discussion in Chang, 2012, 2019a; de Leeuw, 2019b).
7. **Different variables in both the L1 and the L2 can be affected differently due to sociolinguistic factors.** Recent studies of bilingualism highlight the relevance of sociolinguistic factors for understanding cross-language interactions and the lack thereof (e.g., Passoni et al., 2018). For example, research suggests that some L1 variables are more prone to being influenced by a new language or dialect due to their role in socio-indexical marking (Bergmann et al., 2016; de Leeuw, 2019b; Sankoff, 2004) or, alternatively, are resistant to such influence due to their socio-indexical value (Nodari et al., 2019). This is not to rule out the possibility of across-the-board, systematic change; rather, given that different linguistic variables have different social meaning (e.g., stereotypes, markers, and indicators; Labov, 1971), different L1 variables may be affected differently by L2 counterparts dependent on their social meaning. According to ADAPPT, when we see differences between variables with respect to attrition and drift, we should look to sociolinguistic explanations.
8. **Different variables in both the L1 and the L2 can be affected differently due to language-internal and cross-linguistic factors.** The language-internal functional role of sounds and other aspects of the L1 influences the likelihood of their attrition/drift (see, e.g., Alkhudidi, Stevenson, & Rafat, 2020; de Leeuw et al., 2018, 2023). In particular, a high functional load or otherwise important functional role in the L1 may inhibit L1 change. Various types of similarity between aspects of the L1 and the L2 also affect the likelihood of L1 change. For example, where an L1 sound is similar to, but still noticeably different from, a nearby sound in the L2, this proximity could lead to competition between the two sounds or to a perceptual conflation of the two sounds that allows the L1 sound to be influenced by the properties of the L2 sound. Alternatively, where an L1 sound is unique to the L1 (i.e., has no L2 counterpart), there will be little to no competition with L2 sounds, so an L2 speaker could spend years in an L2 immersion setting without hearing the L1 sound and show no attrition of that L1 sound when finally tested. On the other hand, L1 contrasts may benefit from being similar to parallel L2 contrasts, by way of having their contrastiveness reinforced (Ahn et al., 2017; see also Chang & Ahn, 2023). In other words, cross-linguistic similarities that effectively weaken aspects of the L1 promote the likelihood of drift/attrition, whereas those that strengthen them reduce the likelihood of drift/attrition.

9. **It is possible for bilinguals to be conscious of changes in their speech.** Bilinguals may be consciously aware of changes in their L1, and we hypothesize that as time proceeds in the L2 environment and/or in their use of the L2, bilinguals' consciousness of these changes becomes more likely. As such, bilinguals are more likely to be conscious of attrition than of drift. It would be interesting in future studies to examine consciousness systematically and measure how strongly it correlates with different stages of attrition/drift.
10. **Bilinguals have agency in their speech development and use.** This agency can be expressed in a number of ways, such as through *choosing* environments in which their L1 is practiced and/or their L2 is promoted – choices that crucially affect L1 input (compare with the SLM-r, which emphasizes the role of quantity and quality of L2 input for L2 development; Flege & Bohn, 2021). For example, some bilingual parents choose to speak their L1 with their children, while others choose to speak the new language of their environment; regardless, when the children become adults, they may then choose to learn the parents' L1 and even live in the respective language environments. Such choices, when available, play a significant role in the course of potential drift and attrition. As the late bilingual who is undergoing attrition (as opposed to drift) is more likely to be conscious of this change in L1 speech, so is the late bilingual undergoing attrition more likely to be able to express their agency about this change (e.g., if a foreign accent in their L1 is pointed out to them, they might choose to talk more with old friends and acquaintances in their L1). Future studies may wish to investigate the extent to which particular choices made through a bilingual's agency affect attrition and drift.

By incorporating the findings of research on attrition and drift – which we consider central facets of bilingualism – we submit that ADAPPT offers a more holistic theoretical account of bilingual speech than theories which focus primarily on L2 speech learning. As outlined here, the ten principles of ADAPPT are testable and therefore falsifiable. As such, we hope that this initial version of ADAPPT will help spur future research that will shed further light on the dynamics of bilingualism.

### 32.4 Implications for Major Branches of Linguistics

In the final section of this chapter, we briefly discuss the significance of findings revealing attrition and drift in relation to major theoretical approaches and branches of linguistics. In doing so, we aim to highlight the breadth of implications of findings on attrition and drift, which have often not been adequately acknowledged in these other parts of the field. We begin with sociolinguistics, continue with usage-based theory, and close with generative linguistics.

### 32.4.1 Implications for Sociolinguistics

There are three main points we would like to make about sociolinguistics. Firstly, despite a compelling body of studies which has revealed that an L1 can change in adulthood and undergo drift in the short term and attrition in the long term (see Sections 32.1.2.3, 32.1.2.4, and 32.1.3), as well as corpus-based longitudinal research showing systematic L1 changes in young and middle-age adulthood independent of language contact (Gahl & Baayen, 2019), the assumption that the L1 acquired during childhood and adolescence is stable, or potentially even impermeable to change, is often (we believe inappropriately) applied in sociolinguistic research (see, e.g., Meyerhoff, 2011, pp. 134–136, who describes this issue in further detail).

More specifically, sociolinguistic “apparent time” studies interpret the speech of individuals in adulthood based on this questionable assumption. Language change at the community level is taken to be measurable through the comparison of younger and older individuals (i.e., different generations of speakers): if older individuals speak differently than younger individuals, this difference is interpreted as evidence that the (community-level) language has changed since the time the older individuals were the age of the younger individuals (again, because older individuals’ speech is assumed to have remained the same since the close of a proposed critical period). However, if it is accepted, in light of findings of attrition and drift, that the L1/D1 can *and does* change in adulthood, then we propose that it is not actually possible to deduce the former speech patterns of any language user from their currently observed adult speech patterns, and the older versus younger comparison in “apparent time” studies breaks down. Therefore, where possible, “apparent time” studies would be wisely augmented by longitudinal studies to draw conclusions about language change over time.

Secondly, particularly in highly diverse multilingual communities, which are increasingly the object of sociolinguistic investigations, it would be interesting to investigate more specifically longitudinal effects of attrition and drift to see how these processes potentially interact with and influence language change and variation (see, e.g., Cheshire, 2020; Cheshire et al., 2011; Fox, 2015; Fox & Torgersen, 2018; Marzo, 2016; Oxbury & de Leeuw, 2020). For example, in countries impacted by colonization, the L1 of the colonized speakers could undergo changes due to mass (forced) acquisition of an L2. Similarly, in countries less directly impacted by colonization, the hegemony of certain “world languages” such as English may have effects on the L1 of speakers who are not otherwise immersed in a multicultural environment (see, e.g., Chang, 2012, p. 266). Accordingly, it is relevant for sociohistorical studies investigating language variation and change to consider the potential effects of attrition and drift on the level of community language change.

Finally, we believe that studies of attrition and drift should, in turn, bear sociolinguistic factors in mind (see principle 7 of ADAPPT). This has not been a focal point of research into attrition and drift, but we believe that studies of L1 change – in particular, in the phonetic and phonological



domains – could fruitfully use social and indexical information about bilinguals' L1 and L2 to help explain their findings (see, e.g., Nodari et al., 2019; Passoni et al., 2018).

### 32.4.2 Implications for Usage-Based Theory

There is one main point about usage-based theory – specifically, exemplar theory – that we would like to make. By way of background, usage-based studies of attrition and drift use the construct of memory to explain their findings. For example, the Activation Threshold Hypothesis stipulates that more frequently used items have a lower threshold for activation and are more accessible than less frequently used items (Paradis, 2004). In this vein, a language which is rarely used due to immigration to another country would become less accessible and potentially undergo drift in the short term and attrition in the long term (Paradis, 2007).

Exemplar theory is a usage-based theory which stipulates that language sound systems are represented in a set of detailed phonetic exemplars that the individual perceives and that feed the individual's production; phonological rules – if they exist at all – emerge from these exemplars. As a result of the perception and use of these exemplars, which are stored in memory with indexical (e.g., talker) characteristics, indexical meaning emerges and sound inventories of languages change over time. For example, it has been claimed, alternately, that high-frequency words lead sound changes (Bybee, 2002) or that low-frequency words lead sound changes (Hay et al., 2015). However, in these investigations, bilingualism was not incorporated into the analysis, despite the fact that the languages of bilinguals influence each other and are not produced in isolation, and more people in the world speak two or more languages than only one language (e.g., Grosjean, 1998).

Research on speech production and/or perception from an exemplar theory perspective should account for bilingualism explicitly, because cross-linguistic influence is particularly apparent in the *speech* of bilinguals. Research into language acquisition and attrition has shown that the languages of both simultaneous bilinguals (Sundara, Polka, & Baum, 2006) as well as early bilinguals (Caramazza et al., 1973) influence one another; in late sequential bilinguals, too, there is mutual cross-linguistic influence, including drift in the short term and attrition in the long term. We are unaware of studies coming from an exemplar theory perspective which have focused on bilinguals, but we believe that, to be generalizable to all language users, usage-based theories such as exemplar theory need to account for bilingualism. After all, the frequency and the manner of bilinguals' *using* their languages seem to play a central role in the way they perceive and produce them, including the L1, and their production of these languages is also perceived (and remembered) by monolinguals.

### 32.4.3 Implications for Generative Linguistics

There are two points which we believe are important for generative linguistics. Our first point is a practical one: given the reality of L1 change in adulthood, researchers working in the “monolingual model” encouraged by generative linguistics (Chang, 2019a) should consider the consequences of attrition and drift for their target population(s). For example, if the research questions concern a “homeland” language variety, it may not make sense to target diaspora users of the language, who may evince (a type of) bilingualism that is not characteristic of homeland users and who may therefore diverge from them linguistically in unintended or unexpected ways. Crucially, such divergence may occur in such unambiguously structural aspects of the L1 as inflectional morphology (Jarvis, 2003) and phonemic contrast (de Leeuw et al., 2018), which means that no L1 feature should be considered exempt from change in the context of bilingualism (see principle 2 of ADAPPT). This is especially true for speech, which has been our focus in this chapter and which is known to show remarkable plasticity in adulthood.

The second point is in reference to Chomsky’s (1965) differentiation between linguistic “competence” (i.e., internal knowledge) and “performance” (i.e., the externalization of internal knowledge). In the past, demonstrating attrition at any linguistic level was almost exclusively accomplished by comparing the performance of a group of immigrant bilinguals in their L1 with that of monolinguals from the immigrants’ country of origin. In such cross-sectional studies, if the performance of the bilinguals was different from that of the monolinguals, the conclusion was that attrition (of competence) had occurred. However, it has been argued (as in ADAPPT) that any potential attrition, as reflected in performance differences, might not be permanent. Going one step further, it has been argued that, by looking at performance differences that could change over time, competence per se has not been assessed; therefore, since no change in competence has been shown, actually no attrition has occurred.

We argue that this view of the relationship between performance and competence, and of the role of permanence in interpreting observed changes in L1 performance, is unnecessarily limiting. It is possible to assume a competence versus performance distinction and still allow that competence may change over time, even in adulthood. To put it another way, one can say that some performance changes do not reflect changes in underlying competence without saying that *no* performance changes (because of their potentially temporary nature) can reflect changes in underlying competence. Otherwise, we are left in the paradoxical position of drawing conclusions about competence from performance without being able to consider performance. In our view, this is not the way forward; instead, researchers should have the ability to adjudicate when some deviation in L1 performance from a reference group (which may not necessarily comprise monolingual users of the L1) is systematic – and should therefore count as drift or attrition – versus not (e.g., isolated memory lapse).

### 32.5 Concluding Remarks

We close with an acknowledgment of Vivian Cook's notion of "multicompetence" (Cook, 1992, 2003), which established, decades ago, a conceptual framework for understanding how the L1 adapts as the result of acquiring an L2. In this chapter, we have outlined a theory of attrition and drift that we call ADAPPT, for a specific reason: like Cook, we regard the L1 as dynamic, capable of change over the life span, and we believe that the way in which the L1 changes is, in a sense, logical. When language users add a new variety to their language repertoire, the rest of the language repertoire must adapt to the presence of this new variety to facilitate its integration into the repertoire. Thus, just as Cook argued, L1 change in the context of L2 acquisition should not be surprising; on the contrary, it should be expected. With ADAPPT, our goal is to begin to formulate a testable theory of how bilingual speech develops, giving due consideration to the L1 changes that have been mostly left out of other theories in this area. Our hope is that future work on L2 speech learning, attrition, and drift will further develop and refine this theory, leading to new questions about bilingual speech and multiple facets of language change over the life span.

### References

- Ahn, S., Chang, C. B., DeKeyser, R., & Lee-Ellis, S. (2017). Age effects in first language attrition: Speech perception by Korean-English bilinguals. *Language Learning*, 67(3), 694–733.
- Alkhudidi, A., Stevenson, R., & Rafat, Y. (2020). Geminate attrition in the speech of Arabic-English bilinguals living in Canada. *Heritage Language Journal*, 17(1), 1–37.
- Baese-Berk, M. M. (2019). Interactions between speech perception and production during learning of novel phonemic categories. *Attention, Perception, & Psychophysics*, 81, 981–1005.
- Baker, W. & Trofimovich, P. (2005). Interaction of native- and second-language vowel system(s) in early and late bilinguals. *Language and Speech*, 48(1), 1–27.
- Barrientos, F. (2023). On segmental representations in second language phonology: A perceptual account. *Second Language Research*, 39(1), 259–285.
- Beach, E. F., Burnham, D., & Kitamura, C. (2001). Bilingualism and the relationship between perception and production: Greek/English bilinguals and Thai bilabial stops. *International Journal of Bilingualism*, 5(2), 221–235.
- Bergmann, C., Nota, A., Sprenger, S. A., & Schmid, M. S. (2016). L2 immersion causes non-native-like L1 pronunciation in German attriters. *Journal of Phonetics*, 58(Supp. C), 71–86.
- Best, C. T. (1995). A direct realist view of cross-language speech perception. In W. Strange, ed., *Speech Perception and Linguistic Experience: Issues in Cross-Language Research*. Baltimore, MD: York Press, pp. 171–204.
- Best, C. T. & Tyler, M. D. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. In O.-S. Bohn & M. J. Munro, eds., *Language*

- Experience in Second Language Speech Learning: In Honor of James Emil Flege.* Amsterdam: John Benjamins, pp. 13–34.
- Bybee, J. (2002). Word frequency and context of use in the lexical diffusion of phonetically conditioned sound change. *Language Variation and Change*, 14(3), 261–290.
- Caramazza, A., Yeni-Komshian, G. H., Zurif, E. B., & Carbone, E. (1973). The acquisition of a new phonological contrast: The case of stop consonants in French-English bilinguals. *Journal of the Acoustical Society of America*, 54(2), 421–428.
- Celata, C. (2019). Phonological attrition. In M. S. Schmid & B. Köpke, eds., *The Oxford Handbook of Language Attrition*. Oxford: Oxford University Press, pp. 218–227.
- Chambers, J. K. & Trudgill, P. (1998). *Dialectology*, 2nd ed. Cambridge: Cambridge University Press.
- Chang, C. B. (2012). Rapid and multifaceted effects of second-language learning on first-language speech production. *Journal of Phonetics*, 40(2), 249–268.
- Chang, C. B. (2013). A novelty effect in phonetic drift of the native language. *Journal of Phonetics*, 41(6), 520–533.
- Chang, C. B. (2019a). Language change and linguistic inquiry in a world of multi-competence: Sustained phonetic drift and its implications for behavioral linguistic research. *Journal of Phonetics*, 74, 96–113.
- Chang, C. B. (2019b). Phonetic drift. In M. S. Schmid & B. Köpke, eds., *The Oxford Handbook of Language Attrition*. Oxford: Oxford University Press, pp. 191–203.
- Chang, C. B. & Ahn, S. (2023). Examining the role of phoneme frequency in first language perceptual attrition. *Languages*, 8(1), 53.
- Chang, C. B., Yao, Y., Haynes, E. F., & Rhodes, R. (2011). Production of phonetic and phonological contrast by heritage speakers of Mandarin. *Journal of the Acoustical Society of America*, 129(6), 3964–3980.
- Cheng, H.-S., Niziolek, C. A., Buchwald, A., & McAllister, T. (2021). Examining the relationship between speech perception, production distinctness, and production variability. *Frontiers in Human Neuroscience*, 15, 660948.
- Cheshire, J. (2020). Taking the longer view: Explaining Multicultural London English and Multicultural Paris French. *Journal of Sociolinguistics*, 24(3), 308–327.
- Cheshire, J., Kerswill, P., Fox, S., & Torgersen, E. (2011). Contact, the feature pool and the speech community: The emergence of Multicultural London English. *Journal of Sociolinguistics*, 15(2), 151–196.
- Chomsky, N. (1965). *Aspects of the Theory of Syntax*. Cambridge, MA: MIT Press.
- Cook, V. J. (1992). Evidence for multicompetence. *Language Learning*, 42(4), 557–591.
- Cook, V. [J.] (2003). The changing L1 in the L2 user's mind. In V. Cook, ed., *Effects of the Second Language on the First*. Clevedon, UK: Multilingual Matters, pp. 1–18.
- Coupland, N. (1984). Accommodation at work: Some phonological data and their implications. *International Journal of the Sociology of Language*, 46, 49–70.
- De Bot, K. & Clyne, M. (1994). A 16-year longitudinal study of language attrition in Dutch immigrants in Australia. *Journal of Multilingual and Multicultural Development*, 15(1), 17–28.
- De Bot, K., Lowie, W., & Verspoor, M. (2007). A dynamic systems theory approach to second language acquisition. *Bilingualism: Language and Cognition*, 10(1), 7–21.
- De Leeuw, E. (2019a). Phonetic attrition. In M. S. Schmid and B. Köpke, eds., *The Oxford Handbook of Language Attrition*. Oxford: Oxford University Press, pp. 204–217.

- De Leeuw, E. (2019b). Native speech plasticity in the German-English late bilingual Stefanie Graf: A longitudinal study over four decades. *Journal of Phonetics*, 73, 24–39.
- De Leeuw, E. & Celata, C. (2019). Plasticity of native phonetic and phonological domains in the context of bilingualism. *Journal of Phonetics*, 75, 88–93.
- De Leeuw, E., Kapia, E., & Lewis, S. (2023). Sound change in Albanian monolinguals and Albanian-English sequential bilingual returnees in Tirana, Albania. *Languages*, 8 (1), 80.
- De Leeuw, E., Mennen, I., & Scobbie, J. M. (2012). Singing a different tune in your native language: First language attrition of prosody. *International Journal of Bilingualism*, 16(1), 101–116.
- De Leeuw, E., Mennen, I., & Scobbie, J. M. (2013). Dynamic systems, maturational constraints and L1 phonetic attrition. *International Journal of Bilingualism*, 17(6), 683–700.
- De Leeuw, E., Opitz, C., & Lubinska, D. (2013). Dynamics of first language attrition across the lifespan. *International Journal of Bilingualism*, 17(6), 667–674.
- De Leeuw, E., Schmid, M. S., & Mennen, I. (2010). The effects of contact on native language pronunciation in an L2 migrant setting. *Bilingualism: Language and Cognition*, 13, 33–40.
- De Leeuw, E., Stockall, L., Lazaridou-Chatzigoga, D., & Gorba Masip, C. (2021). Illusory vowels in Spanish-English sequential bilinguals: Evidence that accurate L2 perception is neither necessary nor sufficient for accurate L2 production. *Second Language Research*, 37(4), 587–618.
- De Leeuw, E., Tusha, A., & Schmid, M. S. (2018). Individual phonological attrition in Albanian-English late bilinguals. *Bilingualism: Language and Cognition*, 21(2), 278–295.
- Dmitrieva, O., Jongman, A., & Sereno, J. (2010). Phonological neutralization by native and non-native speakers: The case of Russian final devoicing. *Journal of Phonetics*, 38 (3), 483–492.
- Dmitrieva, O., Jongman, A., & Sereno, J. A. (2020). The effect of instructed second language learning on the acoustic properties of first language speech. *Languages*, 5, 44.
- Escudero, P. (2005). Linguistic perception and second language acquisition: Explaining the attainment of optimal phonological categorization. [Doctoral dissertation, University of Utrecht].
- Escudero, P. (2009). The linguistic perception of SIMILAR L2 sounds. In P. Boersma & S. Hamann, eds., *Phonology in Perception*. Berlin: Mouton de Gruyter, pp. 151–190.
- Evans, B. G. & Iverson, P. (2007). Plasticity in vowel perception and production: A study of accent change in young adults. *Journal of the Acoustical Society of America*, 121(6), 3814–3826.
- Flege, J. E. (1987). The production of “new” and “similar” phones in a foreign language: Evidence for the effect of equivalence classification. *Journal of Phonetics*, 15, 47–65.
- Flege, J. E. (1995). Second language speech learning: Theory, findings, and problems. In W. Strange, ed., *Speech Perception and Linguistic Experience: Issues in Cross-Language Research*. Baltimore, MD: York Press, pp. 233–272.
- Flege, J. E. & Bohn, O.-S. (2021). The revised Speech Learning Model (SLM-r). In R. Wayland, ed., *Second Language Speech Learning: Theoretical and Empirical Progress*. Cambridge: Cambridge University Press, pp. 3–83.

- Flege, J. E. & Eefting, W. (1987). Cross-language switching in stop consonant perception and production by Dutch speakers of English. *Speech Communication*, 6(3), 185–202.
- Fox, S. (2015). *The New Cockney: New Ethnicities and Adolescent Speech in the Traditional East End of London*. New York: Palgrave Macmillan.
- Fox, S. & Torgersen, E. (2018). Language change and innovation in London: Multicultural London English. In N. Braber & S. Jansen, eds., *Sociolinguistics in England*. Basingstoke: Palgrave Macmillan, pp. 189–213.
- Gahl, S. & Baayen, R. H. (2019). Twenty-eight years of vowels: Tracking phonetic variation through young to middle age adulthood. *Journal of Phonetics*, 74, 42–54.
- Giles, H., Coupland, N., & Coupland, J. (1991). Accommodation theory: Communication, context, and consequence. In H. Giles, J. Coupland, & N. Coupland, eds., *Contexts of Accommodation: Developments in Applied Sociolinguistics*. Cambridge: Cambridge University Press, pp. 1–68.
- Gorba Masip, C. & Cebrian, J. (2021). The role of L2 experience in L1 and L2 perception and production of voiceless stops by English learners of Spanish. *Journal of Phonetics*, 88, 101094.
- Greenwood, M. L. & de Leeuw, S. N. (2012). Social determinants of health and the future well-being of Aboriginal children in Canada. *Paediatrics & Child Health*, 17(7), 381–384.
- Grosjean, F. (1998). Studying bilinguals: Methodological and conceptual issues. *Bilingualism: Language and Cognition*, 1(2), 131–149.
- Harrington, J. (2006). An acoustic analysis of “happy-tensing” in the Queen’s Christmas broadcasts. *Journal of Phonetics*, 34(4), 439–457.
- Haugen, E. (1966). Dialect, language, nation. *American Anthropologist*, 68(4), 922–935.
- Hay, J., Jannedy, S., & Mendoza-Denton, N. (1999). Oprah and /ay/: Lexical frequency, referee design and style. In J. J. Ohala, Y. Hasegawa, M. Ohala, D. Granville, & A. C. Bailey, eds., *Proceedings of the 14th International Congress of Phonetic Sciences*. International Phonetic Association, pp. 1389–1392. [www.internationalphoneticassociation.org/icphs-proceedings/ICPhS1999/papers/p14\\_1389.pdf](http://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS1999/papers/p14_1389.pdf).
- Hay, J. B., Pierrehumbert, J. B., Walker, A. J., & LaShell, P. (2015). Tracking word frequency effects through 130 years of sound change. *Cognition*, 139, 83–91.
- Herd, W. J., Walden, R. L., Knight, W. L., & Alexander, S. N. (2015). Phonetic drift in a first language dominant environment. *Proceedings of Meetings on Acoustics*, 23(1), 060005.
- Hopp, H. & Schmid, M. S. (2013). Perceived foreign accent in first language attrition and second language acquisition: The impact of age of acquisition and bilingualism. *Applied Psycholinguistics*, 34(2), 361–394.
- Hulsen, M. (2000). Language loss and language processing: Three generations of Dutch migrants in New Zealand. [Doctoral dissertation, Katholieke Universiteit Nijmegen].
- Jarvis, S. (2003). Probing the effects of the L2 on the L1: A case study. In V. Cook, ed., *Effects of the Second Language on the First*. Clevedon, UK: Multilingual Matters, pp. 81–102.
- Kartushina, N. & Frauenfelder, U. H. (2014). On the effects of L2 perception and of individual differences in L1 production on L2 pronunciation. *Frontiers in Psychology*, 5, 2014.

- Kartushina, N., Hervais-Adelman, A., Frauenfelder, U. H., & Golestani, N. (2016). Mutual influences between native and non-native vowels in production: Evidence from short-term visual articulatory feedback training. *Journal of Phonetics*, 57, 21–39.
- Kartushina, N. & Martin, C. D. (2019). Third-language learning affects bilinguals' production in both their native languages: A longitudinal study of dynamic changes in L1, L2 and L3 vowel production. *Journal of Phonetics*, 77, 100920.
- Kellogg, J. & Chang, C. B. (2023). Exploring the onset of phonetic drift in voice onset time perception. *Languages*, 8(1), 78.
- Kim, M. (2009). Phonetic accommodation in conversations between native and non-native speakers. *Journal of the Acoustical Society of America*, 125(4), 2764.
- Köpke, B. (2004). Neurolinguistic aspects of attrition. *Journal of Neurolinguistics*, 17(1), 3–30.
- Köpke, B. & Schmid, M. S. (2004). Language attrition: The next phase. In M. S. Schmid, B. Köpke, M. Keijzer, & L. Weilemar, eds., *First Language Attrition: Interdisciplinary Perspectives on Methodological Issues*. Amsterdam: John Benjamins, pp. 1–46.
- Labov, W. (1971). The study of language in its social context. In J. A. Fishman, ed., *Advances in the Sociology of Language*. Berlin: Mouton de Gruyter, pp. 152–216.
- Lang, B. & Davidson, L. (2019). Effects of exposure and vowel space distribution on phonetic drift: Evidence from American English learners of French. *Language and Speech*, 62(1), 30–60.
- Larsen-Freeman, D. (2005). Second language acquisition and the issue of fossilization: There is no end, and there is no state. In Z. Han & T. Odlin, eds., *Studies of Fossilization in Second Language Acquisition*. Clevedon, UK: Multilingual Matters, pp. 189–200.
- Lenneberg, E. H. (1969). On explaining language. *Science*, 164(3880), 635–643.
- Lev-Ari, S. & Peperkamp, S. (2013). Low inhibitory skill leads to non-native perception and production in bilinguals' native language. *Journal of Phonetics*, 41(5), 320–331.
- Linck, J. A., Kroll, J. F., & Sunderman, G. (2009). Losing access to the native language while immersed in a second language: Evidence for the role of inhibition in second-language learning. *Psychological Science*, 20(12), 1507–1515.
- Major, R. C. (1992). Losing English as a first language. *Modern Language Journal*, 76(2), 190–208.
- Marzo, S. (2016). Exploring the social meaning of contemporary urban vernaculars: Perceptions and attitudes about Citétaal in Flanders. *International Journal of Bilingualism*, 20(5), 501–521.
- Mayr, R., Price, S., & Mennen, I. (2012). First language attrition in the speech of Dutch-English bilinguals: The case of monozygotic twin sisters. *Bilingualism: Language and Cognition*, 15(4), 687–700.
- Melnik-Leroy, G. A., Turnbull, R., & Peperkamp, S. (2021). On the relationship between perception and production of L2 sounds: Evidence from Anglophones' processing of the French /u/-/y/ contrast. *Second Language Research*, 38(3), 581–605.
- Mennen, I. (2004). Bi-directional interference in the intonation of Dutch speakers of Greek. *Journal of Phonetics*, 32(4), 543–563.
- Mennen, I. (2015). Beyond segments: Towards a L2 intonation learning theory. In E. Delais-Roussarie, M. Avanzi, & S. Herment, eds., *Prosody and Language in*

- Contact: L2 Acquisition, Attrition and Languages in Multilingual Situations*. Berlin: Springer, pp. 171–188.
- Meyerhoff, M. (2011). *Introducing Sociolinguistics*, 2nd ed. Abingdon, UK: Routledge.
- Munro, M. J., Derwing, T. M., & Flege, J. E. (1999). Canadians in Alabama: A perceptual study of dialect acquisition in adults. *Journal of Phonetics*, 27(4), 385–403.
- Nodari, R., Celata, C., & Nagy, N. (2019). Socio-indexical phonetic features in the heritage language context: Voiceless stop aspiration in the Calabrian community in Toronto. *Journal of Phonetics*, 73, 91–112.
- Nycz, J. (2015). Second dialect acquisition: A sociophonetic perspective. *Language and Linguistics Compass*, 9(11), 469–482.
- Oh, J. S., Au, T. K., & Jun, S.-A. (2010). Early childhood language memory in the speech perception of international adoptees. *Journal of Child Language*, 37(5), 1123–1132.
- Oxbury, R. & de Leeuw, E. (2020). Style-shifting in Multicultural London English in an all-girls homework club: A group of 11-year-old girls in Hackney change their pronunciations of the innovative Multicultural London English diphthongs according to the speech context. *English Today*, 36(3), 59–69.
- Paradis, M. (2004). *A Neurolinguistic Theory of Bilingualism*. Amsterdam: John Benjamins.
- Paradis, M. (2007). L1 attrition features predicted by a neurolinguistic theory of bilingualism. In B. Köpcke, M. S. Schmid, M. Keijzer, & S. Dostert, eds., *Language Attrition: A Theoretical Perspective*. Amsterdam: John Benjamins, pp. 121–134.
- Passoni, E., Mehrabi, A., Levon, E., & de Leeuw, E. (2018). Bilingualism, pitch range and social factors: Preliminary results from sequential Japanese-English bilinguals. In K. Klessa, J. Bachan, A. Wagner, M. Karpiński, and D. Śledziński, eds., *Proceedings of the 9th International Conference on Speech Prosody*. International Speech Communication Association, pp. 384–388. <https://doi.org/10.21437/SpeechProsody.2018-78>.
- Rubinstein, J. S., Meyer, D. E., & Evans, J. E. (2001). Executive control of cognitive processes in task switching. *Journal of Experimental Psychology: Human Perception and Performance*, 27(4), 763–797.
- Sancier, M. L. & Fowler, C. A. (1997). Gestural drift in a bilingual speaker of Brazilian Portuguese and English. *Journal of Phonetics*, 25(4), 421–436.
- Sankoff, G. (2004). Adolescents, young adults and the critical period: Two case studies from “Seven Up.” In C. Fought, ed., *Sociolinguistic Variation: Critical Reflections*. Oxford: Oxford University Press, pp. 121–139.
- Schmid, M. S. (2011). *Language Attrition*. Cambridge: Cambridge University Press.
- Schuerman, W. L., Meyer, A., & McQueen, J. M. (2015). Do we perceive others better than ourselves? A perceptual benefit for noise-vocoded speech produced by an average speaker. *PLoS ONE*, 10(7), e0129731.
- Sheldon, A. & Strange, W. (1982). The acquisition of /r/ and /l/ by Japanese learners of English: Evidence that speech production can precede speech perception. *Applied Psycholinguistics*, 3(3), 243–261.
- Shockey, L. (1984). All in a flap: Long-term accommodation in phonology. *International Journal of the Sociology of Language*, 1984(46), 87–96.



- So, C. K. & Best, C. T. (2010). Cross-language perception of non-native tonal contrasts: Effects of native phonological and phonetic influences. *Language and Speech*, 53(2), 273–293.
- Sterud Miller, D. (2019). Indigenous language revitalization on Puyallup territory. In K. Denham, ed., *Northwest Voices: Language and Culture in the Pacific Northwest*. Corvallis: Oregon State University Press, pp. 81–92.
- Sundara, M., Polka, L., & Baum, S. (2006). Production of coronal stops by simultaneous bilingual adults. *Bilingualism: Language and Cognition*, 9(1), 97–114.
- Tice, M. & Woodley, M. (2012). Paguettes and bastries: Novice French learners show shifts in native phoneme boundaries. *UC Berkeley Phonology Lab Annual Report*, 8, 72–75.
- Tobin, S. J., Nam, H., & Fowler, C. A. (2017). Phonetic drift in Spanish-English bilinguals: Experiment and a self-organizing model. *Journal of Phonetics*, 65, 45–59.
- Turner, J. (2022). Analysing the relationship between L2 production and different stages of L2 processing: Eye-tracking and acoustic evidence for a novel contrast. *Journal of Phonetics*, 91, 101134.
- Turner, J. (2023). Phonetic development of an L2 vowel system and tandem drift in the L1: A residence abroad and L1 re-immersion study. *Language and Speech*, 66(3), 756–785.
- Tyler, M. D., Best, C. T., Faber, A., & Levitt, A. G. (2014). Perceptual assimilation and discrimination of non-native vowel contrasts. *Phonetica*, 71(1), 4–21.
- Ulbrich, C. & Ordin, M. (2014). Can L2-English influence L1-German? The case of post-vocalic /r/. *Journal of Phonetics*, 45, 26–42.
- Wode, H. (1999). Perception and production in early L1 acquisition and some theoretical implications. In J. J. Ohala, Y. Hasegawa, M. Ohala, D. Granville, & A. C. Bailey, eds., *Proceedings of the 14th International Congress of Phonetic Sciences*. International Phonetic Association, pp. 1265–1268.
- Yao, Y. & Chang, C. B. (2016). On the cognitive basis of contact-induced sound change: Vowel merger reversal in Shanghainese. *Language*, 92(2), 433–467.
- Zampini, M. L. (1998). The relationship between the production and perception of L2 Spanish stops. *Texas Papers in Foreign Language Education*, 3(3), 85–100.