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EMPIRICAL STUDY

First Language Attrition as a Function of Age at Onset of Bilingualism: First Language Attainment of Turkish–English Bilinguals in the United Kingdom

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This investigation aimed to provide insights into the controversial debate on the role that age at onset of bilingualism plays in human language capacity with a focus on what it entails for first language (L1) attrition. L1 performance of Turkish immigrants ($n = 57$) in the United Kingdom with age at onset ranging between 7 and 34 years was compared to that of Turkish monolingual controls ($n = 29$) across two linguistic properties: structural complexity and accent. Findings generally showed that although the immigrants achieved nativelike proficiency with respect to the overall structural complexity of their L1, this was not the case for accent as those with an earlier age of onset were less likely to sound like native Turkish speakers. We discuss these findings in relation to two competing theoretical models of age effects and suggest that attrition data need to be better accommodated within these models.

Keywords first language; attrition; age; bilingualism; critical period; entrenchment; Turkish immigrants

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Introduction

The nonpathological deterioration of a previously acquired native language—that is, first language (L1) attrition (Köpke & Schmid, 2004)—is strongly influenced by the age at which a speaker becomes bilingual (i.e., age at onset of bilingualism), and the impact of this factor appears to be quite pronounced in both production (Bylund, 2009a; Montrul, 2008) and perception (Ahn, Chang, DeKeyser, & Lee-Ellis, 2017) across various linguistic levels. Research on L1 change is usually carried out in one of two settings with little overlap: language development among heritage speakers (usually children of first-generation immigrants who acquire their home language as their L1 and the majority language spoken outside the home as their second language [L2] during early childhood) and among late bilinguals (speakers who leave their L1 environment post puberty, usually in early adulthood). There is a notable dearth of studies attempting to fill the gap in the age at onset of bilingualism between adult heritage speakers (age at onset 0–6 years) and late bilinguals (age at onset > 12 years) and of studies directly comparing the L1 development between adult heritage speakers and late bilinguals (e.g., Montrul & Sánchez-Walker, 2013).

Background Literature

L1 Development Among Heritage Speakers

In heritage language development, there are two important observations. First, heritage speakers often show much greater variability in their use of the heritage language. Although some heritage speakers typically score within the range of monolingual speakers—and of L1 speakers who learned another language later in life—others show accuracy levels below chance even on features that monolingual children master before the age at which these heritage speakers became bilingual (e.g., Cuza & Pérez-Tattam, 2016). This nontargetlike performance is usually observed in the form of simplifications and reductions, especially in morphosyntactic categories, such as inflectional morphology (Montrul, 2016) and complex syntactic phenomena or properties at the interfaces of syntax and pragmatics (e.g., Montrul, 2004; Treffers-Daller, Ozsoy, & van Hout, 2007). For example, Hindi heritage speakers' judgments and oral performance in the Hindi case system has been reported to be eroded in comparison to the performance of a control group of first-generation late Hindi–English bilinguals in the United States (Montrul, Bhatt, & Bhatia, 2012).

Second, the level of L1 proficiency that heritage speakers may eventually retain has proven extremely difficult to account for. Some heritage speakers ultimately become nativelike although others end up with rudimentary skills, and this ultimate success may relate to a combination of factors, such as

quantity/quality of input and heritage language instruction (Kupisch & Rothman, 2016; Montrul, 2016; Rothman, 2009). Studies tracing heritage speakers' L1 development longitudinally have provided further evidence for the rate and degree of structural erosion that these speakers often experience, which can be quite severe (especially in the case of international adoption) even if the property under investigation had stabilized before immigration took place (Altenberg, 1991; Isurin, 2000; Montrul, 2008; Schmitt, 2004; Zaretsky & Bar-Shalom, 2007).

Zaretsky and Bar-Shalom (2007), for instance, tested whether age at onset and frequency of L1 use would prevent attrition of morphosyntactic categories in L1 Russian in children and adults. They investigated error rates in the narrative and grammaticality judgment task performance of 10 Russian–English children (aged 4–13 years) with age at onset ranging from 0 to 6 years and 10 adults (aged 19–53 years) with age at onset ranging from 4 to 37 years. Although older ages of onset predicted fewer errors in both groups, L1 use did so only in children. Yet in the case of a Russian–American child whose L1 exposure was reduced considerably after she was adopted at the age of 9 years, the attrition set in very quickly in the first year of adoption and the participant started to refuse to communicate in her L1 (Isurin, 2000). There is strong evidence suggesting that by adulthood, this knowledge can be completely erased from the brain, indicating the paramount role played by continuous input in maintaining previously acquired L1 proficiency (Pallier et al., 2003; but see Pierce, Chen, Delcenserie, Genesee, & Klein, 2015, for counterevidence obtained from a functional magnetic resonance imaging study showing long-lasting effects of early exposure on the maintenance of the perception of Chinese lexical tone contrasts among Chinese adoptees despite being deprived of continuous L1 input).

It appears, however, that even in such severe cases of L1 loss or incomplete acquisition (as observed in child overhearers), early exposure might be advantageous in relearning the L1 in adulthood, compared to the experience of L2 learners. These advantages seem to be limited to phonological categories rather than structural ones and are evident in both perception, such as differentiation of minimal pairs (Hyltenstam, Bylund, Abrahamsson, & Park, 2009), and production, for instance, with respect to the production of voice onset time and accent rating (Au, Knightly, Jun, & Oh, 2002; but see Ventureyra, Pallier, & Yoo, 2004, for null results). Despite these long-lasting advantages over L2 learners, heritage speakers are usually perceived as sounding less nativelike in comparison to monolinguals (Kupisch et al., 2014), and the acoustic properties for some aspects of their speech (i.e., voice onset time in production of stops)

are not always nativelike (Lein, Kupisch, & van de Weijer, 2016). With respect to voice onset time specifically, one likely cause of the changes in L1 values for this temporal characteristic of stop production has been suggested to be crosslinguistic influence, a process that might lead to the development of an accented L1 (Lein et al., 2016). There is also some evidence showing that the accented L1 speech developed alongside that of a L2 from early on cannot be reversed even after having lived in the home country for more than 8 years, and this seems to be predominantly determined by the postpuberty ages of return to the home country (Flores & Rato, 2016).

To summarize, findings from studies conducted with heritage speakers have revealed a complex interaction of factors but have pointed to one straightforward conclusion: Early exposure in itself does not constitute a sufficient criterion for becoming nativelike in the L1 (heritage language), nor does age-appropriate development up to puberty. L1 knowledge that is acquired before puberty is unstable and can regress when another language becomes more dominant.

L1 Development Among Late Bilinguals

Late bilinguals differ from heritage speakers in two respects when it comes to their L1. First, age at onset ceases to play a role around puberty. Most studies investigating attrition in late bilinguals have adopted a minimum threshold for age at onset of 15 to 17 years, following recommendations by De Bot, Gommans, and Rossing (1991), but even in populations with age at onset below this threshold—but above or around the onset of puberty—no age effect has been found (Schmid, 2002).

Second, the L1 of late bilinguals appears to be stable. Although scores attained by attriting populations on virtually any measure of L1 proficiency have been almost invariably distributed over a wider range than the scores of monolingual control populations—with some attriters scoring lower than the worst-performing controls—this has not appeared to indicate any systematic impairment to L1 knowledge. Error rates have usually remained below 5% on any grammatical structure (Montrul, 2008; Schmid, 2013). It has also been shown that attrition effects in late bilinguals can be reversed by L1 reexposure through visits to the home country, indicating that attrition does not affect the underlying language system (Chamorro, Sorace, & Sturt, 2016). Unlike in heritage language development, it has been difficult to obtain a comprehensive picture of the predictors driving language attrition in late bilinguals (e.g., de Leeuw, Schmid, & Mennen, 2010). Even in extreme cases of traumatic experiences accompanied by prolonged lack of continuous L1 contact (for around 50 years), an investigation carried out on the structural complexity

and morphosyntactic accuracy in the L1 German of Holocaust survivors with adolescent ages at onset (11–17 years) showed no age at onset effect or erosion exceeding the 5% error rate (Schmid, 2012).

More interestingly, however, phonological categories have been found to be more vulnerable to crosslinguistic influence even in late bilingualism (Bergmann, Nota, & Schmid, 2017; de Leeuw et al., 2010; Hopp & Schmid, 2013). Although in these studies the performance of L1 attriters was usually not different from that of monolingual controls at the group level, a good percentage of bilinguals (up to 40%) remained well outside the monolingual control range. This suggested that the L1 may be susceptible to the effects of a L2 even in late bilingualism, leading to bidirectional transfer. Although some studies have shown that maintenance of the L1 accent may be linked to the effects of external factors, such as professional L1 use (de Leeuw et al., 2010) and linguistic aptitude (Hopp & Schmid, 2013), the extent of the contribution of these factors as well as that of age at onset to this performance is still unclear.

Echoing the above findings, a handful of studies that have attempted to fill the age-at-onset gap between adult heritage speakers and late bilinguals have demonstrated a discontinuity around puberty by plotting slopes for L1 proficiency by age at onset. Although participants with ages at onset over 10 to 12 years were found to be indistinguishable from monolingual controls in L1 pronunciation (Yeni-Komshian, Flege, & Liu, 2000), perception of L1 speech sounds (Ahn et al., 2017), general proficiency (Hakuta & D'Andrea, 1992), verbal morphology (Silva-Corvalán, 1994), and conceptualization patterns of goal-oriented events (Bylund, 2009a), those with ages at onset below this range were reported to show more variability, with the majority performing outside the monolingual control range.

Taken together, it seems that there is a qualitative change in the stability of the L1 around puberty (age 12 years). This seems to lead to a restructuring in the L1 of the speakers whose first exposure to L2 occurs before this age, leaving the performance of those with an age at onset past this age comparatively mildly affected. L1 phonological categories, however, seem to be flexible even beyond this age (e.g., Hopp & Schmid, 2013). Why this should be the case, what exactly happens around this age, to what extent the L1 remains flexible beyond it, and whether there are different outcomes of age at onset across linguistic levels are a few of the most important questions for bilingualism research to address.

Theoretical Background to Age Effects in Bilingualism

In a recent theoretical review, Schmid and Köpke (2017) discussed the relevance of L1 attrition research to theories of bilingualism. As they underlined, the

fact that acquired linguistic knowledge may change alongside development of another language in the brain is not usually acknowledged in theoretical models of bilingual development. Championing an integrated approach to bilingualism, Schmid and Köpke thus argued that

> to fully understand the nature of bilingual development and to resolve important and fundamental questions about the human capacity for language learning, processing, and use, we need to arrive at a better understanding of how the mechanisms that drive and constrain L2 acquisition may also affect already established linguistic knowledge, both in the immediate and in the longer term. (2017, p. 5)

It follows from this that more L1 attrition studies need to be conducted that look at the impact of age at onset, which has been shown previously to be an important factor constraining L2 acquisition. This would allow a demonstration of the extent to which this phenomenon has been accounted for by relevant previous theoretical approaches to bilingualism.

The effect of age at onset of bilingualism on language learning has long been a topic of controversial debate especially in L2 acquisition research. To date, this has been predominantly addressed by two competing accounts. The first account relates to the maturational state of the learner. Both human and animal developmental behavior is acknowledged to be sensitive to environmental stimuli, the timing of which is crucial for proper physiological development (Bornstein, 1989). Early exposure is claimed to be a prerequisite for successful language development as well (Newport, 1990). Studies reporting ultimate attainment in a L2 as a function of age at onset have thus often been framed within the critical period hypothesis along with other maturational explanations (see DeKeyser, 2013; Kinsella & Singleton, 2014, for reviews). The traditional view of the critical period hypothesis in L2 acquisition research predicts loss of capacity for language acquisition past a critical period (usually around puberty) due to gradual maturation in the neural substrates responsible for language learning. This loss of plasticity, in turn, prevents postpuberty learners from attaining nativelike proficiency in the L2 (DeKeyser; Kinsella & Singleton).

One strong argument against maturational age effects is the L1 entrenchment or the interference view. Proponents of this approach argue that the consistently observed age-at-onset effect that previous literature has reported for L2 learning is not necessarily an indication of an irreversible biological constraint but is a disguised form of the entrenchment of the L1 that causes stabilization in the neural substrates and provides a filter to L2 learning (Pallier

et al., 2003; Pallier, 2007). This view thus holds that stronger L1 links with age due to increased proficiency imply weaker L2 representations, indicating an inverse relationship between the L1 and L2 proficiency (Yeni-Komshian et al., 2000). As a result of this inverse relationship, nativelike success in the L2 can only be achieved by losing the L1 completely (Pallier, 2007). Studies conducted with adult Korean adoptees to France with age at onset ranging from 3 to 10 years demonstrated that if L1 exposure stops completely up to age 10 years, it is possible to reverse its filtering effects on the L2 and the L2 can override the L1 as a result of a complete reset of the neural substrates (Pallier et al., 2003; Ventureyra et al., 2004, but see Norrman & Bylund, 2016; Schmid, 2012).

In agreement with this account of age effects, the main L2 performance differences between early and late bilinguals have been suggested to be natural consequences of age-related factors rather than of irreversible maturational variables (see Muñoz & Singleton, 2011, for a review). Early learners, for example, might lack a strong sense of the L1 being a component of their identity and thus might show intrinsic motivations toward adapting to the L2 environment more quickly (Köpke, 2007). Furthermore, for early bilinguals, being enrolled in compulsory education inevitably makes their L2 environment richer than that of late bilinguals (Jia & Aaronson, 2003). This, in turn, may result in using the L1 less and the L2 more, leading to a shift in language dominance (Jia & Aaronson, 1999) and thus to loosened L1 links in the neural substrates facilitating the learning of a L2 (Pallier et al., 2003).

Given the competing nature of the maturational and the entrenchment accounts of age effects and the conflicting empirical evidence provided, testing their premises in a similar group of bilingual speakers but this time for what happens to their L1 might help resolve the fundamental issue of how to conceptualize age effects. As argued by Schmid and Köpke (2017), a theoretical approach to bilingual development should be capable of predicting both attrition and acquisition phenomena: "[I]f the framework fails to predict patterns which can be shown to occur in attrition, this should invalidate the theory in the same manner as would counterevidence from language acquisition studies" (p. 36).

In line with this argument, some L1 attrition researchers investigating age effects have interpreted their findings within the premises of the maturational and the entrenchment accounts, which were originally developed for L2 acquisition. In this study, we followed the perspectives taken by these researchers and used the implications of these accounts for L1 attrition to evaluate our findings. One implication of the maturational view (i.e., critical period hypothesis) for L1 attrition, for example, centers around the idea that although the

chances to become nativelike in the L2 before the so-called critical period are increased, this will have inevitable consequences for the degree of L1 attrition or maintenance (Bylund, 2009b; Montrul, 2008). During the critical period, L1 knowledge is highly susceptible to attrition. This susceptability declines gradually due to maturation in the neural connections and starts to plateau around the onset of puberty (Bylund, 2009b, 2009a).

In a study with adult Korean adoptees in Sweden whose ages at onset ranged from 1 to 10 years and Swedish late learners of Korean, Hyltenstam et al. (2009) investigated whether the adoptee participants could recover some of the L1 remnants through a relearning methodology. Both groups of participants were enrolled in a foreign language classroom at a university, learning Korean for an average of 3 years. Although the L2 learners outperformed the adoptees in a grammaticality judgment task in Korean, there was no statistical significance between the two groups in the perception test targeting the production of voice onset time. However, the performance of some individual adoptees was better than that of the best-performing L2 learners, and the best L1 relearning performance (i.e., regaining some of the L1 skills) belonged to the adoptees with the oldest ages at onset.

Based on these findings, Bylund (2009b) suggested that L1 ultimate attainment of late bilinguals is mainly constrained by maturational age effects (because their age at onsent of bilingualism is past that of the critical period) that play a determining role over other factors, such as L1 contact. In the case of early learners, in line with what Montrul (2008) claimed, Bylund saw differences in input conditions and other nonmaturational cognitive factors, for example, language aptitude (see Bylund, Abrahamsson, & Hyltenstam, 2010), resulting in variability in the linguistic knowledge of early bilinguals within the critical period. In a way, these factors have been suggested to compensate for the degree of loss that is proposed to occur due to maturational age effects in the first place.

The L1 entrenchment view (i.e., interference hypothesis), on the other hand, has to date usually been applied to severe cases of L1 loss, thus underscoring the important role played by continuous L1 exposure (e.g., after immigration to a L2 environment) in maintaining the L1 (Pallier, 2007). Its implications for less severe cases of L1 attrition seem to have most clearly been observed in phonetic categories as predicted by Flege's speech-learning model (Flege, 1995; Flege, Schirru, & MacKay, 2003), which is compatible with the interference hypothesis. The speech-learning model was originally proposed to account for observed difficulties in the pronunciation of individual sounds experienced by L2 learners, which also has predictions for L1 speech production and

perception. In this model, both L1 and L2 sounds are assumed to exist in a common phonological space and to influence each other (Flege, 1995). Interaction between the languages is proposed to lead to a bidirectional transfer between L1 and L2 sounds, which over time might result in production of both L1 and L2 sounds that differs from monolingual production (Flege et al., 2003).

Although the speech-learning model does not predict a direct relationship between articulatory modifications of this sort and a global foreign accent in the L1 and/or L2, the possibility that changes in the production of L1 and L2 sound categories lead to accented speech in both languages has been previously tested and evaluated from the combined perspectives of the interference hypothesis and speech-learning model by Yeni-Komshian et al. (2000). In their reasoning, advanced L2 learning predicts more changes in the L1 phonetic system, and these changes may cause the L1 to be produced with a foreign accent. In this view, the degree of L2-induced changes is determined by factors such as L1/L2 proficiency levels and amount of L1/L2 use rather than by biological age effects (Yeni-Komshian et al., 2000). It has, however, been acknowledged that early bilinguals (with age at onset up to puberty) are more likely to establish categories for the new L2 sounds because the representation of L1 sounds, that is, the filtering effect of the L1 on the L2, in their case is not so strong (Yeni-Komshian et al., 2000). For this reason, early bilinguals are considered to be more likely to experience L2-induced sound modifications and develop an accented L1, although this might also be observed to a lesser degree in the case of older bilinguals. In this study, we followed this reasoning.

The Current Study

With the view of contributing to what is known so far about age effects on language- learning capacity and maintenance, this study first aimed to provide an overall picture of L1 proficiency in an immigrant context as a function of age at onset of bilingualism by investigating the L1 performance of Turkish–English adult bilinguals in the United Kingdom across a wide range of age at onset of bilingualism (7–34 years). Second, it aimed to investigate how well the role, if any, played by age at onset can be evaluated within the premises of two theoretical accounts of bilingualism—the maturational and the entrenchment views. Finally, to address the underlying sources of the observed asymmetry in the degree of vulnerability to attrition between phonological and structural properties as a function of age at onset, the study targeted two different linguistic skills pertaining to these two domains (structural complexity and global L1 pronunciation). Given that previous literature has linked both L1 and L2 ultimate attainment in similar linguistic properties to the impact of additional

factors, we also tested the effects of L1 proficiency, amount of L1 contact, linguistic identification, and cultural affiliation.

Carrying out this investigation in Turkish was particularly relevant because Turkish has a variety of structures (e.g., complex morphology) that have previously been shown to be potential loci for erosion and age effects in other languages. Moreover, although previous findings pointed to a deterioration in the knowledge and use of Turkish spoken in Europe across generations (Arslan, De Kok, & Bastiaanse, 2017; Gürel & Yılmaz, 2011; Huls & van de Mond, 1992; Onar Valk & Backus, 2013; Yılmaz, 2011), we know very little about the role played by age at onset in this; this role can only be revealed by looking at the age-at-onset effect in similar features/properties previously shown to be eroded.

One such feature is structural complexity. Turkish is an agglutinative language with complex morphology and employs a variety of complex subordination structures through synthetic processes (Huls & van de Mond, 1992). One way attrition manifests itself is through simplifications and reductions in the overall complexity of the linguistic system either because L1 is not activated enough or because of contrastive differences between L1 and L2 (Andersen, 1982; Schmid, Köpke, & de Bot, 2013; Seliger & Vago, 1991). Due to its agglutinative nature, Turkish allows such tendencies to be observed very easily, for example, with simplication manifesting itself first in word formation. As hypothesized by Huls and van de Mond, instead of relying on suffixation—a costly process with each suffix having its own morphological function—a speaker may develop an analytical tendency toward using free morphemes instead. They tested this in a small-scale study focusing on the L1 performance of two Turkish families (parents and children) in the Netherlands by using a measure called an agglutination index based on Lyons (1969) and calculated as the ratio of the number of morphemes to words per sentence produced. This measure proved to be reliable for revealing differences between generations.

Similarly, Treffers-Daller et al. (2007) and Onar-Valk and Backus (2013) confirmed that their adult heritage speakers of Turkish avoided complex nonfinite clauses and relied on more analytical means by using finite subordination, which also structurally resembles the subordination formation in the L2s tested (Dutch or German). Such tendencies, however, were not observed in the performance of late Turkish–Dutch bilinguals (Yılmaz, 2011). As revealed by Treffers-Daller et al., heritage speakers showed a tendency to avoid nonfinite relative clauses and noun clauses where the embedded verb was marked with one of the nominalizer suffixes *–mA*, *–DIK*, or *–AcAK* (verbal complements) due to costly functional operations (e.g., agreement morphology between the

subject and the verb of the subordinate clause, genitive case-marked overt subjects) required for their formation (see Treffers-Daller et al. for details and examples). The researchers acknowledged, however, that this might have been a result of incomplete acquisition rather than attrition because subordination is a relatively late-acquired phenomenon. Monolingual acquisition of relative clauses has been reported not to stabilize before ages 4 to 5 years (Slobin, 1986), and acquisition of noun clauses is not stable until around ages 5 to 6 years (Aksu-Koç, 1994). We took these facts into consideration in selecting our participants.

Another linguistic property investigated was global L1 accent. To our knowledge, the only study looking at this in L1 Turkish has been conducted by Stangen, Kupisch, Proietti Ergün, and Zielke (2015) who examined whether being bilingual entails sounding less nativelike (i.e., accented) in one or both languages of Turkish–German bilinguals as a function of age at onset of bilingualism. The age at onset ranged between 0 and 9 years, divided into two groups (0–3 vs. 4–9). The majority of bilinguals were perceived as sounding less nativelike in one or the other of their languages, and only 3 out of 21 speakers were perceived as sounding nativelike in both. Age at onset, however, did not play a deterministic role in this outcome. Given that the raters linked intonation and pronunciation of some vowels to the degree of accentedness, the researchers attributed their findings to bidirectional transfer. There were no data on the L1 pronunciation of these late Turkish bilinguals; therefore, it is difficult to derive conclusions regarding which factors constrain L1 accent. By including a wide age-at-onset range in our study, we thus aimed to provide some answers to this question.

Acknowledging the difficulty of disentangling the role played by age at onset in language acquisition and retention as predicted by the maturational view (critical period hypothesis) and the enttrenchment view (interference hypothesis), recent L2 acquisition studies have suggested controlling for possible confounding factors, such as amount of language use and language proficiency, either statistically (e.g., Veríssimo, Heyer, Jacob, & Clahsen, 2017) or by establishing a control group that matches the experimental group in terms of confounding factors (e.g., Hopp & Schmid, 2013; Schmid, 2014). In this study, we controlled for the effects of confounding factors statistically, taking the range of scores delimited by the monolingual controls as the baseline. This meant that bilinguals scoring lower than the worst-performing monolingual controls on the L1 measures were considered to have remained below the monolingual control range and thus experienced some degree of attrition. The following two hypotheses were formulated.

1. L1 maintenance is constrained by maturational age effects.
   If maturational age effects determine the degree of L1 maintenance, age at onset of bilingualism should be the primary determining factor accounting for the variability in L1 performance when the impact of confounding factors, such as L1 contact and proficiency, are controlled for. We could only confirm that the role played by age at onset is of a maturational nature if we found the L1 performance of all bilinguals with age of onset past a certain period (age 12 based on previous reports) to be resistant to attrition (Bylund, 2009b). Additionally, the speakers whose age at onset remained below this cutoff point should show greater variation in the degree of their L1 maintenance, with many potentially remaining outside the monolingual control range; age at onset should still make a significant contribution within this group presumably in addition to the effects of other compensatory variables, for example, L1 use (Bylund, 2009b). This should apply to both structural complexity and global L1 accent in the bilinguals' performance.
2. The degree of L1 maintenance is determined by the degree of L1 entrenchment.
   On the other hand, if age effects are disguised as other factors, such as the degree of L1 entrenchment, frequency of L1 use, and attitudes, some or all of these factors should explain the outcome across the entire range of bilinguals' age at onset. Consistent with the predictions of the speech-learning model and the interference hypothesis for L1 attrition (as discussed previously), the L1 accent of bilinguals was expected to show a tendency to deviate from the monolingual performance at the group level. The extent of the deviation, however, might differ between early and late bilinguals due to their differing levels of L1 entrenchment and L2 proficiency (Yeni-Komshian et al., 2000). There was no direct empirical evidence pointing to the degree of L1 attrition for structural properties in traditional cases of attrition from the perspective of the interference hypothesis. That notwithstanding, assuming an inverse relationship between L1 and L2 proficiency (Pallier et al., 2003), reduced frequency of L1 use and speaking another language should have also resulted in loosened links in the degree of L1 entrenchment regarding the structural complexity performance of at least some bilinguals.

Method

Participants

Participants included 57 adult Turkish–English immigrant bilinguals with the ages at onset of bilingualism ranging between 7 and 34 years and 29 monolinguals in Turkey. Although age at onset was considered a continuous variable,

our sample represented two age-at-onset groups, each with a roughly equal number of participants (age at onset less than or equal to 12 years and age at onset greater than 12 years), based on previous literature that has considered age 12 years as a cutoff point between early and late bilinguals (e.g., Bylund, 2009b). All bilinguals were born in Turkey and had acquired Turkish as their L1.[1] Length of residence was set to a minimum of 8 years. Contacts were made through various Turkish clubs in London and via snowball sampling. Individuals were either visited in their homes or in public places of their choice.

Participants were selected based on their age at onset of bilingualism, which was taken as their age of arrival in the United Kingdom. As Flores, Santos, Jesus, and Marques (2017) have pointed out, adult heritage speaker investigations "cannot distinguish effects of acquisition from effects of subsequent language attrition" (p. 797). This is especially the case for late-acquired properties, like noun and relative clauses, which have been reported not to stabilize before the ages of 5 or 6 years in monolingual Turkish speakers (Aksu-Koç, 1994; Slobin, 1986). Previous investigations of subordination have confirmed that Turkish heritage speakers may not acquire these structures completely due to an insufficient amount of input (Huls & van de Mond, 1992; Treffers-Daller et al., 2007). The problem this situation may create for understanding the exact role of age at onset in L1 attrition has been pointed out repeatedly (Bylund, 2009a; Bylund et al., 2010). Based on the psycholinguistic literature that we consulted, our primary motivation behind setting the lowest age-at-onset limit to 7 years was thus to ensure that these late-acquired properties had had time to develop age appropriately before emigration took place. L1 accent, which is usually assumed to develop earlier than the set age limit (Yeni-Komshian et al., 2000), did not seem to pose any problems in this respect. This allowed us to mainly exclude the possibility that any age effect that we might find was due to incomplete acquisition.

Personal and linguistic background information for the bilingual participants was obtained using a sociolinguistic questionnaire (available in Appendix S1 in the Supporting Information online) adapted from Yılmaz (2013), which was constructed based on the test battery from Schmid (n.d.). Following Schmid and Dusseldorp (2010), a principal component analysis with varimax (25) rotation was conducted on the items that asked participants to report the frequency of current L1 contact and linguistic and cultural preferences on a 0–1 scale. Four new composite variables were calculated based on the means of the questionnaire items included in each component (with internal consistency for these composite variables calculated using Cronbach's alpha):

Table 1 Summary of internal consistency estimates, means, standard deviations, and ranges for bilingual participants' personal and linguistic background variables

Variable	Cronbach's α	*M*	*SD*	*Range*
Interactive L1 use	.79	0.86	0.13	0.41–1.00
L1 passive exposure	.65	0.58	0.96	0.00–1.00
Past L1 use	.57	0.96	0.08	0.65–1.00
Linguistic identification	.78	0.93	0.12	0.50–1.00
Cultural affiliation	.60	0.63	0.18	0.18–0.88

Note. Participants' scores were calculated as the mean of responses to all items, scored on a scale of 0 to 1, contrinuting to each variable.

- interactive L1 use (with children, siblings, parents, and grandparents in Turkey; other relatives in the United Kingdom; and in written communication with relatives in the United Kingdom and Turkey);
- L1 passive exposure (through TV, radio, and music);
- linguistic identification (importance given to maintaining L1 and children's understanding and speaking Turkish); and
- cultural affiliation (cultural preferences for friends and L1 use with friends and neighbors).

Although participants were also asked to report on their past L1 use (during the first 5 years after arrival), it was not possible to conduct a principal component analysis for past L1 use due to either lack of variability in the answers given or a large number of missing values for some of the questions. Instead, Pearson correlations were computed for the questions that were answered by all participants, and a mean value for these questions[2] was obtained to represent past L1 use. Table 1 provides quantitative information about the composite variables.

The participants in the control group were selected to resemble those in the bilingual group for city of birth, gender, age at testing, and educational background. The highest education level was calculated in years by taking into account the last education level completed either in Turkey or the United Kingdom. Table 2 provides basic background information about the two participant groups. General L1 proficiency was measured through a 40-item written cloze test. As revealed by an independent-samples *t* test, the bilingual participants ($M = 28.39$) obtained lower scores on the L1 cloze test than the monolingual participants ($M = 31.34$), $t(84) = -2.26$, $p = .026$, although the performance of only five bilinguals remained outside the monolingual control range (see Figure 1).

Table 2 Summary of means, standard deviations, and ranges for the bilingual and monolingual participants' background variables

	Monolinguals ($n = 29$)			Bilinguals ($n = 57$)		
Variable	*M*	*SD*	*Range*	*M*	*SD*	*Range*
Age of testing	32.00	9.75	21–51	35.14	7.81	19–58
Age at onset of bilingualism	—	—	—	15.54	7.48	7–34
Length of residence	—	—	—	19.61	6.72	9–40
Education in years	13.44	2.49	8–15	13.15	2.27	8–15

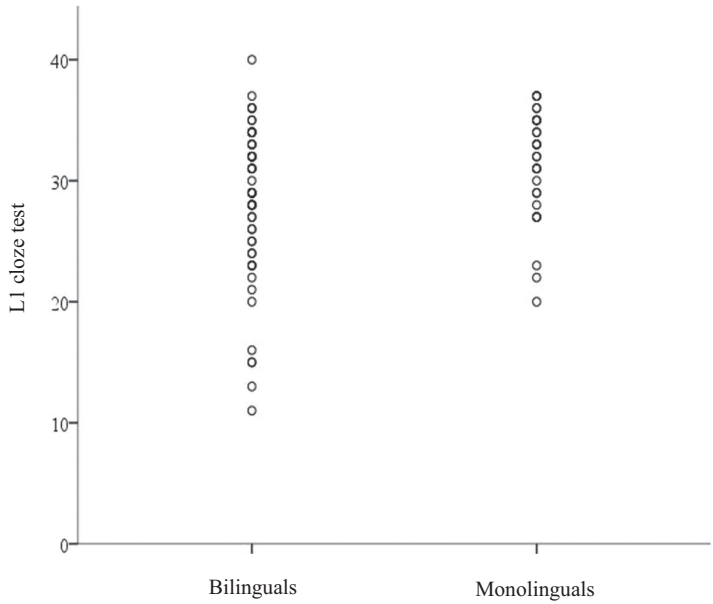

Figure 1 Graphic representation comparing the general L1 proficiency of the two groups as measured on a cloze test. Five bilingual participants are outside the range of the monolingual control group.

Semi-Structured Interviews

The most suitable language data for capturing attrition effects in a group of bilinguals with different ages at onset of bilingualism have been suggested to be free speech data (Schmid et al., 2013). This is because such data allow "every speaker to employ the full range of her language knowledge" (p. 678) without being under too much cognitive pressure. This avoided late bilinguals

performing at ceiling because of a closed-format task not being sufficiently demanding and early bilinguals failing to complete a task because it is too demanding (Schmid et al., 2013). Thus, this study relied on spoken data collected through a semi-structured interview to detect reductions, if any, in the overall complexity and degree of accentedness in the bilinguals' L1.

In addition to asking participants to share their views on daily topics (see the L1 attrition test battery, Schmid, n.d.), four questions, which were originally designed for an earlier investigation of past-tense usage in Turkish (Karayayla, in press), asked participants to tell stories personally experienced or heard from other people that they found interesting, horrifying, or amusing. All conversations were, therefore, spontaneous and rich in subordination and many other grammatical structures. Individual recordings lasted from 10 to 35 minutes ($M = 19.04$ minutes).

The transcription of recorded conversations was done using CHAT conventions (MacWhinney, 2000), and the transcribed data were segmented into analysis of speech units (AS-units) defined by Foster, Tonkyn, and Wigglesworth (2000) as "a single speaker's utterance consisting of an independent clause or subclausal unit, together with any subordinate clause(s) associated with it" (p. 365), with additional criteria adapted from Berman and Slobin (1994) and Young (1995) (for transcription and coding conventions, see Appendix S2 in the Supporting Information online). Among the principled criteria of data exclusion proposed by Foster et al., exclusion was carried out at level three. This means that only the AS-units that included finite or nonfinite subordinate clauses together with a main clause and simple independent clauses were included in the total count, but other units, such as repetitions and errors, were excluded. Subordinate clauses were coded by their type and subtype. Because the number of nontargetlike subordination was extremely low, accuracy was not investigated. There were overall 18,351 AS-units consisting of 25,146 clauses. The pruned speech data consisted of 96,564 words. These data were used to approximate structural complexity and conduct a foreign accent rating experiment.

Structural Complexity

Following findings of previous research, we calculated the ratio of total number of morphemes[3] to words (which corresponded to the agglutination index by Huls & van de Mond, 1992) and counted the number of nonfinite relative clauses and three types of verbal complements marked with nominalizer suffixes *–mA*, *–DIK*, and *–AcAK* per AS-unit per participant. These nonfinite clauses had been revealed to occur least frequently in heritage Turkish by Treffers-Daller et al. (2007). Adapting recent L2 acquisition methodologies that have used

similar measures to approximate structural complexity (Lahmann, Steinkrauss, & Schmid, 2016), we *z* transformed the subscales and then incorporated them into one single measure of structural complexity by using the reshape package in R (Wickham, 2007). We standardized the final scale by *z* transforming it one more time. A higher score in each component—and thus an overall higher score—reflected that a speaker had not developed a preference toward using more analytical means or simpler language.

Global Foreign Accent Rating

To detect potential changes in the L1 accent as a function of age at onset, we conducted a foreign accent rating experiment. Following the procedure and criteria used in de Leeuw et al. (2010), short speech samples ($M = 16.49$ seconds) from the spoken performance of each bilingual and monolingual speaker (as a response to the same question) were extracted. Particular attention was given to include fully finished utterances without any codeswitching or grammatical mistakes. Twenty-eight judges with Turkish as their only L1 ($M_{age} =$ 19.78 years, range = 19–23) were recruited among first-year university students studying foreign language education at the Middle East Technical University in Turkey.[4] The original experiment[5] required 52 minutes to complete and took place in a quiet university room where the judges listened to the samples through laptop speakers and were asked to rate the degree of perceived foreign accent of each speaker during 7-second pauses after each sample. The scale was the 6-point Likert scale used in Hopp and Schmid (2013) and ranged from 1 (*native accent*) to 6 (*strong foreign accent*). During the practice session provided before the experiment, the judges were advised not to confuse a regional accent with a foreign accent.[6] Each speaker's final score was calculated as the mean value of the ratings given by the 28 judges. A higher foreign accent rating was an indication that a speaker was perceived as sounding less nativelike.[7]

Data Analysis

For each L1 measure, there were multiple responses per participant, which would violate the independence assumption of traditional linear models. Because mixed-effects models are considered suitable in such cases (Baayen, Davidson, & Bates, 2008), we analyzed the data by using linear mixed-effects regression modeling with the lme4 package (Bates, Mächler, Bolker, & Walker, 2015) for the R statistical platform (R Core Team, 2016). We ran separate models for each measure and considered participant and rater (in foreign accent models) as random effects to control for variability. We log transformed the dependent variable foreign accent to achieve a normal distribution (see Appendix

Table 3 Summary of means and standard deviations for components of the grammatical complexity variable across groups

	Monolinguals ($n = 29$)		Bilinguals ($n = 57$)	
Component	*M*	*SD*	*M*	*SD*
Agglutination index	0.83	0.05	0.83	0.05
–mA[a] per AS-unit	0.05	0.03	0.05	0.03
–DIK[a] per AS-unit	0.03	0.02	0.04	0.03
–AcAK[a] per AS-unit	0.01	0.01	0.01	0.01
Nonfinite relative clauses per AS-unit	0.08	0.04	0.07	0.06

Note. All variable scores were *z* transformed. AS-unit = analysis of speech unit.
[a]Represents a type of verbal complement in Turkish.

S3 in the Supporting Information online for the distribution of residuals of the models built). To test our hypotheses, it was also necessary to statistically control for the effects of external/confounding variables, such as L1 contact, education level, and L1 proficiency. However, so as not to overfit the models by including too many predictors (Wurm & Fisicaro, 2014), we only included in the final models the perdictors that significantly contributed to the outcome when tested alone. Because we were particularly interested in the explanatory power of each fixed effect while holding other variables constant, following suggestions in Wurm and Fisicaro (2014) and the methodology employed by Veríssimo et al. (2017), we included the predictors simultaneously in the final models. The use of this method is also justified if one wishes to control for the correlations between fixed effects (if any) included as covariates (e.g., Veríssimo et al., 2017). We obtained *p* values by using the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2017; Luke, 2017). A comparison of the Akaike information criterion values for the models showed that the addition of random slopes was not justified (Baayen et al., 2008).

Results

Structural Complexity

Table 3 shows that, contrary to our prediction, the two groups' means did not seem to diverge from each other in any of the components used to approximate the structural complexity score. The statistical model conducted on the merged structural complexity *z* scores confirmed that the bilingual group did not diverge significantly from the monolingual control group, $b = 0.016$, $SE = 0.02$, $t = 0.82$, $p = .935$.

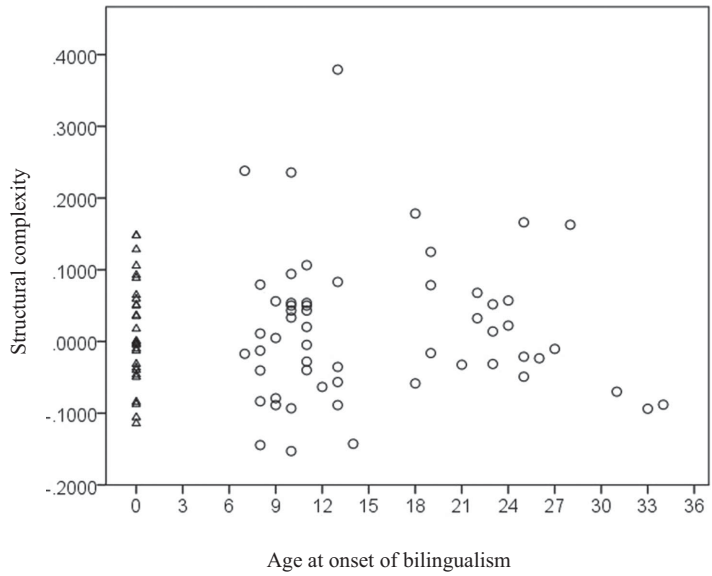

Figure 2 Scatterplot of the relationship between age at onset of bilingualism and structural complexity.

The plot in Figure 2 shows that there was no significant relationship between age at onset and structural complexity, $F(1, 59203) = 2.32$, $p = .127$, $b = –0.00009$, $t = –1.52$, $p = .127$. Only three bilinguals remained outside the monolingual control range, and high scores were obtained at all ages. Although the lowest scores were obtained by participants with ages at onset of 8, 9, and 14 years, the highest scores belonged to participants with ages at onset of 7, 10, and 13 years. Given that participants showed full retention of proficiency regarding the overall structural complexity of their L1 within the age-at-onset range investigated (at least with respect to the measure of complexity used here), no further analyses were conducted.

Foreign Accent Ratings

Figure 3 shows that all monolingual control participants and a great majority of bilingual participants (71.9%) fell within the range of unambiguously L1 speakers (control range). In the case of the bilingual group, however, there was a much wider distribution with 16 participants (28.1%) falling into the nonnative range. Four of these were outliers, with one being perceived as unambiguously nonnative by all raters and the rest having a foreign accent

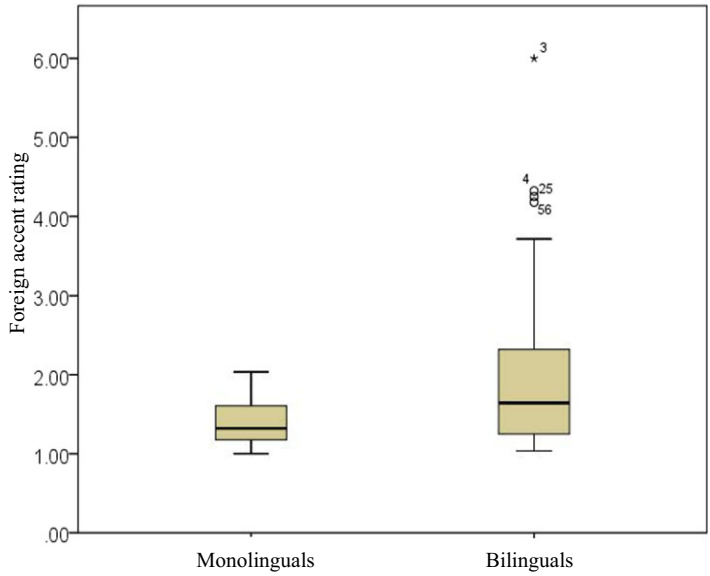

Figure 3 Graphic representation of foreign accent ratings for the two participant groups. The bilingual group has a wider distribution of ratings. [Color figure can be viewed at wileyonlinelibrary.com]

rating over 4. The ages at onset for these outliers were 8, 9, 10, and 13 years, respectively.

To remove the influence of the outliers on the dependent measure, the statistical model was conducted without the outlier data points ($n = 53$). This model gave evidence that the judges had a tendency to perceive the bilingual group ($M = 1.73$) as sounding less nativelike compared to the monolingual group ($M = 1.38$), $b = 0.355$, $SE = 0.12$, $t = 2.79$, $p = .006$. This model accounted for 29.8% of the variance. There was a significant relationship between age at onset and the foreign accent rating, $F(1, 1482) = 138.6$, $p < .001$, $b = –0.05$, $t = –11.77$, $p < .001$, which is captured in Figure 4. As the fitted line of a cubic polynomial function demonstrates, the relationship between age at onset and the foreign accent rating is quite linear until around ages 13 to 14 years, and then it starts leveling off, with foreign accent no longer being a function of age at onset.

Age at onset, however, accounted for only 8.5% of the variance in the outcome. In the next step, we thus tested which other variables besides age at onset contributed to the explained variance. The coefficients of the final

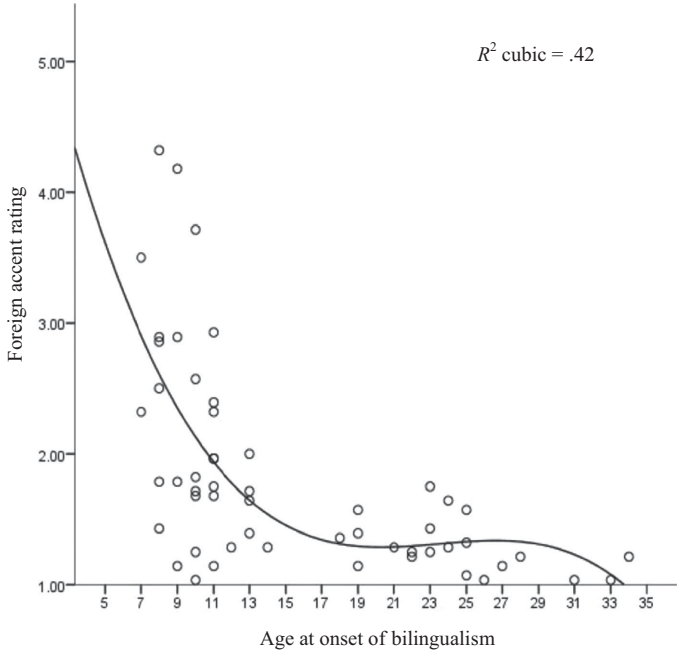

Figure 4 Scatterplot of the relationship between age at onset of bilingualism and foreign accent rating. Around ages 13 or 14 years, the relationship begins leveling off.

mixed-effects model, which accounted for 31.7% of the variance, showed that the participants with older ages at onset, $b = –0.013$, $SE = 0.004$, $t = –2.66$, $p = .011$, those with higher scores on the L1 cloze test, $b = –0.014$, $SE = 0.004$, $t = –2.94$, $p = .005$, those with more passive L1 exposure, $b = –0.287$, $SE = 0.133$, $t = –2.16$, $p = .036$, and those who were older at the time of testing, $b = –0.009$, $SE = 0.005$, $t = –2.14$, $p = .037$, were perceived as sounding more nativelike. No other variables, including education level, predicted the outcome.

Based on the function of the slope in Figure 4, we created two subsets of bilingual participants with ages at onset of less than or equal to 13 years ($n = 30$) and with ages at onset of greater than 13 years ($n = 23$), calling these groups early bilinguals and late bilinguals, respectively. This was crucial for testing our hypotheses and for determining if the above-reported role played by age at onset remained significant and independent when the effects of the confounding predictors were controlled for. For the early bilinguals, the final model accounting for 29.7% of the variance revealed that increased L1

proficiency as shown on the cloze test, $b = –0.015$, $SE = 0.007$, $t = –2.12$, $p = .044$, and more passive L1 exposure, $b = –0.502$, $SE = 0.206$, $t = –2.44$, $p = .022$, were associated with sounding more nativelike, but age at onset ceased to contribute to the explained variance, $b = –0.019$, $SE = 0.029$, $t = –0.66$, $p = .213$.

For the late bilinguals, on the other hand, the only variable that came back as significant was age at testing, $b = –0.012$, $SE = 0.005$, $t = –2.44$, $p = .024$, such that older participants were perceived as sounding more nativelike. To unravel whether the role played by age at testing was attrition specific, we checked whether it predicted the variability in the performance of the monolingual control group as well. A simple linear regression analysis revealed that the older monolingual participants were also perceived as sounding more nativelike, $F(1, 810) = 9.00$, $p = .002$, $b = 0.009$, $t = 3.00$, $p = .003$. Why this should be the case deserves further empirical scrutiny, but for our data, it is safe to say that an age at onset over 13 years was not an attrition-specific variable and that the L1 accent of the bilinguals older than 13 years was resistant to attrition.

Discussion

Overall, our findings showed that, although the bilingual participants as a group managed to attain a targetlike level of proficiency regarding the overall structural complexity of their L1, this was not the case regarding their degree of sounding nativelike. Although the performance of only three participants (5.2%) remained below the monolingual control range in the structural complexity measure, with the rest performing in a targetlike manner, 16 participants (28.1%) fell into the nonnative range, which significantly distinguished their accent from that of the monolingual controls at the group level.

Age Effects in Foreign Accent Ratings

The full retention of proficiency did not allow us to establish a relationship between age at onset of bilingualism and the structural complexity scores that participants had obtained. The age at onset–foreign accent rating slope, on the other hand, dropped linearly until it leveled off after age 13 years. In other words, it showed a clear discontinuity, with all participants—except for one with age at onset of 18 years—who were past this age subsumed within the monolingual control range. A close inspection of this participant's data showed that he had a heavy regional accent. Although the judges had been informed about this, some variability in this participant's grammatical/lexical choices due to the regional accent might have misled the raters' judgment (de Leeuw et al., 2010). In the group whose ages at onset remained below this cutoff point

(age at onset ≤ 13 years, $n = 34$, including the four outliers), there was much more variability, and the foreign accent ratings of 15 participants (44.1%) fell outside the control range. This part of our observation thus seemed to confirm our first hypothesis, which had stated that the degree of L1 retention is primarily determined by maturational constraints.

We found, however, that age at onset was not the only significant predictor explaining the variability in the scores. The outcome was instead a result of an interplay between age at onset, amount of passive exposure to the L1, level of general L1 proficiency, and biological age. Furthermore, the individual explanatory power of age at onset was not any better than that of the other predictors. This seemed to run contrary to the expectations about an independent or more significant role played by age at onset and thus prevented us from ascribing our findings fully to maturational age effects. The nonnative traces in the L1 accent of the bilingual participants might rather have been a result of the reorganization of the L1 phonetic system under the influence of the L2, assuming that L1 and L2 sound categories exist in a shared system interacting with each other and that the same speech-learning mechanisms are active throughout the lifespan (Flege, 1995). In line with the predictions of the speech-learning model, our statistical findings thus appeared promising in showing that L1 sound categories were adaptive even in adulthood, presumably under the influence of L2 sound categories, and the degree of this influence was not constrained by age at onset only but also by L1 proficiency, frequency of L1 exposure, and biological age. Later, we showed that biological age did not play an attrition-specific role here because older monolinguals were also perceived as sounding more nativelike.

The role played by the frequency of (passive) L1 exposure was remarkable, which relates to what Schmid (2007) suggested about the role played by the quality of L1 contact in attrition. Being exposed to qualitatively nativelike input in adulthood on a frequent basis might have prevented L1 sound categories and any other relevant components to sounding nativelike, such as prosody and fluency, from being modified after immigration. This finding parallels previous results concerning the protective role of L1 contact in maintaining L1 accent in adulthood (Yeni-Komshian et al., 2000). It is thus plausible to assume that the role played by age at onset in this study was quantitative rather than qualitative, contrary to the prediction of the critical period hypothesis. More precisely, consistent with our second hypothesis, the individual contribution of age at onset to the explained variance seemed to result from different degrees in the participants' L1 entrenchment rather than from irreversible neurological changes (Flege, 1995).

The fact that all bilinguals in our study (except for the one case that was discussed previously) past the age at onset of 13 years were perceived as sounding unambiguously nativelike still poses a significant challenge to the entrenchment-based explanation. Interference accounts assume an inverse relationship between L1 and L2 proficiency, which should result in at least some of the late bilinguals' L1 accent being perceived as divergent as well. That notwithstanding, these accounts, in general, acknowledge that L2 interference with the L1 might be limited in late bilingualism due to deeply entrenched L1 representations (Pallier, 2007; Yeni-Komshian et al., 2000). Based on our findings, we can speculate that being monolingual at least for this amount of time results in the representations for L1 categories being deeply entrenched, and this makes these categories quite resistant to external factors and L2 interference. This does not necessarily indicate irreversibility or that no interaction between L1 and L2 took place. Phonetic drifts might have happened as a result of interactions between phonetic aspects of L1 and L2 that our experiment was not able to capture. Yet these changes might not have led to an increase in the L1 accent if, for example, certain conditions related to frequency and intensity of L1 and/or L2 contact had not been met (Chang, 2012).

In general, adult immigrants tend to continue using their L1 on a frequent basis and remain mostly L1 dominant (Jia & Aaronson, 1999). It is thus plausible to assume that there might be a certain threshold of L1 use/exposure necessary for the established L1 links not to be weakened upon immigration, and this threshold might have already been reached in the case of the late bilingual participants in this study. This would explain the null effects of the external variables in this group. In a similar vein, a certain level of intense L2 experience going beyond typical daily L2 use might be necessary for the L2 to affect the deeply entrenched L1. Previous investigations of L1 accent conducted with late German bilinguals, who were reported to be very proficient L2 users and to use their L1 less frequently than the current participants, have provided some support to this explanation (e.g., Bergmann et al., 2017; de Leeuw et al., 2010). As a result, the high levels of L1 retention in this group could have been due to the availability of the L1 upon immigration rather than to age-related reduced susceptibility to attrition.

Distinguishing between the effects of maturational constraints and L1 entrenchment in a group like ours is indeed very difficult. In theory, one solution could be to investigate the L1 performance of an additional group of late bilinguals whose L1 contact ceased completely upon immigration (see Schmid, 2012, for details). In this hypothetical scenario, if the main cause of high levels of L1 retention among late bilinguals was due to reduced susceptibility to

attrition, which is predicted to be an irreversible process, then no group differences should be obtained, and L1 should be retained to a considerable degree even in the group with no prolonged L1 contact. In practice, however, it is extremely difficult to find such comparable groups.

To our knowledge, the only investigation to date has been Schmid's (2012) investigation of age effects in two groups of postpuberty bilinguals—Holocaust survivors with age at onset ranging from 11 to 15 years—with and without continuous L1 contact upon immigration. This research demonstrated that the degree of L1 loss in morphosyntactic properties, which was found to be minimal, was better predicted by age at onset rather than availability of the L1 upon emigration. It is however not easy to see how this finding can be taken as direct counterevidence to our argument above regarding the L1 accent of our participants, which would require further investigations of L1 accent with a similar profile of bilingual participants. Until it is proven otherwise, our findings, in general, are therefore more compatible with the entrenchment view than with the maturational view. However, we acknowledge that more detailed reports on L1/L2 use and proficiency should be obtained and additional analyses (e.g., acoustic analyses) should be carried out to arrive at a more definitive answer.

Age Effects in Structural Complexity

The picture for the L1 performance in structural complexity was quite different from what we observed for L1 accent because all participants performed in a fully targetlike manner. Although this is an outcome that was not predicted in our hypotheses, these findings are entirely in line with what Kupisch et al. (2014) found in the performance of adult French–German simultaneous bilinguals (i.e., with two L1s) who had acquired French either in a minority or majority context. Although all participants, regardless of the context, performed in a targetlike manner in a variety of morphosyntactic categories in controlled tasks, those who acquired French in the minority context had an accented L1 and drifted in voice onset times. The authors argued that, even if they had investigated the morphosyntactic performance in free speech rather than in controlled tasks, their participants would still have performed in a targetlike fashion. According to the authors, this is because speakers are in control of how to express ideas and may avoid certain structures by compensating for them through other means, but the same is not true for pronunciation because it is not possible to find alternative ways of pronouncing a sound.

This explanation might account for the asymmetry that we found across our linguistic measures to some extent. Although we counted the number of

different types of nonfinite clauses that have previously been reported to be used infrequently in immigrant Turkish (Treffers-Daller et al., 2007), we did not look at the finite/nonfinite clause distribution in general or in specific contexts. In Onar-Valk and Backus's (2013) study, for example, adult heritage speakers compensated for their nonuse of nonfinite clauses by using finite clauses in reported speech contexts more than they did in other contexts. In that sense, as one of the reviewers also commented, our measure might not have been sensitive enough to detect such compensatory tendencies.

On the other hand, our participants showed full retention of L1 proficiency in one of the components that we included in the structural complexity measure—the agglutination index. This indicated that none of the participants avoided costly synthetic processes by relying on more analytic means. It follows from this that not all linguistic measures are subject to age effects. It is widely acknowledged in the L2 acquisition literature that age effects do not modulate the ultimate attainment in a L2 across the entire range of linguistic domains or even across the properties within the same domain, which is called the selectivity of age effects (e.g., Veríssimo et al., 2017). We can argue that the same holds for L1 attrition, and general structural complexity may be something that is not selective by age effects.

Selectivity phenomenon is, in fact, not new to L1 attrition research. Previous research demonstrated external interface-governed structures, such as distribution of subject pronouns and differential object marking as potential loci for erosion (Chamorro, Sturt, & Sorace, 2016), which is often framed within the interface hypothesis as formulated by Sorace (2011). There is also evidence showing that structures that are not in competition between the L1 and L2 may be fully retained (Gürel, 2004). As Gürel's investigation of L1 attrition in long-term Turkish late bilinguals in Canada exemplified, only the pronoun *o*, the binding domain of which is in competition with the English pronoun s/he, was affected. The binding domains of the other two Turkish pronouns were fully retained. By analogy, high levels of L1 retention across the entire age-at-onset range in our study may thus relate to the lack of direct competition between the L1 and L2 structures under investigation (e.g., agglutination, nonfinite clauses) and also to the fact that these properties are not governed by external interfaces.

Unlike what Gürel's study revealed, a recent study investigating the role of age at onset in a group of Korean–English pre- and postpuberty learners showed that prepuberty learners with ages at onset up to 12 years failed to perceive L1-specific phonemic contrasts, but they did not have problems with the contrasts that are similar to the L2 sounds (Ahn et al., 2017). Therefore, it appears that even phonological competence might be subject to a

selective process determined by age at onset of bilingualism, but how the level of crosslinguistic similarity or competition between the L1 and L2 influences this outcome might vary based on the language pairs and the linguistic domain. If this is the case, it remains to be seen in the future to what extent there is an overlap between selectivity of attrition and age effects across different linguistic properties with different levels of L1–L2 competition. It will also be important to employ different methodologies to see whether task demands play a role in this selectivity.

Conclusion

This investigation set out to explore the relationship, if any, between age at onset of bilingualism and degree of L1 attrition in overall structural complexity and perceived accent in heritage speakers. The spoken performance of adult Turkish immigrants in the United Kingdom ($n = 57$) with a wide age-at-onset range (7–34 years) was compared to that of a group of monolingual controls ($n = 29$). We formulated our hypotheses based on the premises of two competing accounts, the maturational view (critical period hypothesis) and the L1 entrenchment view (interference hypothesis), on the assumption that testing these models' capacities for explaining L1 attrition phenomena might help resolve the fundamental issue of how to conceptualize age effects.

Our findings generally suggested that L1 accent is sensitive to the effects of external factors and age at onset, which we proposed as a proxy for level of L1 entrenchment instead of the maturational state of the speaker. However, given that we did not have detailed reports on L2 use and did not obtain any measures of L2 proficiency, these findings should be taken as preliminary and tentative. It is difficult to claim something similar for the structural complexity performance because all participants performed in a targetlike manner. One possible explanation for the asymmetry found in the degree of attrition across the two linguistic measures could be due to different levels of L1–L2 competition. Even if this was the case, neither account makes an explicit claim for this, and therefore they remain insufficient to account for our findings. Taken together, if Schmid and Köpke (2017) are right in their proposal that L1 attrition findings can "be used to inform, challenge, and validate theoretical approaches of bilingual development" (p. 2), we believe that our findings, despite being preliminary, should be used to inform implications of these models for L1 attrition to accommodate phenomena, such as selectivity and degree of competition between L1 and L2 structures.

Without any doubt, more research needs to be carried out to arrive at more definitive answers. We suggest that future researchers investigate age

effects in a number of other linguistic properties with different levels of L1–L2 competition by including participants with younger ages at onset and a greater variety of language use. This could be achieved using an additional group with a profile similar to that of adoptees whose L1 exposure ceases completely upon immigration either in post- or prepuberty ages. Based on our findings, this is crucial for testing the limits of various theoretical models in accounting for L1 attrition phenomena.

Final revised version accepted 22 June 2018

Notes

1 Effects of any other known L1s, such as Kurdish, were controlled. Nevertheless, in some cases, knowledge of other native languages was inevitable. One participant learned some Kurdish from her grandmother at age 7 years but lost the ability to speak the language upon immigration at age 8. Similarly, two participants stated that they had a minimum level of knowledge of Kurdish. One participant was born in Cyprus, where she had spent 13 years before her arrival in the United Kingdom. She reported not to have acquired/used Cypriot Turkish because her parents were from Turkey.

2 Past L1 frequency of use with siblings and parents, $r = .45$, $p = .01$.

3 The morpheme counts were obtained automatically with the aid of a Turkish morphological parser and a disambiguator developed by Sak, Güngör, and Saraçlar (2009) with a 96.7% success rate.

4 An anonymous reviewer pointed out that using monolingual raters instead of raters with a L2 English background would have been more appropriate. Our choice of bilinguals, however, was a deliberate one: Various studies have found that familiarity with the language background and language combinations of the speakers to be rated can improve interrater reliability and also leads to raters being somewhat more lenient (e.g., Carey, Mannell, & Dunn, 2011) and that even nonnative speakers are able to rate speakers reliably (e.g., Xi & Mollaun, 2011). To give all of our speakers the best chance of being perceived as natives, we felt that the choice of bilingual raters would be better than choosing speakers entirely unfamiliar with the language that our speakers used in daily life.

5 This investigation was originally designed for a larger project and thus included speech samples of an additional group of adult heritage speakers ($n = 31$), born in the United Kingdom, who were not included in this study due to concerns about their incomplete attainment.

6 The same anonymous reviewer also suggested that the raters should ideally have had the same region of origin as that of the participants in the sample because raters' choices when judging whether a participant's accent is foreign might be confounded with that participant's heavy regional accent. The reviewer was, indeed,

correct that familiarity with regional accents can affect the accuracy of ratings (e.g., Flege, Frieda, & Nozawa, 1997). This is why we very carefully matched the experimental and the control speakers for region of origin. We can thus assume that regional dialects occured to the same degree in the monolingual and the bilingual groups, and the fact that all monolinguals were unambiguously rated as L1 speakers strongly suggested the absence of the confound that this reviewer speculated could have happened.

7 Being perceived as sounding nonnative does not entail that a speaker is a nonnative speaker of Turkish.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendix S1. Sociolinguistic Questionnaire.
Appendix S2. Transcription and Coding Conventions.

Appendix S3. Distribution of Residuals in Mixed-Effects Models.

Appendix: Accessible Summary (also publicly available at https://oasis-database.org)

Does the Age When Bilingualism Starts Influence How Well Immigrants Maintain Their First Language?

What This Research Was About And Why It Is Important

Maintaining your first language can be important for immigrants and their children, especially when the first language is needed to communicate with relatives in the country of origin. It could be that exposure to a second language at the time of immigration might influence how well immigrants can maintain their first language. To explore this, we compared the Turkish speech of immigrants who had arrived in the United Kingdom at different ages with the Turkish speech of monolinguals living in Turkey. We examined (a) their use of Turkish complex grammar structures and (b) how much immigrants sounded like native Turkish speakers. We found that all immigrants used grammar structures similarly, regardless of the age at immigration. The chances of sounding like a native Turkish speaker were reduced if immigration happened at younger ages. However, more exposure to the first language increased these chances, among other factors.

What the Researchers Did

- To get samples of speech in Turkish, the researchers interviewed 86 participants who were all born in Turkey and had learned Turkish as their first language:
  - 29 were Turkish monolinguals living in Turkey;
  - 57 were adult long-term Turkish immigrants around London. These immigrants had different ages of first exposure to English (their second language), having arrived in the United Kingdom between 7 and 34 years old.
- Participants were asked about everyday topics (such as health and education), their linguistic and cultural preferences (such as how often they used Turkish with friends and family), and about events in their past.
- Participants' Turkish speech was analyzed in two ways:
  - how often they used complex grammar structures;
  - how nativelike their speech sounded, based on ratings by 28 university students in Turkey.

What the Researchers Found

- All immigrants used as many complex structures as the monolinguals living in Turkey, regardless of the age at which the immigrants arrived in the United Kingdom.
- Age of exposure to the second language affected whether immigrants' first language sounded nativelike:
  - immigrants who were older than 13 when they started exposure to their second language sounded the same in their first language as the Turkish monolinguals;
  - however, immigrants with exposure to their second language before age 13 were perceived, in general, to sound "accented" in Turkish (their speech did not sound the same as the speech of Turkish monolinguals).
- Immigrants who were young when they immigrated could sound native in Turkish if they had been exposed to their first language a lot (e.g., via the media) and if they had been more proficient to begin with.
- Generally, while older immigrants tended to maintain their Turkish fully, younger immigrants' Turkish was more variable and was influenced by several additional factors.

Things to Consider

- Being exposed to a second language at a young age does not necessarily lead to loss of the first language. Given adequate exposure to the first language, children of immigrants can fully learn it.
- Similarities between first and second languages might impact the maintenance of the first language, as the languages may interfere with each other. In this study, early exposure to a second language had a negative impact on pronunciation, which has similarities between Turkish and English. In contrast, there was no negative impact on complex grammar structures that are different across the languages.

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