PART I

THEORETICAL IMPLICATIONS OF LANGUAGE ATTRITION

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CHAPTER 2

LANGUAGE ATTRITION AND THE COMPETITION MODEL

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THIS chapter explores ways in which the Competition Model can illuminate our understanding of language attrition. We begin by formulating some of the key puzzles that arise from empirical studies of language attrition. After this initial problem description, we will consider how the cognitive and social processes included in the Competition Model can help in the formulation of solutions to these various puzzles.

2.1 FOUR PUZZLES

2.1.1 Puzzle #1: permastore

It is easy to imagine that language attrition arises simply from disuse of a speaker's first language (L1). The idea is that, for any given ability, you must 'use it or lose it' (Pinker, 1994, p. 294). Experimental psychology has provided abundant evidence indicating that unused memory traces fade over time (Ebbinghaus, 1885). In some accounts, forgetting arises through the weakening of a memory trace by changes at the level of the synapse. In other accounts, forgetting arises through interference of old memories with new memories. In either scenario, failure to repeatedly access and use the old memory is viewed as the cause of forgetting and problems with retrieval (Paradis, 1993). Problems of this type also arise in people suffering from dementia or anomia.

However, there is also evidence that adults can maintain linguistic representations for decades without active use. For example, Bahrick (1984b) and Bahrick & Phelps (1987) demonstrated that vocabulary learned in college Spanish classes was maintained after as much as fifty years without significant maintenance or reuse. This type of 'permastore' corresponds to what we find in people who continued using L1 through adolescence, but then ceased its use during adulthood. These speakers retain their ability to use their

L1 despite years of disuse (Schmid & Dusseldorp, 2010). We can refer to these speakers as 'maintainers', because they manage to maintain their L1 abilities despite years of disuse. We can contrast people in this group with 'attriters' who show a greater loss of L1 forms. Within this group, we can contrast 'strong attriters' who have undergone the greatest amount of attrition with 'weak attriters' who show less attrition, but still not full maintenance. What is puzzling for standard psychological theories of forgetting is that even the strongest attriters maintain a large amount of their L1, despite years of disuse (Steinkrauss & Schmid, in press). We can also distinguish a third group of adult second language (L2) learners that maintains use of L1 in various aspects of daily life. Because this group suffers minimally from attrition, we can refer to them as 'late bilinguals'. There are no sharp cutoffs between these three groups; rather they represent various points along a continuum of degree of language attrition. Understanding why a speaker ends up at a given point along this continuum constitutes a further aspect of this puzzle.

2.1.2 Puzzle #2: variation across levels

Both attriters and maintainers show the impact of an increasingly stronger L2 on a somewhat weakened L1. These effects can reveal themselves through the inappropriate use of L2 words, expressions, and structures while speaking an L1. In such cases, we can say that the L1 and the L2 are competing for activation and that the L2 form is used because the L1 form is weaker. There are at least five ways in which this competition can play out.

1. First, intrusion of an L2 form when speaking L1 may arise from problems retrieving the L1 form. If the activation of the L1 form is insufficient, the L2 form will win out in the horse race for activation and production (Ratcliff, 1978). This effect underscores the extent to which L2 remains active, if somewhat repressed, during production of L1.
2. In a related case, the weaker activation of the L1 form can lead to a total failure to recall the required form. In such cases, we see omissions, hesitations, and other disfluencies without actual intrusion of an L2 form.
3. When L1 and L2 share words or constructions, it can happen that both sources of activation support the use of the same form (Tokowicz & MacWhinney, 2005). In such cases, intrusions may be scarcely noticed. This is particularly likely in closely-related languages, such as Norwegian and Danish.
4. In other cases, it may be that the L2 form is slightly more appropriate in the given context than the L1 form. This type of transfer from L2 resembles what we see in cases of lexical insertion during code-switching (Poplack, 1980; Myers-Scotton, 2005) in which a speaker will insert an L2 word into an L1 matrix sentence because it seems like the *mot juste* or most appropriate form in a particular context. It would be a mistake to think of this use of an L2 form as indicative of a weakened L1 alternative.
5. If a speaker's L1 has marked dialect features, the contrast between those features and the features of the standard version of L1 can further complicate the competition between L1 variants and L2. What may appear to be an error in L1 may simply be a reliance on a non-standard form. In some cases, the form in question may derive from an earlier standard L1 form that has now fallen out of use. Such competitions between alternative forms can lead to delays or errors in retrieval.

What complicates matters further is that these alternative forms of competition and transfer work in different ways across the language levels of output phonology, input phonology, lexicon, collocation, syntax, and pragmatics. For output phonology, Schmid (2011a) has shown that maintainers are perceived as having the accent of native speakers, although strong attriters may eventually lose their native accent. We know that second language learners show a type of backward transfer in terms of shifts in the details of their control of phonetic features, such as voice onset time (VOT) for stop consonants (Major, 1992) during the process of L2 learning. The fact that this happens so quickly during early stages of L2 learning is surprising, given the relative resistance of L1 phonology to loss in language attrition. However, the variations that L2 learning forces on L1 phonetics are not so extreme as to push L1 sounds out of the normal range; rather, they represent deviations within the overall range of potential L1 sounds. Basic syntactic patterns also seem resistant to loss during attrition. However, attriters can begin to reduce their use of marked orders and formats, avoiding some of the more complex L1 forms they would have used in earlier years. These adjustments amount to minor losses of L1 forms and fluency (Schmid & Beers Fägersten, 2010). Complete abandonment of L1 syntax under the pressure of L2 learning seems to be minimal, even in strong attriters.

The relative resistance of phonological and syntactic structures to attrition contrasts with greater attrition in vocabulary, idioms, and collocations. There are three theoretical approaches to explaining this contrast. A basic usage-based or frequentist account predicts that the least frequent L1 words should be the ones most subject to L2 intrusion. A further consequence of this would be that the first forms that are lost are also the ones that were learned last during L1 acquisition (Wixted, 2004). However, in a careful study of frequency effects on these intrusions, Schmid (2011a) finds only marginal effects for lexical or collocational frequency. A second account, based on the theory of between-language competition, suggests that intrusions arise from forces such as the appropriateness of the L2 form, contextual support for code-switching, and structural similarities between L1 and L2. A third approach focuses on the contrast between procedural and declarative memory systems (Ullman, 2001c). Here, the idea is that entrenchment operates most strongly for systems such as output phonology and word order patterning that have undergone proceduralization through basal ganglion and striate functioning (Stocco et al., 2010), whereas lexical and collocational patterns that are more responsive to hippocampal consolidation are more susceptible to intrusion. Figuring out which of these three accounts for the contrasting effects of linguistic levels is operative in a given case is a major challenge for studies of language attrition.

2.1.3 Puzzle #3: childhood forgetting

Of the four puzzles related to language attrition, the third is the most perplexing. This puzzle arises from the observation that children who are adopted into a new family in a new country before the age of 8 show a nearly complete loss of the ability to use their L1 (Pallier et al., 2003; Ventureyra et al., 2004). A basic psycholinguistic characterization of the process of entrenchment would predict that this should not happen. If a child is younger than age 4 when coming to a new country, one could argue that their language had not yet fully consolidated and was therefore vulnerable to complete language loss. However, by age 8,

a child will have spent six years making continual daily use of the L1 in fully appropriate social contexts. Based on Bahrick's (1984b) findings regarding the entry of memories into a 'permastore', these children should have thoroughly consolidated or 'overlearned' their L1 by the age of 8. The type of natural learning that children experience is particularly well suited to the development of long-term consolidation (Pashleret al., 2007; Pavlik & Anderson, 2008). Moreover, studies of monolingual first language learners demonstrate entrenchment well before the age of 8. For example, Brooks & Tomasello (1999) showed strong entrenchment effects for item-based patterns in causative constructions in English by age 5. These considerations indicate that late adoptees should retain a significant amount of L1 knowledge in permastore. At the very least, this knowledge should facilitate rapid relearning or recognition of L1 forms (MacLeod, 1988). However, studies of adoptee's L1 relearning during adolescence have provided only weak evidence of any retention of L1 sensitivities, as revealed through somewhat more accurate relearning of some phonetic contrasts (Au et al., 2008; Oh, Au, & Jun, 2010; Oh, Jun, et al., 2003; Park, 2015; Singh et al., 2011). However, even these results may be due to motivational factors, rather than stored memories.

There are two solutions that have been offered to this puzzle of childhood forgetting. The most popular solution is the Critical Period Hypothesis (CPH), which attributes childhood L1 loss to the expiration of a critical period for language acquisition. However, that theory was intended to account for language learning, not language loss. Nonetheless, it might be possible to relate early language loss to neurodevelopmental processes that impact both the ability to learn and the ability to lose a language. For example, declines in susceptibility to loss could be related to increases in the myelination of cortical layers. On this account, a high level of neuronal plasticity facilitates new learning, but also permits quick loss of new patterns.

The theory of Universal Grammar offers a related viewpoint on this issue, particularly as elaborated in terms of 'biolinguistics' (Boeckx & Grohmann, 2007). On this account, L1 learning involves the setting of a series of parameters. Problems with resetting these parameters are supposed to be at the root of difficulties adult learners have acquiring L2. In accord with the CPH, parameter setting by children is labile and incomplete, allowing for reversal and modification during childhood, but not afterwards. The actual neuronal implementation of this version of the CPH account could conceivably rely on the same neuronal mechanisms used to support other accounts based on entrenchment and plasticity.

A second approach focusses changes in the social and emotional supports needed for language maintenance. Pulvermüller & Schumann (1994) argue that first language learning links in more directly to emotional roots than does second language learning. In addition, we need to consider the extent to which adoption and immigration can break off links between language and the original social and experiential contexts to which linguistic forms refer. Moreover, childhood forgetting may arise from the involvement of additional neuronal circuitry supporting changes in attention and motivation. We will consider these two accounts—critical periods vs. abrupt contextual change—in further detail later.

2.1.4 Puzzle #4: catastrophic interference

The fourth and final puzzle derives as a further complication from the third. This puzzle involves the fact that parallel distributed processing (PDP) connectionist models of second language acquisition demonstrate 'catastrophic interference' or complete loss of L1 at the

beginning of learning of a second language. This occurs because L2 knowledge overwrites the connection weights established during L1 learning (Zevin, 2012). The fact that adult maintainers demonstrate minimal language loss argues strongly against models predicting such catastrophic loss. At the same time, developers of these models could point to catastrophic loss in children as evidence in support of their account. There are also other neural network models, such as DevLex (Li et al., 2007) that avoid the problem of catastrophic interference through reliance on learning through self-organizing feature maps. However, those models then have no ready account of the phenomena of language loss by children.

2.2 The Competition Model

Taken together, these four puzzles indicate that no single-process model will be sufficient to account for the observed phenomena in language attrition. A model that combines the mechanism of entrenchment with a model of transfer would come close to explaining some of the puzzles, particularly if it incorporates a theory of differences between linguistic levels. However, a full account of these phenomena will require still further detail regarding social and motivational inputs, contextual changes, internal processing mechanisms for consolidation, and neurological foundations of plasticity and reorganization.

The Competition Model (MacWhinney, 2015b, in press) is designed to provide an integrated approach to these issues, as well as to additional issues in online language processing, first and second language learning, bilingualism, code-switching, and language loss in aphasia. The model holds that language, as a fundamentally biological system, emerges from processes of competition. Like other emergent biological systems, language structure derives from properties and interactions unique to hierarchically organized levels of processing that interoperate across differential timescales. Implications of the emergentist constructs of competition, levels, and timescales are further explored in MacWhinney (2015a).

This view of language structure as emerging from competing motivations (MacWhinney et al., 2014) is based on mechanisms that have been documented by experimental psychology, cognitive linguistics, sociolinguistics, typology, neuroscience, conversation analysis, and social research. However, we do not yet understand how these competing component processes fit together cooperatively into a functional system. This means that use of the model to account for patterns of language attrition requires extensive consideration of the ways in which competing motivations and forces are integrated.

For the study of language attrition, the most important aspects of Competition Model analysis are those relating to the interplay between risk factors and protective factors. Risk factors are forces that operate to reduce smooth language learning and functioning. Support factors are forces that work to promote fluent language functioning. The model specifies the risk factors of entrenchment, transfer, over-analysis, and isolation, and the support factors of resonance, decoupling, chunking, and participation. The processes of over-analysis and chunking apply mostly to the first stages of language acquisition, so we will not consider them here. Let us consider how the other six factors (entrenchment, transfer, isolation, participation, decoupling, and resonance) operate in the case of language attrition.

2.2.1 Entrenchment

The basic unit of Competition Model analysis is the cue. Cues are relations between forms and functions (de Saussure 1915/66). Cues can involve units on any level of linguistic structure—phonology, lexicon, or grammar. If a cue correctly predicts a function during comprehension or selects out the correct expression during production, then it is high in reliability. Competition Model studies (MacWhinney, in press) have shown that, during early stages of language learning, cue frequency or availability is more important than reliability. However, over time, cue reliability becomes the major determinant of cue strength. Cue availability and reliability are estimated through corpus-based counts (McDonald, 1989; Ellis et al., 2015), whereas cue strength is estimated through experimental studies that place different cues into competition (MacWhinney & Bates, 1989). A core finding of these studies is that cue reliability closely predicts cue strength. Like other models that are implemented in the neural network framework, the Competition Model assumes that cues are in continual competition and that this competition is determined through cue strength.

Entrenchment arises from the continual use of a cue. When a cue is reliable, strength is increased; when it is unreliable, strength is decreased (McDonald & Heilenman, 1991). Entrenchment from this process of cue strengthening must play a central role in language maintenance and attrition. However, the four puzzles we have discussed suggest that entrenchment cannot work alone, and that its operation may be quite complex. Recent work in neurobiology has begun to uncover some of the mysteries of entrenchment in sensory areas. Examining the neuronal basis of amblyopia (poor visual acuity) arising from a lazy eye, researchers (Takesian & Hensch, 2013) have demonstrated an interplay between five neurobiological forces that lead to the entrenchment of a cortical region and those that can reopen that area for new learning.

1. Initial brakes. Before the onset of entrenchment, the polysialic acid / neural cell adhesion molecule (PSA-NCAM) prevents the opening of a cortical area to learning.
2. Triggers. A sensitive period opens when molecular triggers (such as orthodenticle homeobox 2, BDNF)—in response to sensory input—promote parvalbumin (PV) cell maturation, turning on GABA (gamma-aminobutyric acid) circuit functioning. GABA circuit maturation may operate by suppressing responses to intrinsic activity, allowing a focus on extrinsic input (Sale et al. 2007; Van Versendaal et al., 2012; Toyoizumi et al., 2013).
3. Learning. Learning then involves physical pruning and homeostatic regrowth of synapses by tPA, TNFα, and protein synthesis.
4. Terminal brakes. A consolidated or entrenched state is maintained by the production of functional molecular brakes, such as Lynx1 and NgR1, and physical brakes such as PNN and myelin, which may limit plasticity by preventing further structural changes. These brakes rely on the same processes that created changes during the plastic period, essentially preserving these changes.
5. Reopeners. The reopening of cortical areas to new inputs can be achieved by lifting the brakes through epigenetic manipulation (HDAC inhibitors) or heightened attention (neuromodulators such as 5-HT, Ach, NE).

The operation of this system of excitation and inhibition across sensory levels varies based on the timing of maturation of the PV cells that trigger the opening of the learning

period. The variability in these distributions of PV cells could help us understand variations in entrenchment and maintenance across language levels. Because entrenchment can be reversed through attentional processes, we should think of this system as one supporting variable entrenchment, rather than an irreversible critical period. We should also note that research to date has focused on the operation of these brakes and reopeners in sensory systems. How they operate in motor areas and higher cortical regions is not yet clear, although the neurobiological components are common across areas.

2.2.2 Transfer

Entrenchment constitutes a risk factor for L2 learning, because it restricts the availability of cortical areas for new learning, forcing the learner to engage in transfer of L1 forms to L2. At the same time, entrenchment serves as a protective factor promoting L1 maintenance, as opposed to L1 loss. However, once L2 has become established as the primary means of daily communication, transfer from an increasingly stronger L2 to L1 begins to operate against the forces of L1 entrenchment.

Because of the emphasis it places on interactive activation, the Competition Model holds that, for initial L2 learning, 'everything that can transfer will'. In the domain of phonology, whenever an L1 phoneme can be mapped onto an L2 sound, learners will attempt to transfer that form and slowly correct for the inevitable mismatch. For lexicon, the meanings of L1 words will transfer, although the sounds typically will not. In morphology, transfer is seldom possible except between closely-related languages. In syntax, transfer will impact collocations and even basic word order. In each of these areas, what will transfer from L1 is the unmarked pattern. Studies of transfer in L2 learning largely support these predictions. There is evidence that they also apply to language attrition, as an increasingly stronger L2 begins to transfer patterns to L1. For example, Tóth (2007) compiled an inventory of transfer patterns in Hungarian and German L1 speakers in the San Francisco Bay Area. He could identify an L2 English source for each erroneous form he observed. The patterns of language transfer found in such studies also closely resemble those reported in cases of simultaneous childhood bilingualism (Döpke, 1998, 2000; Yip & Matthews, 2007).

Looking in greater detail at areas of particular susceptibility to transfer, some studies (Seliger, 1989; Ribbert & Kuiken, 2010) have suggested that transfer is particularly strong in areas where uses of an L1 form constitute a subset of uses of a similar, but more general, L2 form. This finding is in accord with the Competition Model expectation that the degree of interference from L2 to L1 will depend on the closeness of the mapping, as well as the markedness of forms in L1 and L2 (Eckman, 1977, 2011).

Because of its emphasis on competition, interaction, and variation, the Competition Model also predicts back transfer from L2 to L1, as well as partial merger of grammar in certain areas. Such effects have been observed for syntactic structure (Liu et al., 1992; Dussias, 2004; Dussias & Sagarra, 2007), lexicon (Malt et al., 2015), and phonology (Major, 1992; Mennen, 2004), sometimes arising after only a few weeks of exposure to L2 (Chang, 2012). Thus, when studying speakers of two or more languages, we must always keep in mind the possibility that there will be dynamic interactions between the languages (Cook, 2003a). However, such interactions do not, in themselves, constitute full language attrition.

2.2.3 Participation, isolation, and identity

For successful L2 learning, the single greatest protective factor is the ability to participate actively in L2 social groups without having to rely on switches to L1. Conversely, the greatest risk factor for L2 learners is the threat of isolation from L2 groups. De Bot & Clyne (1989, 1994) have described situations in which immigrants give up on attempting to integrate with the L2 community and revert to reliance on L1. However, there are also cases in which immigrants integrate so thoroughly with the L2 community that they cease daily use of L1. This is the situation that gives rise to Puzzle #2 regarding the maintenance of an unused L1 in permastore.

Schmid (2002) conducted an examination of attrition effects in Jews who escaped to Anglophone countries from Germany between early adolescence and young adulthood at various times during the Fascist pogroms. If they escaped before the onset of the racial discrimination laws, these people tended to maintain a high level of functional use of German, along with a basic acceptance of their German heritage. However, people who escaped after the November 1938 pogrom and the beginnings of deportations tended to reject their German language and heritage. Schmid found that the single best predictor of degree of language attrition in this group was the time of leaving Germany. Although this is an extreme case, it still serves to reveal the importance of fundamental cultural identification as either a risk or protective factor for language maintenance.

There are two ways in which cultural identity can play out on a daily level. For those who have decided to reject their L1 identity, there can be active suppression of L1 words and thoughts. This type of suppression of L1 can be accompanied by enthusiastic use of new L2 forms both in conversation and in inner speech, formulation, and planning. The other way in which cultural identity can play out in everyday life is through the organization of activities in L1 and L2. Schmid (2011a) reports that ongoing use of L1 in a professional context is a good predictor of a minimal level of L1 attrition. For example, the need to use L1 for translation or writing requires ongoing attention to correct use of L1 forms. Conversely, if L1 usage is confined to less demanding environments such as the home or if it is being used in code-switched interactions, then relatively more attrition will occur.

The link between identity and language maintenance may also help us understand Puzzle #3 regarding children's forgetting of L1. For many adoptees, life in the L1 setting may have been relatively unstable and harsh. Moreover, the new L2 environment provides little support for or even recognition of L1. Because of this, adoptees may have also decided to actively repress their L1. Burling (1959) presents a rather poignant case of this type. During a two-year-long field trip in the hills of Myanmar, his son acquired Garo and English simultaneously. On the airplane flight home to the States, the 3-year-old boy attempted to speak to the flight attendant in Garo and she only replied in English. After that, he never used a word of Garo again.

2.2.4 Resonance

In second language learning, the effects of L1 entrenchment can be countered through the process of resonance. This process is supported by resonant connections between the hippocampus and cortical areas, leading to the consolidation of memories and linkages

in the cortex. The hippocampus has connections to all cortical areas, each arranged in distinct subareas. When a new experience or episode is encountered, the hippocampus uses these connections to maintain an ongoing interaction or conversation with these cortical areas. This is not a one-shot activation of the cortex, but a process of ongoing maintenance of cortical activity (Nadel et al., 2000) through reentrant connections (Wittenberg et al., 2002).

These patterns of activation go beyond mere consolidation of individual episodes. Relying on additional control from medial prefrontal areas, the consolidation process can link new experiences with old concepts into increasingly rich conceptual networks (Schlichting et al., 2014; Zeithamova et al., 2012). This method of building up new relational networks from new experiences can be particularly important for consolidation of language structures such as words and collocations, as specified in the Competition Model theory of learning from item-based patterns (MacWhinney, 2014). For people who are trying to maintain their L1 in an L2 environment, resonance can rely both on continued L1 input from conversation and reading, as well as internal use of L1 for formulation and planning. Resonance can operate both passively and actively. Its passive operation can be detected during rest (Karni & Sagi, 1995) and sleep (Lindsay & Gaskell, 2010). Its active function arises when learners use orthography to activate phonology (Share, 1995) or when they derive word meanings from analysis of derivational and inflectional patterns (Presson et al., 2013).

There is also a second form of consolidation that is important for motor and sequential procedures. This system utilizes frontal-striatal and basal ganglion structures (thalamus, striatum, cingulate, precuneus, substantia nigra, globus pallidus) in coordination with the cerebellum to coordinate and proceduralize smoothly functioning action sequences for speech and syntax (Graybiel, 1998; Hinaut & Dominey, 2013). Although attriters may have developed these patterns in earlier years, they may need to reactivate these processes to maintain fluency.

These two systems for resonant consolidation allow the language learner to avoid the potential problem of catastrophic interference. Although the L1 and L2 may share some phonological and semantic resources, the connections between linguistic elements are structured to maintain a separate pattern of connectivity, even if they reside in neighbouring areas of the cortex.

The role of resonance in language learning helps us understand Puzzle #3 and the problems faced by international adoptees. During their first years of language learning, all children work intensely on the learning of systems for audition and motor planning. These systems rely on statistical learning (Thiessen & Erickson, 2015), rather than resonance, for consolidation. These are the systems that show the clearest entrenchment during L1 learning. On the other hand, resonance is centrally involved in the learning of the higher linguistic levels of lexicon, morphology, collocation, syntax, clause combination, narrative, dialogue, and discourse. Learning on these levels requires support from resonant connections based on episodic encounters with objects, events, and situations. For the youngest learners, these connections depend heavily on direct support from specific situations, people, and objects. Later, as children start to rely increasingly on inner speech, language forms resonate more and more with one another independent of the environmental context. For example, 3- and 4-year-olds can recite only a few short songs, but when they are a few years older they will repeat much longer songs with ease.

If a child is removed from the original language context before being able to make extensive internal resonant connections, their L1 will be missing the crucial match to the situational context that it needs for support. The result of this rapid and forced environmental change is a type of linguistic amnesia that impacts systems depending on resonance more than systems depending on statistical learning.

Resonance may also be involved in the phenomenon of permastore. Bahrick (1984b) emphasized the fact that his subjects made minimal use of Spanish after the end of their courses in college. However, because these forms were learned through internal resonant processes initially, rather than through direct contact with environmental experiences, there may have been enough ongoing resonant links between these forms and other L1 forms to show evidence of retention even decades later.

2.2.5 Decoupling

Successful second language learning depends on the decoupling of L2 from its dependence on L1 (Kroll et al., 2010). To the degree that a speaker can use resonance to construct each language as a (partially) separately activated neural circuit, the effects of transfer can be minimized. To achieve decoupling, an L2 learner must combine inhibition of L1 with resonant activation of L2. In addition to the underlying cognitive processing involved in resonance, learners and maintainers may need to establish social and attitudinal methods for decoupling their two languages. If use of L1 can be localized to contexts that require minimal competition with L2, there can be greater decoupling and maintenance of the two systems. At this point, the second language learner is functioning in a more truly bilingual fashion.

The fact that lexical semantics and idiomatic expressions are particularly subject to intrusion from L2 can be related to the fact that L2 learning relies so heavily on L1 resources in this area. In effect, the two languages derive their meanings from similar experiences in the world. However, even here, careful use of resonance and decoupling can pull apart forms based on fine-grained distinctions.

Phonological processes must also involve shared resources between L1 and L2. However, in this case, L1 has experienced earlier consolidation through the fronto-striatal procedduralization system and fine-tuning involves the development of recombinations of these gestures to support L2.

2.3 Conclusions

Language is a dynamic, emergent system (Van Geert & Verspoor, 2015), grounded on complex inputs from biology and society. As such, we should not be surprised that theories of language acquisition and loss must refer to a wide range of processes to understand language patterning across individuals, groups, language levels, and language change. To solve the four puzzles involved in language attrition, we need to refer to various combinations of these processes. The conclusions we reach here are very close to those developed in Steinkrauss & Schmid (in press).

Entrenchment is certainly involved in the initial consolidation of L1. However, as we now know, entrenchment is not irreversible. If life events force a person to abandon their L1, they can avoid use of that language, emphasize decoupling and resonance in L2, and actively suppress internal use of L1. This type of abandonment of L1 is most easily achieved by young learners of L2. For them, higher linguistic levels are particularly vulnerable to the loss of specific contextual supports for the L1 world.

Speakers who do not seek to abandon their L1 will still need to deal with the pressures of transfer from an increasingly robust L2. The exact nature of these transfer phenomena depends on the strength and accessibility of the L1 pattern, as well as the nature of the match between L1 and L2.

Because learners can make use of resonant connections to decouple L1 from L2, they can avoid the problem of catastrophic interference. In effect, each language becomes a separate functional circuit, while still sharing common resources at the level of articulatory output and semantic reference. Because it is difficult to fully decouple languages at these levels, they remain susceptible to at least some transfer from L2 or L1-L2 merger.

By comparing the processes determining the shape of language attrition with those involved in L1 and L2 acquisition, as well as language loss in aphasia and dementia, we can gain an increasingly deeper understanding of the emergent structure of human language.