Beyond Segments: Towards a L2 Intonation Learning Theory

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Chapter 9
Beyond Segments: Towards a L2 Intonation Learning Theory

Ineke Mennen

Abstract This chapter presents a working model of L2 intonation learning, the L2 Intonation Learning theory (LILt), which ultimately aims to account for the difficulties that L2 learners encounter in producing L2 intonation. The model works on the premise that cross-language differences in intonation can occur along four intonation dimensions, and that this, along with some general assumptions and hypotheses on L2 intonation learning, can predict where L2 deviation is likely to occur. The four dimensions LILt recognizes are (i) the systemic dimension, which refers to the inventory and distribution of structural phonological elements; (ii) the realizational dimension, which refers to the way the systemic elements are phonetically implemented; (iii) the semantic dimension, which refers to how systemic elements are used to signal intonation function and (iv) the frequency dimension, which refers to the frequency of use of the structural elements. The existing evidence for the occurrence of L2 intonation deviation in each of these dimensions is examined, and some generalizations and hypotheses derived from research on L2 intonation are presented. These generalizations and hypotheses will allow for future testing of this theoretical model.

9.1 Introduction

Mastering foreign language pronunciation is considered extremely difficult, and only few individuals succeed in sounding like a native speaker when learning a second language (L2) in adulthood. One well-known aspect of pronunciation L2 learners appear to struggle with is intonation. L2 learners often end up with intonation patterns that differ somewhat from patterns produced by native speakers of the language they are acquiring, even after many years of exposure to the L2, and these deviations can contribute to the perception of a foreign accent (e.g. Anderson-Hsieh et al. 1992; Jilka 2000a; Mennen 2004; Magen 1998; Munro 1995; Munro and Derwing 1995; Trofimovich and Baker 2006; Willems 1982). Intonation is regarded by some as particularly vulnerable to cross-language influences (Mackey 2000),

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and it is therefore not surprising that influences from the native language (L1) are commonly observed in non-native intonation production even at high levels of proficiency (see Mennen 2004, 2007 for an overview). Nevertheless, most research on L2 speech production and perception has focused on segmental acquisition such that the field of L2 speech learning has gained a fairly good understanding of segmental aspects of language differentiation. As a result, current models of L2 speech learning, such as Flege's (Flege 1995) SLM and Best's (Best 1995; Best and Tyler 2007) PAM/PAM L2 base their predictions of the relative difficulty or ease of production and perception of non-native speech on comparisons of L1 and the to-be-learned segments. To date, no model has been proposed that exclusively deals with and makes predictions of the relative difficulty of producing and perceiving non-native intonation, although some recent attempts have been made to extend the PAM-L2 to the perception of lexical tones (So and Best, 2010, 2011, 2014).

This chapter will present an attempt to formulate a model of L2 intonation learning that aims to account for the difficulties that L2 learners encounter in producing L2 intonation. Although problems may also occur in the perception of intonation, the focus of this chapter is on intonation production. It will present an overview of empirical research in the area of L2 intonation and some generalizations and hypotheses that can be derived from it. These generalizations and hypotheses will allow for future testing of this theoretical model.

9.2 Determining Cross-Language Similarity in Intonation and the Autosegmental-Metrical Approach

Perhaps the most important notion in any L2 speech studies is that of cross-language similarity, often referred to as phonetic similarity. L2 models for segmental speech learning generally rely on this concept of similarity between native language (L1) and L2 segments to generate testable predictions as to the relative difficulty of producing and perceiving L2 speech (e.g. Bohn 2002; Strange 2007). Although it is generally agreed that establishing similarity is crucially important for any model of L2 speech learning, identifying on which basis L1 and L2 sounds can be considered the same or different is very tricky indeed. In fact, to date there is no commonly accepted metric to measure cross-language similarity (Bohn 2002) and our understanding of the exact nature of cross-language similarity/dissimilarity is still rather limited (Strange et al. 2001).

The problem of establishing similarity of cross-language intonation is perhaps even more acute, given the complex nature of intonation, and its interaction with other prosodic parameters such as lexical prosody, tempo, duration, pauses, loudness and voice quality (e.g. Nolan 2006). It is therefore not all that surprising that the focus of L2 speech models has been on segments rather than intonation, given that segments are relatively easy to describe, to analyse and to test compared to intonation. As intonation signals multiple functions, it is particularly difficult to establish whether certain intonation differences are categorical or gradient in nature,

more so than in the segmental domain (Gussenhoven 2006). In fact, it has long been debated whether intonation actually involves a categorical structure and, if so, what its structural elements are (Ladd 1996).

With the development of a more explicitly phonological approach to intonation and researchers now largely converging on a broadly 'autosegmental-metrical' (AM) framework (Pierrehumbert 1980; Pierrehumbert and Beckman 1988; see also Ladd 1996 and Jun 2005, for overviews), cross-language comparisons of intonation have been facilitated enormously. The central tenet of the AM framework is that intonation consists of a limited number of categorical phonological elements (e.g. high or low underlying tonal targets) that are phonetically implemented in continuous speech. That is, it explicitly distinguishes between a phonological and a phonetic component. Mennen (1999, 2004, 2007) argued that such a distinction is crucial for establishing cross-language similarity in intonation. To generate predictions as to the relative difficulty of producing and perceiving L2 intonation it is necessary to—at the very least—take both the phonetic shape as well as the phonological organization of L1 and L2 intonation patterns into account. The next section will introduce how the proposed L2 Intonation Learning theory (LILt) can be used to compare cross-language intonation in order to ultimately increase our understanding of the exact nature of cross-language similarity/dissimilarity in intonation with a view to generating predictions as to the relative difficulty of aspects of L2 intonation.

9.3 L2 Intonation Learning Theory (LILt)

9.3.1 Framework for Cross-Language Comparison

The theoretical model that is proposed here builds on the dimensions of cross-language (and cross-varietal) variation that have been identified by Ladd (1996). This approach separates the phonological representation from its phonetic implementation as recommended in our earlier work (e.g. Mennen 1999, 2004, 2007) and the AM approach (Pierrehumbert 1980; Pierrehumbert and Beckman 1988), but allows for a more detailed comparison that has been shown to considerably increase the analysis depth of cross-linguistic and L2 intonation studies (e.g. Mennen et al. 2010). The LILt recognizes four dimensions (modified from Ladd 1996) along with similarities and differences between L1 and L2 intonation can be usefully characterized:

1. The inventory and distribution of categorical phonological elements ('systemic dimension')
2. The phonetic implementation of these categorical elements ('realizational dimension')
3. The functionality of the categorical elements or tunes ('semantic' dimension)
4. The frequency of use of the categorical elements ('frequency' dimension)

Cross-language similarity/dissimilarity in the systemic or phonological dimension concern typological similarities or differences in the inventory of structural phonological elements (such as pitch accents, accentual phrases, prosodic words and boundary phenomena). Languages are known to differ in their intonation typology. An example of such a difference is the 'rise-plateau-slump' (Cruttenden 1986, 139 ff.) used amongst others in rising nuclear accents in Belfast and Glasgow, a L*HL% tonal sequence that according to Ladd (1996, p. 126) does not occur in statements in RP or American English. Cross-language differences in the systemic/phonological dimension are also concerned with how the different structural elements combine with one another (i.e. what structures of tunes are permitted) and their 'tune-text association' (Ladd 1996, p. 119). Ladd gives an example of the latter, stating that accents in Italian may occur on lexically unstressed syllables, a phenomenon which 'does not seem to occur in other European languages in the same way as in Italian […]' (1996, p. 129). Similarly, Arvaniti et al. (2006) found that in Greek yes/no questions with focus on the last word, a L+H^{-} phrasal accent is realized on the final syllable of the utterance, even when this syllable is unstressed. Mennen (1999) observed that this results in a pitch movement that looks and possibly sounds to Western European listeners (e.g. Dutch or English) as a nuclear accent on the final syllable, given that in many Western European languages such phrasal or postnuclear accents do not seem to occur. Languages may also differ in the legal combinations of structural elements of intonation. For example, Post et al. (2007, p. 192) argue that English allows considerably more combinations of possible tone sequences than French, which is 'poorer' in that it allows less elements in less positions and less combinations.

The realizational or phonetic dimension charts cross-language similarity/dissimilarity in how the systemic elements of intonation are phonetically implemented or realized. This involves, for example, how pitch accents are lined up with the segments of utterances (usually referred to as tonal alignment), how they are scaled (i.e. what their relative height is) or what their shape or slope is (e.g. shallow versus steep rising or falling pitch accents, pitch accents with a clear peak versus flat or plateau pitch accents). There are many reports of cross-language differences in the realizational dimension of intonation, most notably for differences in how tonal elements are coordinated in time with specific locations in the segmental string (such as syllable boundaries). To give a few examples, the start of prenuclear rises are found to occur later in Standard German than in English (Atterer and Ladd 2004); the peaks of prenuclear rising accents typically occur considerably later in Greek than in comparable Dutch prenuclear rising accents (Mennen 1999, 2004) and alignment of nuclear peaks is earlier in English than in Dutch (Schepman et al. 2006; Ladd et al. 2009). There is also evidence for cross-varietal differences in this dimension. For instance, alignment of nuclear and prenuclear peaks is later in Southern Standard British English than in RP (Ladd et al. 2009); Southern speakers of Standard German align rises later than Northern speakers (Atterer and Ladd 2004); Southern Californian speakers of American English align rising accents earlier than Minnesotan speakers (Arvaniti and Garding 2007) and peaks are aligned earlier in Connaught than in Donegal Irish (Dalton and Ní Chasaide 2005).

Similarity/dissimilarity in the semantic dimension concerns the use of structural elements or tunes for conveying meaning. For example, languages may differ in how they mark focus or interrogativity. In most varieties of English, questions are signalled by rising pitch, whereas in Greek yes/no question falling intonation is used (Arvaniti et al. 2006). Similarly, in Belfast English statements are most commonly marked by rising intonation, whereas in most other varieties of English rising intonation is used to signal questions (Grabe 2004). Different tonal sequences may be used for focus across languages, such that for instance, European Portuguese signals focus with a distinct pitch accent (Frota 2000), whereas in other languages, focus may be signalled by other prosodic means or by word order.

Finally, the LILt proposes that another dimension, the 'frequency dimension', needs to be added to the dimensions proposed by Ladd (1996). This dimension refers to cross-language similarities and differences in the frequency of use of the language's inventory and distribution of intonation primitives. Languages and language varieties may greatly differ in their frequency of use of these primitives. Grabe (2004) found that even when varieties have the same inventory and distribution of pitch accents and boundary tones, they may differ considerably in the frequency with which these phonological elements are used. For instance, rises are far more frequent in Belfast English than in London or Cambridge English (Grabe 2004). Similarly, Mennen et al. (2012) found that rises are more commonly used by female speakers of Northern Standard German than by female speakers of Southern Standard British English (at least in read speech).

9.3.2 Identifying L2 Intonation Deviation

The LILt's method of classifying and charting cross-language intonation differences has been found useful for studying L2 acquisition of intonation (e.g. Mennen et al. 2010). In particular, LILt's method can identify where deviations from the native norm occur and whether they occur more frequently in some than in other dimensions. It also makes it possible to systematically compare L2 learners at different levels of proficiency, different ages of arrival (AOA), different L1 backgrounds, different speaking styles or any other variables that may be relevant in the learning process. This can shed light on issues such as whether and how deviations diminish as proficiency increases, whether deviances in different dimensions of intonation diminish in parallel, whether there are symmetries in the pace and trajectory of intonation acquisition across learners of different L1 backgrounds, and how speaking style may affect intonation in each of its dimensions and at different levels of proficiency.

The remainder of this section will examine the currently available evidence for the usefulness of the LILt in identifying deviation. The next section will then examine whether it is possible to generate testable predictions and hypotheses in a similar vein as those made for the acquisition of L2 segments.

A review of L2 intonation studies shows that deviations from the native norm are evidenced in each of the LILt's four dimensions of intonation variation, although some appear more susceptible to deviation than others (but see for a discussion below). Support for deviations in the systemic dimension comes from evidence that L2 learners may fail to produce certain accents that do not form part of the source language inventory. For example, an examination of the tonal inventory of Italian and Punjabi learners of English showed an absence of the more complex pitch accents H*LH or L*HL, whereas they do occur in London English (Grabe 2004), the target variety the L2 learners had been exposed to. Support has also been found for deviances in how the different structural elements combine with one another (i.e. the permitted structure of tunes). For instance, Jilka (2000b) reports on an American L2 learner of German who uses a typical American English continuation rise involving a rise-fall-rise movement on the last word in an intonation phrase, while this particular tonal sequence is not a permitted boundary pattern in the target language (German).

Perhaps most support is found for deviations in the realizational dimension of intonation. Many studies report differences in, amongst others, the alignment (timing) and scaling (height) of pitch accents. For example, Dutch learners tend to align the peaks of prenuclear rises in their L2 Greek much earlier than native Greek speakers do (Mennen 2004), showing evidence of L1 transfer of alignment patterns to the L2. Similarly, German learners were found to transfer their typical late L1 alignment of the start of rises to their L2 English. Further support comes from evidence of deviances in the timing of pitch accents by Korean (Trofimovich and Baker 2006) and German (O'Brien and Gut 2010) learners of L2 English. Deviances in scaling are also frequently reported for pitch accents as well as boundary tones. Final rises (boundary tones) were reportedly scaled too high in Dutch learners of L2 English (Willems 1982), whereas they were too low in Venezuelan (Backman 1979) and Punjabi (Mennen et al. 2010) learners of L2 English. Pitch accents were also often found to be scaled too high or low in comparison to native norms (e.g. Backman 1979; McGory 1997; Wennerstrom 1994; Willems 1982). Further evidence for deviances in the realizational dimension comes from observations of different shape and slopes of intonation primitives, such as a different steepness of rises (e.g. Jilka 2000a; Ueyama and Jun 1998; Willems 1982) or a smaller declination rate (Willems 1982).

Deviances in the semantic dimension may occur in the failure to use intonation to signal certain functions in a language appropriate way. For instance, Wennerstrom (1994) found that Thai, Japanese and Spanish learners of L2 English do not consistently use a high pitch accent (H*) to signal new information in English (Pierrehumbert and Hirshberg 1990). Wennerstrom (1994) showed that differences between the three learner groups in their ability to use this cue could be attributed to a combination of transfer from the L1 and the amount of exposure to the L2. Similar difficulties with signalling new information were also reported for Chinese (Juffs 1990) and Zulu learners of L2 English (Swerts and Zerbian 2010). In another study, Wennerstrom (1998) found deviations in the realization of contrastive stress in Mandarin Chinese learners of L2 English. She attributed this finding to

transfer from the L1 given that, unlike English, Mandarin Chinese expresses contrastive stress more through durational than intonational cues. Another example of deviations in the semantic dimension is reported by McGory (1997). She found deviations in the production of native English prominence relations by Seoul Korean and Mandarin Chinese learners of L2 English, who fail to produce pitch accents in prominent target words only, but rather produced stressed syllables with higher F0 values in both prominent and less prominent words. A failure to deaccent given information was also reported for Austrian learners of English (Grosser 1997) and learners of English from various L1 backgrounds (Gut 2009). Problems with marking prominence relations and information structure have also been reported for Venezuelan learners of L2 American English (Backman 1979), and Spanish (Ramirez Verdugo 2002) and Dutch learners of L2 British English (Jenner 1976). Finally, Ulbrich (2008) found that even when highly proficient L2 learners are able to produce some of the typical intonation patterns of the L2 variety they have been exposed to, they often do not vary these patterns in a native-like way across speaking styles. She concluded that the use of intonation to signal stylistic variation might not be acquired until very late in second language acquisition.

Finally, evidences for deviations in the frequency dimension have also been reported. For instance, Dutch learners of L2 English have been found to use rising pitch accents more often than falling ones (Willems 1982), where most native varieties of English would use falls more frequently than rises (Willems 1982; Grabe 2004). This was clearly attributed to an influence of the L1, where rises are more frequent than falls (Willems 1982). Jilka (2000b) noted similar deviations in the choice of pitch accent, with American learners of L2 German using rises in certain discourse situations where native German speakers would typically use falls. In fact, substitution of rises with falls and vice versa in pitch accents and boundary tones have been reported for a range of L1–L2 combinations (Adams and Munro 1978; Backman 1979; Hewings 1995; Jenner 1976; Lepetit 1987; Mennen et al. 2010; O'Brien and Gut 2010; Santiago-Vargas and Delais-Roussarie 2012; Willems 1982). Such deviances in the frequency of use of structural elements of intonation were mostly found to arise from L1 transfer. The only exception to this was a study by Santiago-Vargas and Delais-Roussarie (2012), where an influence from the L1 could not be found.

It should be noted that it is not always easy to classify intonational deviances into the four dimensions of the LILt, and that the dimensions can on occasion interact with one another. For example, as we saw above, when Mandarin Chinese and Korean learners of L2 English realize unstressed syllables that are too high compared to native speakers of English (McGory 1997) this may affect the signalling of focus in the L2. That is, a deviance in the realizational dimension of intonation may result in a semantic or functional deviation. In some cases it may be difficult to establish what the underlying cause of the observed differences between non-native and native intonation is. For example, as we saw above, it has been reported that when focus is on the last word of Greek yes/no questions, a L+H^{-} phrasal accent is realized with a pitch movement on the final syllable, even when this syllable is unstressed (Arvaniti et al. 2006). Mennen (1999) reported that Dutch learners of Greek realized

this pitch movement on unstressed syllables with an earlier peak and higher F0 values than native Greek speakers. However, it was hypothesized that this surface deviance in the realizational dimension may have resulted from an underlying difficulty in the systemic dimension. Given that phrasal accents do not occur in Dutch, it is quite possible that the Dutch learners of Greek had simply produced a nuclear accent where native Greek speakers would produce a phrasal (i.e. postnuclear) accent. That is, the deviance may have resulted from an underlying difficulty in the systemic dimension, specifically in the language-specific tune-text association. This hypothesis was strengthened by the fact that no differences were found in the realization of nuclear and phrasal accents in the Dutch learners of Greek, whereas nuclear accents in native Greek occurred earlier (and had marginally higher peaks) than phrasal accents (Mennen 1999).

Despite these difficulties in classifying the dimensions, there is clear value in the use of these four dimensions of intonation variation as a first step in characterizing L2 intonation. Further experimentation and analysis will then be needed in those cases where the underlying cause of deviation is not clear.

9.3.3 General Theoretical Assumptions of the LILt as Compared with L2 Models for Segmental Speech Learning

From the above presented literature, it seems clear that a division into the four dimensions of LILt provides the necessary tools for an in-depth characterization of intonation deviation. Once languages have been compared along the four intonation dimensions, some general predictions can be made as to where deviation may occur in certain L1–L2 combinations. However, the most important goal of any L2 intonation model would be to predict the relative difficulty learners would experience with certain L2 intonational parameters or dimensions, and to shed light on the principles, which govern the acquisition process of intonation such as the rate and order in which parameters of intonation develop in a L2. Given the general lack of empirical studies on L2 intonation, we can say preciously little about this. As the LILt has not been tested directly as yet, it should therefore be treated as an evolving or 'working' model, which is subject to change when more data are published.

Some generalizations and hypotheses can, however, be generated from prior research, in particular assumptions arising from our general knowledge of L2 speech learning and from the theoretical underpinnings of L2 models for segmentals such as SLM and PAM-L2. This section will evaluate the extent to which theoretical assumptions of L2 segmental acquisition can be incorporated into LILt, and how they diverge:

1. A central theoretical assumption of both the SLM and the PAM-L2 is that deviations in L2 speech production are perceptually motivated (Strange 2007). It is assumed that 'the perception of L2 segments is somehow influenced by or "filtered through" the over-learned and automatic perceptual strategies by which

incoming phonetic segments are recognised as exemplars of L1 phonological categories', which in turn results in L1 interference (Strange 2007, pp. 36–37). It seems logical to assume a similar perceptual basis to the difficulties adult learners face when attempting to produce L2 intonation. Indeed, the few existing studies on the perception of L2 intonation suggest that learners' perception of intonational cues that are not present in or differ from the L1 is often poor (e.g. Gili Fivela 2012; Liang and Van Heuven 2007; Nibert 2006; Trimble 2013). Both the SLM and PAM-L2 hold that the perception of L2 segments crucially depends on the similarity of phonetic properties of the L2 segment and L1 categories. When L2 segments are sufficiently similar to L1 categories, they will be 'perceptually assimilated' (in PAM-L2 terminology) or 'equivalence-classified' (in SLM terminology) to L1 categories, and deviances in production are likely to occur. When L2 segments are sufficiently different to L1 categories, it should be possible for the learner to develop a new category. For intonation, it is equally possible to come up with examples where discernable differences in the phonetic properties of the L2 and L1 categories exist. For example, as we have seen above, the same phonological category (e.g. a rising pitch accent) may have cross-language differences in the realizational dimension such that it is scaled higher or aligned later in the L2 compared to members of L1 categories. Crucially though, in order to generate predictions as to the relative difficulty of this particular example, one would need to determine whether instances of the L2 category are identified by the learners as members of an L1 category. As briefly discussed earlier in this chapter, it is more difficult to determine the existence and perception of categories for intonation than it is for segments because of the close intertwining of gradient and categorical variations in intonational form, each of which convey both linguistic and paralinguistic meaning (e.g. Ladd 1996; Gussenhoven 2006). It is therefore necessary to consider both form (realizational dimension) and meaning (semantic dimension) when predicting the relative difficulty of L2 intonation categories. Recent studies have shown that when precise reference is made to specific meanings or functions it is possible to predict the relative difficulty of L2 intonation categories (Gili Fivela 2012; So and Best 2014). Although some element of functionality is also required in PAM-L2 (which recognizes that equivalence between the L1 and L2 at the lexical-functional level may play a role), for intonation such specification is deemed specifically important. While LILt therefore agrees with SLM and PAM-L2 that many difficulties may be perceptually motivated, it posits that explicit reference needs to be made to the semantic dimension of intonation when determining perceptual similarity. Finally, as with segmental models, the LILt does not rule out other explanations of deviations in production, such as an inability to articulate certain differences between L1 and L2 intonation or store them in acoustic memory.

2. A second important assumption of the SLM and PAM-L2 is that L1 influences are not solely restricted to the level of phonological contrasts. PAM-L2 explicitly mentions that fine-grained phonetic similarities and dissimilarities between L1 and non-native/L2 phones and 'the relationship between phonetic

details and phonological categories and contrasts' (Best and Tyler 2007, p. 16) are important. Similarly, the original SLM hypothesizes that 'sounds in the L1 and L2 are related perceptually to one another at a position-sensitive allophonic level, rather than at a more abstract phonemic level' (Flege 1995, p. 239). This view is consistent with the principles of LILt. The LILt recognizes that similarities and dissimilarities between L1 and L2 intonation can occur along more than just the systemic dimension, as explained in Sect. 9.2, and that variation in the realizational dimension may impact on a learner's ability to discriminate, categorize and produce a L2 phonological category. As with segments, the LILt posits that the position and context in which certain contrasts occur is equally important in intonation, and needs to be tested and controlled for.

3. A third assumption of the SLM and PAM-L2 is that age of arrival (AOA) or age of learning (AOL) is an important predictor of success. Flege (1995, p. 239) states that 'the likelihood of phonetic differences between L1 and L2 sounds, and between L2 sounds that are non-contrastive in the L1, being discerned decreases as AOL increases'. Just as AOL or AOA has been found to exert an influence on L2 segmental learning (e.g. Flege 1992; Flege et al. 1995; Piske et al. 2001), research indicates that 'the earlier, the better' also applies to L2 intonation learning. The LILt therefore hypothesizes that the age of first (regular) exposure to a L2 or AOA in a L2-speaking country is an important factor in predicting overall success in acquiring L2 intonation. Support for this hypothesis (although admittedly rather limited at this point in time) comes, amongst others, from Mennen (2004) who investigated tonal alignment patterns of five advanced Dutch learners of Greek. Her results showed that although in four out of five Dutch learners of Greek a clear influence of the L1 in the production of Greek prenuclear rises was observed, one speaker produced values that were entirely within the norms for the L2. This particular learner was considerably younger than the other four at first exposure to the L2 (15 as opposed to 20–25 years of age), suggesting that her success was due to earlier exposure. Partial support for this hypothesis was found by Chen and Fon (2008) who investigated age effects on the alignment of prenuclear and nuclear accents in L2 English by two groups of Taiwanese learners who differed in their age at first exposure to English (age 3–4 versus age 9–10). Their results showed that age of first exposure played a role in the learners' success at producing accurate peak alignment in nuclear pitch accents. Further evidence for an effect of AOA on success in intonation production was found by Huang and Jun (2011). Their study specifically explored the effect of AOA on the production of American English prosody by three groups of Mandarin immigrants that differed in their AOA (child arrivals, adolescent arrivals and adult arrivals). Their results showed an age-related decline for some aspects of intonation production (frequency of pitch accents and high boundary tones), although no effect was observed for other prosodic aspects (such as articulation rate, prosodic phrasing and pitch accent type).
   Interestingly, the factor AOA appears to impact different aspects of intonation to varying degrees, and in some cases no support for an age effect has been found. For example, Chen and Fon (2008) only found evidence for an effect of AOA in

the alignment of nuclear but not prenuclear pitch accents, which emphasizes the point made above that context may be important and needs to be controlled for. Likewise, no effect of AOA was found for the production of tonal peak alignment by Korean speakers of L2 English (Trofimovich and Baker 2006). Some of the contradicting evidence may be related to methodological differences between the studies, hindering cross-study comparisons and problems related to the study design. For example, participant numbers in Chen and Fon (2008) were rather small (five per group) and words across the nuclear and prenuclear conditions did not appear to be matched. Although Trofimovich and Baker's (2006) study used larger participant groups, their study was not designed to test for an age effect but rather tested the effect of L2 experience or length of residence (LOR). As a result, there was little variation in the participants' AOA and all started learning the L2 after puberty. It is therefore not surprising that no effect was found.

Thus, although LILt predicts more success in intonation production when learning starts at a younger age, it is not assumed that the influence of AOA is necessarily the same for each dimension of intonation. More research is needed into the degree to which early exposure may impact different aspects and dimensions of intonation. Future studies may also want to investigate how frequent this early exposure needs to be for it to take effect and to what extent it would play a role in L2 learning outside the L2 environment.

4. Another theoretical assumption that the SLM and PAM-L2 share is that 'the same basic perceptual learning abilities are available to adults learning a L2 as to children learning an L1 or L2' (Best and Tyler 2007, p. 19). That is, it is posited that over the course of L2 development, learners could become increasingly perceptually attuned to the language-specific phonetic properties of the L2 and may approximate, or even reach, L2 norms in production (Flege 1995, 2003). There is no reason to believe that this is any different for intonation; therefore, the LILt posits that as learners gain experience in the L2, production of L2 intonation parameters will approximate L2 norms more closely. As with L2 segments, learners will rely on their L1 in the production of L2 intonation when they have limited experience with the L2. Transfer is therefore commonly observed at the earlier stages of L2 learning (e.g. McGory 1997; Mennen 2004; Jun and Oh 2000; Ueyama and Jun 1998). There is evidence, albeit limited, to suggest that over time, learners will improve at least in some dimensions of intonation. For instance, in a longitudinal study of L2 intonation, Mennen et al. (2010) examined intonation production by Punjabi and Italian learners of English at two points during their longitudinal development. Results showed an improvement towards the target norm in both learner groups within a period of 30 months after their arrival in the UK. However, improvement was slow and not found for all dimensions of intonation investigated. In particular, no improvement was found in the systemic dimension of intonation and improvement appeared to be restricted to the realizational and frequency dimension only. However, as participant numbers were small and the study did not control for AOA in the L2-speaking country, evidence in support of an indepen-

dent role of experience is limited, and it is likely that—as with segments—it is related to other influences such as AOA, frequency of use of the L1 and L2, etc. (for a discussion of the interrelatedness of age-related effects with other influences, see Flege and MacKay 2011). It is well possible that the degree to which experience affects each suprasegmental property, dimension of intonation or intonation parameter differs. For example, Trofimovich and Baker (2006) only found evidence for the role of experience in one out of five L2 suprasegmentals produced by Korean learners of English, such that an effect was found for stress timing but not for peak alignment, speech rate, pause frequency and pause duration. Similarly, in a study investigating the production of Seoul Korean intonation by a small group of beginning, intermediate and advanced American learners of Korean, Jun and Oh (2000) found that the more advanced learners were better than the less advanced speakers only with respect to producing target-like phrase-final tones that mark a phrase boundary, but not with regards to producing the phonetic realization of accentual phrases. This suggests that they were better in producing aspects of the systemic dimension than those relating to the realizational dimension. Furthermore, the results showed that the advanced learners struggled with the phonological phrasing that served a semantic purpose (i.e. to distinguish WH-questions from yes–no questions), showing a difficulty with the semantic dimension of intonation. The LILt therefore hypothesizes that not all intonation dimensions constitute the same amount of difficulty in L2 learning.

The SLM and PAM-L2 agree that as the learning mechanisms used in learning the L1 sound system are available to L2 learners, it should be possible for learners to ultimately approximate, or even reach, L2 norms in production. The LILt posits that this is also true for intonation, and that it is perfectly possible for learners to produce intonation that is entirely within the norms for the L2. Support for this claim comes from a number of studies showing that learners produced L2 intonation that matched the intonation produced by native speakers of the L2. In some cases, the learners appeared to be exceptional learners, such that they were unlike the majority of the other learners in these studies. For example, Mennen (2004) found that one Dutch learner of Greek produced Greek peak alignment values that were entirely within the norms for the L2. Likewise, De Leeuw et al. (2012) report on one exceptional German learner of L2 English, who—unlike the other nine participants in their study—managed to produce tonal alignment values at the start and end of prenuclear rises that conform with the norms of monolingual speakers of English. Such reports of exceptional learners suggest that it is likely that most learners will fail to reach native-like values for intonation, in a similar vein to what has been attested for L2 segmental learning (see Bongaerts et al. 1997 for an overview). However, a more general trend for intonation productions to be within the norms for the L2 has also been reported. Mennen et al. (2014) investigated the production of pitch range by advanced German learners of L2 English and found that learners performed within the norms for the L2 in most of their measures of

pitch range. In those measures where they differed from the native norm, learners approximated the target language values. This suggests that it is entirely possible to produce at least some aspects of intonation (in this case an aspect of the realizational dimension of intonation) accurately in the L2, and that such achievement is not restricted to just a few exceptional learners. It remains to be seen whether success is equally achievable in all intonation dimensions, or whether there are limits on attainment in some but not in other dimensions or parameters within.

5. Both, the SLM and PAM-L2, hold that L1 and L2 categories exist in a common phonological space. This may cause languages to interact, and this interaction is thought to be bidirectional in nature (Flege 1995; Mennen 2004). Interaction between the two languages can take the form of assimilation or merging of L1 and L2 properties, where L2 learners tend to produce values that are intermediate between the L1 and L2. Such cross-linguistic assimilation is well attested at the segmental level (e.g. Flege and Hillenbrand 1984; Flege 1987; Major 1992). For example, Flege (1987) reported that very experienced French learners of English (with more than 12 years of residency in an English-speaking environment) produced French /t/ with voice onset time (VOT) values that were intermediate between those of French and English monolinguals. The notion that L1 and L2 categories exist in a common phonological space and that this can lead to interaction is compatible with LILt's viewpoint. Evidence comes from merging effects, which have recently been found for intonation (e.g. De Leeuw et al. 2012; Mennen et al. 2014). In particular, Mennen et al. (2014) found intermediate values between the L1 and L2 in some of the measures of pitch range examined in German learners of L2 English. Similarly, De Leeuw at al. (2012) found evidence of merged values of the alignment of prenuclear rising accents in German learners of L2 English, and their results demonstrate how L1 and L2 intonation categories (rising pitch accents) can start resembling one another in production.

   Interaction can also take the form of dissimilation or polarization. At the segmental level, highly proficient Dutch learners of English were found to produce VOT values for /t/ in their L1 that were shorter than those produced by less proficient Dutch learners of English (Flege and Eefting 1987). Thus, the proficient learners were in essence overshooting the Dutch monolingual norm, and their production of Dutch /t/ was shifted away from both the typical norms for Dutch and English. This is often interpreted as a polarization effect resulting from bilinguals striving 'to maintain contrast between L1 and L2 phonetic categories, which exist in a common phonological space' (Flege 1995, p. 239). For intonation, similar instances of polarization have been observed. For example, two out of ten German learners of English were found to align the peaks in prenuclear rises of their L1 even later than German monolingual speakers, thus overshooting the German monolingual norm in their L1 and resulting in a larger difference in tonal alignment between the L1 and L2 (De Leeuw et al. 2012).

Interaction effects may, however, not be inevitable. Mennen (2004), for instance, found that one of five Dutch learners of Greek produced tonal alignment in prenuclear rises in conformity with the norms of monolingual speakers of either language. Such a finding was also reported by De Leeuw et al. (2012) who showed that out of ten German learners of English, one speaker's production was entirely native-like in the L1 and L2. Further research is needed to clarify what factors govern assimilation and dissimilation effects, and why some speakers are able to entirely maintain or achieve separateness of L1 and L2 systems.

9.4 Concluding Remarks

This chapter has attempted to outline how the LILt can be used as a tool to characterize differences and similarities between L1 and L2 intonation. It is hoped that readers of this chapter will use the model to formulate and test specific hypotheses so that in future we may be able to account for the difficulties that L2 learners encounter in L2 intonation. An area that has not been discussed in this chapter is the extent to which L2 intonation is dependent on the acquisition of other prosodic and segmental properties. One would have to assume that some segmental learning must have taken place before certain aspects of intonation can be acquired. Similarly, it is assumed that there is likely to be an interdependency between the acquisition of different prosodic domains and parameters, such that successful acquisition of intonation may be partially dependent on acquisition of other prosodic parameters, e.g. prosodic lengthening, prosodic structure (see Li and Post 2014, for a discussion of the interdependency of prosodic parameters and how this may affect L2 acquisition). Another issue that has not been discussed is the role of universal constraints on L2 intonation learning. There is evidence that the relative difficulty of L2 prosody (e.g. accentual patterns) is to some extent predictable from universal markedness (Rasier and Hiligsmann 2007; see also Zerbian, 2015, this volume, for a discussion of prosodic markedness) and universal developmental paths have been observed for L2 prosodic acquisition (e.g. Archibald 1994). While some parallels in the intonation deviations (Backman 1979) as well as similar developmental trajectories (Mennen et al. 2010) have been observed for learners with different L1–L2 combinations, more evidence is needed to investigate the role of universal constraints in the acquisition of L2 intonation.

Other questions that arise from the discussion in this chapter include: whether deviations are equally reflected in different dimensions of intonation; whether some intonation parameters are more susceptible to transfer than others; whether deviances in different dimensions of intonation diminish in parallel; whether there are symmetries in the pace and trajectory across learners of different L1 backgrounds; what the relative contribution of intonation deviances is to the overall perceived degree of foreign accent and which intonation deviations affect understanding of intonation functions. These, and many other questions, must be resolved in order to

improve our understanding of the processes that are involved in the acquisition of L2 intonation. There is work to do!

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