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VARIABLES IN SECOND LANGUAGE ATTRITION

Advancing the State of the Art

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This article provides a comprehensive synthesis of research on language attrition to date, with a view to establishing a theoretically sound basis for future research in the domain of second language (L2) attrition. We identify the variables that must be tracked in populations who experience language loss, and we develop a general model for the assessment of the processes involved. This critical review suggests that future research in this domain should establish baselines for attainment against which to measure attrition, and that learners must be compared to themselves in longitudinal designs that involve periodic assessment of both linguistic and extralinguistic factors. In the proposed model, populations are defined as sets of variables, which are subject to change following shifts in discrete time periods in the general process of acquisition and attrition. A working model is elaborated for the assessment of L2 attrition and retention, which, we hope, might encourage additional work in this area.

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In this review, we outline the main issues in the literature on language attrition. We include first language (L1) attrition as well as second language (L2) attrition in order to establish the general parameters of attrition and retention. *Language attrition* may refer to loss of language as a result of contact with majority languages, loss of language by communities, or loss of language by individuals in both pathological and nonpathological settings. The goal is to identify factors, states, and outcomes relevant to the nonpathological loss of language competence and performance in individuals who have learned a L2 and to elaborate a model for the assessment of L2 attrition and retention.

Research on L2 attrition can trace its origins as a recognized subfield of SLA to a landmark conference on the loss of language skills held at the University of Pennsylvania in 1980, selected papers from which were subsequently published by Lambert and Freed (1982). In this volume, Lambert (1982) made a notable distinction between criterion variables and predictor variables in language attrition. Henceforth, we will refer to this distinction in terms of linguistic and extralinguistic variables, respectively. Linguistic variables subsume factors such as lexical and morphosyntactic influence from the dominant language, frequency of input, loss of morphological complexity, and a reduction in registers of use, whereas extralinguistic variables include the age of the learners, the length of time without input, and motivation for language maintenance. Both sets of variables come into play in the elaboration of a theoretical model of language attrition and are relevant for the design of materials for language maintenance. Similarly, hypotheses proposed to explain the nature of language attrition may be divided into linguistic and extralinguistic hypotheses. Given the importance of both types of variables, it is implausible that a single hypothesis could lead to a comprehensive understanding of the phenomenon; rather, to understand the processes that take place, it is necessary to develop a multifaceted approach.

Whether focusing on linguistic or extralinguistic aspects, research on L2 loss has generally followed ideas first proposed for L1 attrition. Therefore, this review begins by outlining the most prominent general hypotheses of native language loss.[1] The most recent contributions to this debate are of particular interest, because they document a significant refinement of investigative techniques and a partial resolution of that most contentious of issues: whether language attrition involves total loss of linguistic representations from the brain or whether the problem is one of access to and restimulation of such representations. Attention then turns to studies specifically focusing on L2 attrition.[2] Overviews are provided of the hypotheses in play, research designs, measures that have been used to evaluate the data, generally agreed-upon findings, and the variables by which populations may be defined. Finally, the range of possible acquisition and attrition processes in very

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different populations is considered, and a general model for the assessment of language loss and retention is elaborated.

L1 ATTRITION STUDIES

General Hypotheses Concerning the Nature of L1 Attrition

Schmid (2002) and Köpke and Schmid (2004) provided overviews of the general hypotheses that have been proposed for L1 attrition, most of which have subsequently been applied to L2 attrition. However, the majority of studies in both traditions over the last 30 years have adopted a somewhat programmatic tone, looking to future research to determine the nature of attrition rather than rigorously testing hypotheses. We discuss six such proposals that we will term the *regression hypothesis*, the *threshold hypothesis*, the *interference hypothesis*, the *simplification hypothesis*, the *markedness hypothesis*, and the *dormant language hypothesis*.

The regression hypothesis holds that the path of attrition is the mirror image of the path of acquisition. What is learned earlier is maintained longer, and what is learned later is more prone to rapid attrition; this is also referred to as *first in, last out*. This proposal is also the oldest, set out for the first time by Ribot in the 1880s and later advocated by Freud, specifically in relation to language loss in cases of aphasia, and by Jacobson in terms of the acquisition and attrition of phonology (de Bot & Weltens, 1991). Although it is now generally agreed that this account is not applicable to aphasia (Berko-Gleason, 1982; Caramazza & Zurif, 1978), certain influential articles have tentatively proposed that this may be an insightful account of L1 attrition (Andersen, 1982; Berko-Gleason; Seliger, 1991). However, these studies do not investigate the matter empirically, and a review of the literature reveals that there is very little evidence for this surprisingly durable and widely held hypothesis. For example, Jordens, de Bot, and Trapman (1989) studied German case-marking, because this phenomenon "meets the conditions of gradualness and a more or less fixed order of acquisition" (p. 180). They found no evidence that the sequence of L1 attrition mirrors the sequence of acquisition, although they cautiously suggested that L2 attrition may follow this pattern. Similarly, Håkansson's (1995) study of syntax and morphology in the language of expatriate Swedes revealed stages of attrition that did not correspond to any known stage of the acquisition of Swedish.

Apart from a general lack of empirical support, there are also theoretical reasons to doubt the validity of this hypothesis. When Schmid (2002) attempted to tie the regression hypothesis to Chomskyan nativism, such that attrition is the reversal of an innately specified

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sequence of autonomous linguistic development, there is arguably a misconception of how generative linguists view both L1 and L2 acquisition. Although it is true that there were several early attempts to characterize developmental sequences in terms of innate orderings (Bailey, Madden, & Krashen, 1974; Brown, 1973; Dulay & Burt, 1973, 1974; Makino, 1980), such morpheme-order studies are more often used in generative linguistics as cautionary tales (see textbook treatments such as Gass & Selinker, 2008, and Hawkins, 2001). It is not the case that any current proponent of the role of Universal Grammar (UG) in SLA believes that UG actually specifies sequences of development of either morphemes or constructions. Once abstract principles are acquired, control of actual forms depends on much that is acquired piecemeal, such as specifications in lexical entries, and is subject to processing constraints (Lardiere, 2006; Prévost & White, 2000).

A related hypothesis is that what is least vulnerable to language loss is not what is learned first but what is learned best, an important notion being frequency of reinforcement (Berko-Gleason, 1982; Jordens, de Bot, Van Os, & Schumans, 1986; Lambert, 1989). If a certain threshold of use is achieved, a representation may be less susceptible to or even immune from attrition. We use the general term *threshold hypothesis* to cover various proposals in this vein, including the neurolinguistically based activation threshold hypothesis discussed by Paradis (2007) and the more general critical threshold hypothesis (Neisser, 1984). The activation threshold hypothesis stems from research with aphasic patients, for whom the facility of reactivation of linguistic representations has been shown to be at least partly dependent on frequency of use prior to brain damage (Paradis, 2004): The higher the activation threshold, the greater the number of activating impulses needed to reactivate the representation. The critical threshold hypothesis is a much broader notion that has had considerable impact in the field of L2 attrition. Neisser suggested that there might be a general critical threshold during learning after which linguistic knowledge becomes permanent, citing as evidence Bahrick's (1984a) report on language retention in L2 learners of Spanish even after 25 years of nonuse.

The threshold hypothesis is intriguing but is inherently flawed as a general hypothesis of attrition in several respects. First, Paradis (2007) admitted that linguistic subsystems sustained by declarative memory, such as the lexicon, appear to be much more vulnerable to frequency effects than those sustained by procedural memory, including the core linguistic systems of syntax and phonology, and, as such, this hypothesis is not necessarily relevant to the attrition of grammar. This observation is to be expected from the perspective of language acquisition theory, which, by and large, has eschewed the stimulus-reinforcement accounts typical of behaviorist psychology, at least as applied to grammatical knowledge, in the wake of Chomsky's (1959) pivotal critique.

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A related issue is that, in cases of L1 attrition beyond early childhood, principles of syntax and phonology have been acquired to a level at which production is perfect and consistent; however, such principles are still subject to attrition. These objections aside, types of linguistic knowledge that involve domain-general information, such as the lexicon or principles of pragmatics, may conceivably be more susceptible to frequency effects. Even if restricted to such areas of the language faculty, this hypothesis is in need of much greater refinement before being rendered truly testable. Another general issue with the idea of a threshold for attrition is that unless it is established how well a particular rule or representation had been acquired prior to attrition, testing for retention is all but impossible.

The interference hypothesis holds that attrition is directly due to the increasing influence of the newly dominant, competing language. This proposal has also been called the interlanguage hypothesis or the cross-linguistic influence hypothesis (Köpke & Schmid, 2004), but such terms are easily confused with very different hypotheses in the SLA literature. Given what is known about transfer in SLA and bilingualism, it is likely to be true to some degree and it has been advocated by many researchers (e.g., Altenberg, 1991; Grosjean & Py, 1991; Kaufman & Aronoff, 1991; Köpke, 1999; Pavlenko, 2004). In one version of this proposal, Seliger (1991) suggested that after a period without L1 input, learners could unconsciously process L2 input as a kind of indirect positive evidence, which causes them to replace those more complex L1 rules with simpler L2 rules in cases in which the two sets of rules have a similar semantic function. However, this is one of many hypotheses in the attrition literature whose potential interest lies in experiments that have not yet been conducted.

Another idea associated with this general hypothesis is that similarity between the L1 and the L2 is a condition for transfer (Andersen, 1983). In her study of the L1 attrition of German in the context of L2 English, Altenberg (1991) found plural allomorphs to be more severely affected than gender-marking, and she suggested that gender was less affected because this category was not subject to influence from English. This notion of attrition brought on by transfer in cases of similarity dovetails neatly with one avenue of research on SLA, which suggests that, at least in certain areas of language, one can predict difficulty of acquisition based on similarity between forms and rules (Best, 1995; Flege, 1995). Despite the controversy generated by this approach, most researchers would agree that the coexistence of languages in the mind leads to particular grammatical conflicts, and it seems eminently plausible to suppose that interference in L1 attrition might mirror transfer in SLA.

In another approach that emphasizes interference, Pavlenko (2004) and Isurin (2007) have argued that increased exposure to a L2 is likely to involve influence on the L1 and that such influence is not necessarily

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indicative of attrition. Both consider their work to be in line with Cook's (1991) view of L2 users as having a uniquely blended linguistic knowledge that he terms *multicompetence*. Despite the merits of this framework and although effects of knowledge of the dominant language will no doubt be visible during the process of attrition, few would consider that language interference is able to provide a comprehensive account of attrition. Certain aspects of language breakdown appear to unfold according to principles internal to the attrition process and irrespective of the particular competing language, a theme taken up by the next proposal.

The simplification hypothesis is not a hypothesis as such but a catch-all term used to refer to a number of processes that all appear to occur in situations of prolonged lack of input, in cases of both L1 and L2 attrition. One such process is the simplification of morphology: Vulnerable aspects of morphology include agreement markers, case systems, and allomorphic variation (Andersen, 1982; Maher, 1991). Another is the loss of register control: Language attrition often occurs in situations in which the uses of the language are restricted, and there is often a concomitant attrition of unused registers (Andersen; Maher). It is clear that these phenomena are, to some degree, independent of language transfer and require independent explanation; yet, different hypotheses are still required to explain such phenomena as well as their susceptibility to attrition and their particular sequences of breakdown.

What we term the markedness hypothesis is referred to by Schmid (2002) as the parameter hypothesis and is one of several ideas presented by Köpke and Schmid (2004) as the UG hypothesis. The latter term is somewhat misleading, because researchers who assume a role for UG could adopt any number of other hypotheses of attrition and still not subscribe to the hypothesis described here. Håkansson (1995) and Sharwood Smith (1989) suggested that the process of L1 attrition could involve the unmarking of parameters that have been set to marked values; that is, on the assumption that parameters have a default setting, they will revert to this setting given prolonged lack of input. In contrast, it has also been proposed by Sharwood Smith and Van Buren (1991) that marked values of parameters will have the opposite effect: As parameter settings are governed by input and attrition is characterized by lack of input, marked values should persist. The most cited study as evidence for the markedness hypothesis is Håkansson's. However, just as her work found no support for the regression hypothesis, it does not seem to support the markedness hypothesis either. The frequency with which the markedness hypothesis is cited is out of proportion to the number of empirical investigations devoted to it. Given the lack of enthusiasm for theories of parameter-markedness beyond the 1980s in principles and parameters theory (see Guasti, 2002, for a series of critiques), it is unlikely that this approach will be pursued further in the absence of a general shift in the theory of UG.

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The dormant language hypothesis differs from the other hypotheses in that it has been subject to more rigorous definition and more controlled empirical evaluation. Several teams of attrition researchers have attempted to establish whether the end point of attrition is the complete loss of particular kinds of linguistic knowledge or whether vestiges remain in the mind, such that the problem is one of difficulty of access. Earlier research in the debate over loss of representations or loss of access provided interesting but inconclusive findings. Several studies highlighted the dramatic nature of L1 attrition in childhood. For example, Kaufman and Aronoff (1991) observed drastic lexical and morphological attrition of L1 Hebrew in a child who had emigrated to the United States from Israel just a few months earlier, at age 2;6. In another case, Nicoladis and Grabois (2002) studied the simultaneous loss of Cantonese and acquisition of English in a young Chinese girl adopted by an English-speaking family in Canada, at age 17 months. Interactions with native Cantonese speakers over the 3 months following the child's arrival revealed a rapid loss in both production and comprehension of this language by the child. However, other studies point to the possibility of retrieval following cases of language loss in situations of relearning. In one early study, Tees and Werker (1984) investigated English-speaking adults who had been regularly exposed to Hindi during the first few years of life and who were relearning this language in adulthood. Ten early-exposure learners of Hindi and 18 first-time learners of Hindi were tested on a category-change discrimination task that involved a retroflex-dental contrast characteristic of Hindi. The early-exposed participants showed an advantage in the discrimination of the contrast compared to the first-time learners of Hindi. Similar observations are reported by Ammerlaan (1996), de Bot (1996), and Köpke (1999).

More recently, the loss versus access controversy has become a major topic of conference debate and empirical research following a series of controversial findings by Pallier et al. (2003), in which event-related brain imaging technology was used to reveal apparent erasure of all traces of L1 knowledge after a prolonged period of total lack of exposure, even when the attrition process did not begin until the age of 8 or 9 years. The potential importance of these findings is such that they merit closer inspection.

Language Lost or Language Mislaid? The Contemporary Debate on Attrition and Retention

Pallier and his colleagues have produced dramatic evidence from both functional magnetic resonance imaging (fMRI) studies and phoneme

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discrimination tasks that a L1 can apparently be erased from the brain after long periods with no input (Pallier, 2007; Pallier et al., 2003; Ventureyra & Pallier, 2004; Ventureyra, Pallier, & Yoo, 2004). According to one interpretation of these results, prolonged lack of input results in total language loss. In a contrasting set of findings, Footnick (2007) produced new evidence to corroborate long-standing observations that knowledge of a forgotten childhood language can be reawakened using techniques of age-regression hypnosis. Also in apparent contrast to Pallier's results, Oh and her colleagues have produced a series of articles that investigated situations of reexposure after long periods of lack of language input (Au, Knightly, Jun, & Oh, 2002; Oh, Au, & Jun, 2009; Oh, Jun, Knightly, & Au, 2003) that point to lasting knowledge of the L1 and suggest that the lack of evidence in fMRI studies is due to the dormant nature of linguistic knowledge following attrition. Given the importance of the debate over whether attrition involves erasure of knowledge or difficulty of access, we will examine these three avenues of investigation in further detail.

Drastic Attrition Following Childhood Adoption

The research conducted by Pallier et al. (2003) was designed to address certain aspects of the critical period hypothesis (Lenneberg, 1967). The usual interpretation of this hypothesis is that the capacity to acquire languages disappears or declines with maturation (Birdsong, 1999; Herschensohn, 2007). As a corollary of this hypothesis, it is commonly inferred that exposure to the L1 should leave long-lasting traces in the neural circuits that subserve language processing. Pallier et al. set out to discover what might remain of native language knowledge in people who had been adopted as children and who had experienced sudden and definitive isolation from their native language. The study population comprised eight adult Koreans whose age of adoption by families in France varied from 3 to 8 years old. They all claimed to have completely forgotten their native language, which is a typical self-assessment in such circumstances (Maury, 1999). A control group consisted of eight native monolingual French speakers who had had no exposure to any Asian language.

In a language identification task, participants listened to sentences in Korean, Japanese, Polish, Swedish, and Wolof and had to decide whether the sentences were Korean: The native Koreans failed to recognize sentences as even being Korean, and an ANOVA indicated that their performance was essentially the same as that of the French participants. In a word recognition task, participants had to decide which of two aurally presented Korean words was the correct translation of a written French

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word displayed on a screen: The Koreans were again indistinguishable from the monolingual French speakers (56% and 52% accuracy, respectively). In a speech segment detection task, participants listened to sentences in French, Korean, Japanese, and Polish, followed 500 ms later by a speech fragment. The participants were asked to indicate whether this fragment had appeared in the sentence. The main purpose of this task was to ensure that participants paid attention to the sentences while brain imaging was performed using event-related fMRI, so as to detect patterns of brain activity as they processed the stimuli. Both Korean and control participants showed better performance for the only language that they could understand (French) than for the other three languages, and performance did not differ significantly between the two groups. The analyses of the fMRI data showed no detectable difference for either participant group in processing Korean or Polish sentences. In sum, the adoptees' performance on all three tasks appears to confirm their claim to have lost all knowledge of their L1, such that their brains treated input from the attrited language in the same way as input from a language never encountered.

Following this avenue of research, Ventureyra et al. (2004) designed an experiment to test for more subtle remnants of native language knowledge in the minds of Korean adoptees in France. The participants comprised 18 Korean adoptees whose age of adoption varied from 3 to 9 years old and whose reexposure to Korean had been minimal. There were two control groups that consisted of native speakers of French and Korean, respectively. The study focused on language-particular phonemic contrasts, known to be acquired very early across languages, which, in this case, involved a three-way contrast among tense, plain, and aspirated forms of Korean voiceless stop consonants /p, t, k/ and a two-way contrast between tense and plain /s/. A phoneme discrimination task was administered in which the participants were required to determine whether two pseudowords were identical. The Korean controls behaved very differently from the other two groups, but there were no significant differences between the adoptees and the French control group. Ventureyra et al. concluded that "the Korean adoptees have become like native French speakers in their perception of Korean consonants, and quite unlike native Koreans" (p. 87). These results thus corroborate the evidence from the brain-imaging study reported in Pallier et al. (2003) and suggest that all traces of a native language may be eradicated from the mind after a long period of complete lack of exposure.

The most radical conclusion one could draw from these studies is that, in the absence of continued input, not a trace of the L1 remains in the brain. However, it must be borne in mind that, in some ways, fMRI is a rather blunt instrument for measuring knowledge of language. If such knowledge is essentially dormant, then patterns of blood flow in the

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cerebral cortex during exposure to input may not be indicative of language loss but of a lack of active processing of language. In the conclusion of their article, Pallier et al. (2003) admitted the possibility that there remain "implicit unconscious traces at the level of the microcircuitry of the language processing areas" that fMRI is unable to detect (p. 159). They suggested that the existence of such traces might be tested by means of a (re)learning paradigm: Perhaps participants like the adoptees in the Pallier et al. study would be able to acquire Korean faster and more efficiently than control participants if they were to start as beginners in a Korean language program. Similarly, it remains to be seen if the Korean adoptees in the study by Ventureyra et al. (2004) might have an advantage in a situation of relearning. It is noteworthy that one individual, who had revisited Korean for several months prior to the study, performed at 80% accuracy on the tense-aspirated contrast. Not enough is known about the type of input such participants were exposed to during the period of attrition, and no assessment exists of their level of knowledge before and after periods of reexposure, so observations on the effects of reexposure on such participants is purely speculative. The conclusions of Pallier et al. and Ventureyra et al. contrast with two other types of recent evidence that suggest that previous knowledge of language confers an advantage in situations of relearning. The first, more controversial type of evidence comes from studies of age-regression hypnosis, and the second comes from studies of heritage language learners. We consider each in turn.

Reactivation of Dormant Linguistic Knowledge Under Hypnosis

Footnick (2007) argued that both L1 and L2 knowledge acquired in childhood and subsequently forgotten can be made accessible by means of age-regression hypnosis. She cited two early studies that provide a sense of this phenomenon but also convey the lack of linguistic sophistication in previous research in this field. As (1962) presented the case of an 18-year-old Swedish-born American who had reportedly not spoken any Swedish since he was 7 years old. The boy's ability to comprehend and produce his attrited language was significantly higher during hypnosis. In the other cited case, Fromm (1970) described how a 26-year-old Japanese-American with no apparent knowledge of Japanese was age-regressed to 3 years old, whereupon he began to speak rapidly in Japanese without any prompting. Subsequent translation of the transcript revealed that the participant had been placed in a relocation camp with his family during World War II, where, from the age of 1 to 4, he had spoken Japanese. Footnick investigated a 21-year-old university student born in Paris to Togolese parents who spoke only French. From

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age 2 to 6, he had lived with his grandmother in Togo and spoken Mina. When the participant was age-regressed in 6 monthly sessions to 4 or 5 years old, he engaged in both free conversation and question-and-answer routines in Mina. By the end of the study, he had recovered some ability to understand and produce Mina out of hypnosis.

Although the hypnosis studies are intriguing, several important aspects of experimentation render the evidence ultimately unconvincing. Knowledge of language was not really tested for, except by means of general notions such as the ability to converse and to understand questions. There was no examination of syntax, morphology, phonology, or the lexicon. Additionally, in each case the extent of the participants' exposure to the relevant language during the period of attrition is essentially unknown. It is quite conceivable that As's (1962) participant was exposed to his mother speaking her own language either with Swedish relatives or in the community and that Fromm's (1970) participant was similarly exposed to his parents' language. Footnick (2007) reported that although the participant in her study had not spoken Mina since the age of 6, he had been exposed to it during family gatherings throughout his life. One cannot assess the degree of recovery if previous levels of acquisition, the quality and quantity of continued input, and the degree of attrition all remain undocumented.

Relearning a Childhood Language in Adulthood

A second line of research that argues against the extreme interpretation of the eradication of native language knowledge involves the performance in formal instruction by two groups of learners: those who have been exposed to a language in early childhood and their classmates who have not (Au et al., 2002; Oh et al., 2003, 2009). Such studies of relearning have focused on either perception or production of L2 phonology. Au et al. specifically addressed the question of whether overhearing a language in early childhood gave adult learners an advantage over those who had not been significantly exposed to the language until after puberty. At the time of the study, the participants were learners of Spanish at a university in Los Angeles. One learner group had been exposed to several hours of Spanish per week for at least 3 years between birth and age 6. The exposure to Spanish became less frequent thereafter, until age 14, when the participants started receiving formal Spanish instruction in high school. The other learner group had had no input until starting Spanish classes in high school at 14 years old. The participants' pronunciation of Spanish was evaluated by analyzing voice onset time for the stop consonants /p, t, k/, which is typically shorter in Spanish than in English, and lenition of the voiced stops

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/b, d, g/ between vowels. Native-speaker ratings of the target consonants showed that, across the board, the early-exposed participants performed in a more Spanish-like fashion than the late L2 learners.

In a related investigation, Oh et al. (2003) studied three groups of students of Korean at a university in Los Angeles. There were 15 childhood speakers, 6 childhood overhearers, none of whom had spoken Korean other than isolated words and phrases after the age of 6 years old, 10 novice learners of Korean, and 12 native speakers. Both the early-exposed participants and the novice learners were enrolled in first-year university Korean language classes and were tested after 4 months of instruction. The targeted aspect of phonology was the three-way contrast studied by Ventureyra et al. (2004)—that is, plain, aspirated, and tense consonants (e.g., /t/, /t^h/, and /t'/). The childhood speakers and overhearers were better than first-time learners and performed similarly to native Koreans on a phoneme perception task, but only the childhood speakers reliably contrasted all three consonants on a phoneme perception task.

As noted by Ventureyra et al. (2004) and Pallier (2007), the participants in these relearning studies differed fundamentally from those in the adoptee studies, as the adult relearners had had some degree of continued exposure to the relevant language throughout their childhood and teenage years, whereas the adoptees had none. Thus, it is not straightforward to compare the apparently contradictory results of the relearning studies and the adoptee studies. Additionally, levels of knowledge before the period of attrition and immediately prior to relearning are undocumented. Detailed linguistic assessment does not begin until after the presumed attrition has already taken place. Levels of prior knowledge are approximated by self-report or informal family reports (Au et al., 2002). Moreover, the multilingual environment of Los Angeles does not compare experimentally to the monolingual situation of the Korean adoptees prior to adoption. We cannot know if the childhood overhearers of Spanish or Korean were sensitive to the relevant contrasts in their early years. Additionally, given that advantages in perception indeed emerged in the experiments, it is impossible to know whether a sensitivity to such aspects of phonology developed over time, because all these participants were exposed to their respective heritage languages to some degree throughout their lives.

In more recent work, Oh et al. (2009) have suggested that the superior performance of the relearners in their own studies, as compared to the adoptees in the studies by Pallier et al. (2003) and Ventureyra et al. (2004), may have been due to two factors: either continued low-level exposure to the language between the onset of attrition and the period of relearning or the time spent relearning the language. If the latter possibility is true, one would predict that the Korean adoptees in the French studies would have a learning advantage over their French peers if they

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attempted to acquire Korean as adults, as dormant knowledge of the language might resurface in this situation. To test this hypothesis, Oh et al. conducted an experiment with 12 Korean adoptees and 14 novice learners enrolled in first-semester Korean language classes at a university in the United States. The adoptees had been adopted before the age of 1, with one exception who had been adopted at 3 years old (mean age of adoption: 5.4 months). Five had had no exposure to Korean since adoption and seven had had minimal exposure to Korean, mostly in the form of Korean culture classes conducted in English. Eleven novice learners had had no prior exposure to Korean and three had had minimal exposure after age 14, such as overhearing Korean co-workers at their place of employment. Participants were tested after only 8 hr of instruction.

Given the very young age of adoption for most of the adoptees, remnants of L1 phonology were the target of investigation, and the hypothesis was that Korean adoptees would show an advantage over novice learners in the perception of Korean phonemes. Targeted aspects of phonology were aspirated consonants, tense consonants, and lenition of plain consonants in intervocalic position. Participants were given a phoneme identification task, which used standard ABX methodology. As a group, the adoptees were significantly more accurate on aspiration and lenis than the novice learners. Moreover, when those adoptees with no experience of Korean following adoption were analyzed separately, they also exhibited significantly higher rates of accuracy, despite their early age of adoption, their subsequent lack of exposure, and only having been systematically reexposed to Korean for 2 weeks.[3]

Despite the preliminary nature of this investigation and the low number of participants, the results present a striking contrast with those of Pallier et al. (2003) and Ventureyra et al. (2004), suggesting that, at least for phonological knowledge acquired in early childhood, attrition is a question not of permanent loss but of difficulty of access. With respect to the research on the Korean adoptees in France, the claim is that knowledge undetectable during the period of attrition might be rapidly restimulated in situations of relearning. Unfortunately, however, the Oh et al. (2009) study does not prove this. If learners had been tested before the period of relearning and then again during (or following) the period of relearning, we would be able to determine whether exposure to Korean during relearning had had some effect. However, due to the lack of evaluation before the period of instruction, we cannot be sure that the knowledge evinced in experimentation was not already in place before the onset of renewed exposure.

One thing that has emerged over the course of this debate is a sense of certain variables that need to be controlled in order to test whether participants who have experienced abrupt and prolonged lack of exposure completely lose or subconsciously conserve their knowledge of

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language. Experimentation must ideally involve a reliable assessment of linguistic abilities before attrition, a detailed analysis of linguistic abilities following attrition, and a similarly detailed investigation of language knowledge during the relearning process. No investigation of L1 attrition to date has controlled for all three states of knowledge. Additionally, the frequency and quality of small bouts of input during the period of attrition must be controlled for and analyzed for effect. Cross-sectional studies of the type conducted by these researchers tend to rely on self-report and informal reports from family members concerning these vital doses of input. However, it is hard to envisage careful control of this crucial variable in anything other than longitudinal investigations that tie specific fluctuations in input to specific individuals. We will return to this issue after the review of studies of L2 attrition.

L2 ATTRITION STUDIES

Second language attrition shares many features of L1 attrition; however, because of the additional linguistic and extralinguistic variables involved in the former compared to the latter, it is also more complex. The greatest single difference between L1 and L2 acquisition is variation in degree of success. L1 acquisition is invariably successful, whereas L2 acquisition is not. Many factors have been hypothesized to account for this basic difference in level of attainment and these play a role in L2 attrition as well as acquisition. Additionally, studies of L2 attrition also share many similarities with studies of L1 attrition but must also take the additional variables into account. Although the study of L2 attrition has in many respects paralleled that of L1 attrition and draws on the same seminal works (notably Lambert and Freed's, 1982, volume that set the attrition research agenda), contributions from related fields also bring other research questions.

Studies of attrition in learners of second or foreign languages are found in the literature at least as early as 1929. The first studies investigated the question of loss of foreign language skills by high school and college students during summer vacations (Cole, 1929, for French; Kennedy, 1932, for Latin; Scherer, 1957, for German). Two further studies on French were reported by Smythe, Jutras, Bramwell, and Gardner (1973), just as SLA was gaining currency as an emergent field. Additional studies on attrition during summer vacation conducted within a L2 studies framework included those by Moorcraft and Gardner (1987) on French among Anglophones and by Cohen (1974, 1975) on Anglophone elementary school children in a Spanish immersion program between first and second grade. A later study of college students and summer vacation

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was carried out by Hedgcock (1991) between first- and second-year Spanish. The educational perspective is visible by the identification of summer vacation as the period of disuse. Early studies were published in scholarly journals devoted to the study of language, including language teaching, namely *The Modern Language Journal* and *The German Quarterly*. Psychologists interested in general issues of memory and attrition such as Bahrick (1984a, 1984b) and Smythe et al. (1973) also contributed to the literature on language attrition. As a result of their fields of origin, these studies did not investigate language per se (in terms of linguistic systems) but rather language skills as measured by tests, a characteristic of L2 attrition studies that continues today.

Studies of attrition that focused on change in language structure were conducted by L2 researchers and reflected the interlanguage analyses of the period (Andersen, 1982; Berman & Olshtain, 1983; Cohen, 1974, 1975). Such linguistically and acquisitionally oriented studies began to appear in journals devoted to SLA, such as *Language Learning* (Cohen, 1974, 1975; Gardner, Lalonde, & MacPherson, 1985; Hansen, Umeda, & McKinney, 2002; Moorcroft & Gardner, 1987) and *Studies in Second Language Acquisition* (Cohen, 1989; de Bot & Clyne, 1989; Jordens, de Bot, & Trapman, 1989; Olshtain, 1989; Weltens, van Els, & Schils, 1989).

In the following sections, we review attrition hypotheses as they appear in L2 research, discuss research designs, including tasks and measures that have been used to evaluate the data, and review generally agreed-upon findings. We then delineate the general periods of learning and attrition that pertain to the documentation of attrition (or retention) and systematically lay out the most relevant variables. The final section sets out the predictions for particular populations to illustrate our claim that such populations are best viewed in terms of the features that describe their learning and attrition situations. Despite the considerable variation in approaches and method and the inconclusive nature of previous investigations of L2 attrition, we characterize what is needed to develop a testable model of attrition in this domain.

General Hypotheses Concerning the Nature of L2 Attrition

Second language attrition studies have adopted some, but not all, of the hypotheses posited to account for L1 attrition. These often appear as interpretations of findings rather than as hypotheses that frame investigations. Of the six hypotheses posed for L1 attrition, the regression hypothesis, which predicts that the path of attrition is the reverse of the path of acquisition (*last in, first out*), is the most discussed (Cohen, 1975; Hansen, 1999; Hayashi, 1999; Hedgcock, 1991). The most important design feature for a regression study is how it establishes the acquisition

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sequence used as a comparison. Here, we consider four studies that tested the hypothesis and used three different means of establishing an acquisition order.

Cohen (1975) investigated attrition after a summer vacation of three second-grade children who had participated in a larger study (Cohen, 1974). The children's development of L2 Spanish in an immersion program had been documented via six elicitation sessions over 20 months from kindergarten to first grade. Cohen (1975) used the children's own acquisition record to compare changes in production on an oral elicitation task (oral language achievement measure) before and after summer vacation. Cohen found that two of the three children lost grammatical contrasts that had emerged only 1–3 months before vacation. These differed for the children but included the use of *ser* and *estar* "to be," definite articles, and progressive versus simple present. Hansen (1999) and Hayashi (1999) tested the regression hypothesis in L2 Japanese in the domain of negation for two very different learner populations—adult missionaries and children who attended Japanese schools during the Japanese occupation of Micronesia. Given the established acquisition sequence for Japanese negation in which bound negators are first suffixed to predicates that are verbs, then nouns, then nominal adjectives, and, finally, adjectives (V-Neg > N-Neg > NA-Neg > A-Neg), they predicted by the regression hypothesis that the order of attrition would be the reverse (A-Neg > NA-Neg > N-Neg > V-Neg). The production data for both populations supported the regression hypothesis, with adjectives showing the greatest loss; both studies used comparison groups to approximate a baseline. Hedgcock (1991) tested the regression hypothesis eliciting oral production data with the Spanish bilingual syntax measure. He established accuracy orders before and after the summer vacation between the first and second years of Spanish instruction at the college level. He concluded that the accuracy orders did not support the regression hypothesis; however, because accuracy orders do not establish acquisition sequences, the analysis provides a better basis for testing the threshold hypothesis.

The critical threshold hypothesis (*best learned, last out*) claims that there are levels of attainment above which a linguistic system is immune to attrition. What constitutes the critical threshold, or best learned, is not obvious from SLA theory or research, but there have been two attempts to operationalize this notion. Kennedy (1932) defined items on a test of Latin morphosyntax as best learned when all students answered correctly. Hedgcock (1991) identified morphemes that were best learned by establishing rank order scores (but these were not consistent across testing times and thus failed to support the prediction). A variation on the critical threshold hypothesis is known as "the more you know, the less you lose" (Hansen, 1999, p. 151).[4] de Bot and Clyne (1989) reported that the informants who reported loss had

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low proficiency to begin with (Hansen; Nagasawa, 1999b; Reetz-Kurashige, 1999; Smythe et al., 1973). Clark and Jorden (1984) excluded students from their study on the basis that low-level learners show severe attrition, saying that, for first-year foreign language students, "attrition is almost total after a comparatively short period of time away from the classroom" (pp. 16–17). There are also opponents of the critical threshold interpretation, however: Weltens and Grendel (1993) cited Smythe et al., Bahrick (1984a), and Weltens (1989) as studies that do not confirm the threshold hypothesis.

Last in, first out and *best learned, last out* are occasionally collapsed as the following conclusion from Moorcroft and Gardner (1987) shows: "the statistical analysis of some individual grammatical elements showed that most recently learned structures are more likely to be affected by loss than others, suggesting that a thoroughly learned structure is relatively immune to language loss" (p. 339). There is no generalized theory of SLA that parallels this perspective in attrition research. Other studies have proposed an initial plateau (Russell, 1999b; Weltens & van Els, 1986) during which skills are thought to remain relatively stable for a number of years following the onset of disuse of the L2, after which the skills themselves or access to the skills may begin to degrade.

Other hypotheses of attrition such as interference, simplification, and markedness are used to interpret the results of studies that collect production data, but they are not specifically tested in the L2 attrition literature. The dormant language hypothesis surfaces in L2 studies of relearning as the concept of savings (de Bot & Stoessel, 2000; Hansen et al., 2002), the idea being that relearning a language takes less time than learning it for the first time (credited to Nelson, 1978); thus, the problem is seen as lack of access to unconscious linguistic knowledge rather than total loss. This hypothesis has been tested by means as simple as attrition assessment interviews (Clark & Jorden, 1984; Russell, 1999a), which report the ease and speed with which highly advanced language learners can retrieve items in the unused language during interviews or relearning sessions.

Many L2 attrition studies have addressed skill maintenance (reading, listening, speaking, and writing) and the relationship among skills in retention and attrition (productive vs. receptive skills). Others have attempted to provide a general description of L2 attrition. Such inquiries have investigated the lexicon, morphology, and syntax. Retention of the lexicon has been investigated to a greater extent than any other area, perhaps for its apparent ease of testing (but see Meara, 2004, for a discussion of this misunderstanding of vocabulary). Recent studies have investigated attributes of fluency, including speech rate, hesitations, filled and unfilled pauses, and repetition. Isolated studies have also examined communicative competence, register, or turn-taking, but it is

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interesting to note that, as far as we know, only one dissertation (Dugas, 1999) has undertaken an investigation of the attrition of L2 phonology or pronunciation (whereas L1 studies have begun to employ current methods of investigating categorical perception). Researchers such as Cohen (1974, 1975, 1986, 1989) and Olshtain (1986, 1989) have also investigated compensatory strategies among attriters.

Research Design

Like acquisition studies that track change over time, attrition studies also measure change over time but with the expectation of documenting loss. The essential design feature of attrition studies is a comparison between knowledge at peak attainment and knowledge during or after loss. Of the 49 empirical L2 studies included in this review, only 31 conducted an actual test of peak attainment, thus establishing a baseline. Timing is crucial, and these samples tend to be collected either just before learners leave the host environment or the instructional setting (3 weeks to immediately before departure) or shortly after returning to the home country or to school (immediately to 2 months after return). The period of observation of attrition tends to be 1–2 years for studies that elicit relatively frequent data samples; researchers report termination when participants become embarrassed by their own lack of ability in the L2 (e.g., Kuhberg, 1992). The length of observation covaries with the establishment of a baseline and frequency of testing: Studies that compare scores from school or government tests may run up to 4–5 years but sample only once at the end points (Lowe, 1982), whereas studies of attrition over summer vacation tested immediately before and after summer break because the reduction in input is only 3 months long. Studies that asked participants for retrospective self-assessments or used comparison groups to establish level of peak attainment reported the longest attrition periods from 10 to 50 years (Bahrick, 1984a, 1984b; de Bot & Clyne, 1989; de Bot & Lintsen, 1986; de Bot & Stoessel, 2000; Hansen, 1999; Hayashi, 1999).

Also similar to SLA research, some attrition studies are hypothesis-driven, whereas others are not. However, in attrition research, hypothesis-driven studies are in the minority. This may be due at least in part to the fact that to test the regression hypothesis, for example, the design would have to establish an acquisition sequence and an attrition sequence for comparison in the case of languages or structures that have not been previously documented. Similarly, as we have noted, concepts such as best learned or threshold level must be operationalized.

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Tasks

Beyond the hallmarks of attrition design, attrition studies show a variety of tasks just as their acquisition counterparts do. The resultant data allow for both direct and indirect assessment. Direct assessment relies on primary language data, whereas indirect assessment does not.

Self-Assessment. One way that researchers have dealt with the problem of comparing learner performance at multiple points in time is to have learners undertake a self-assessment, by either rating their own abilities or estimating the amount of loss in different skill areas. Self-assessment is the major means of indirect assessment and includes studies by Clark and Jorden (1984), de Bot and Clyne (1989), Hansen and Chantrill (1999), Nagasawa (1999a), and Weltens (e.g., 1989). Clark and Jorden, for example, asked former students to rate their ability to perform specific language tasks (such as ordering a meal in a restaurant or giving an extemporaneous talk on a familiar topic) at two times retrospectively: at peak attainment and at the time of completing the questionnaire. After Clark's (1981; Clark & Jorden) introduction of can-do statements (such as "I can understand almost everything addressed to me by native speakers of the language"), their use became common. Examinations of learner self-reports in light of their demonstrated levels of performance suggest that at least some learners exaggerate or underestimate either their level of peak attainment or decline (Clark & Jorden); as such, learner perception is an unreliable source for assessment. Moreover, self-assessment provides no information on formal linguistic systems.

Written Tasks. Because many of the studies have taken place in universities and other institutions that rely on examinations, most written tasks in the literature tend to be exams. Some studies have used standardized exams (Clark & Jorden, 1984, used the Educational Testing Service Japanese Proficiency Test; Kennedy, 1932, used the Pressey Latin Syntax Test; Scherer, 1957, used a nationally standardized German test). Other researchers used government exams: Edwards (1976) relied on Canadian government language exams and Lowe (1982) relied on U.S. government language exams. Other studies employed local exams: Cole (1929) used a 3-hr local test including translation of French to English and English to French; other studies with local tests include Weltens (1989) and Bahrick (1984a, 1984b). Smythe et al. (1973) compared their locally developed French achievement tests with the Canadian Achievement Test in French. Weltens and his colleagues (Weltens & van Els, 1986; Weltens et al., 1989) examined receptive skills by means of multiple-choice cloze passages, written

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government exams, and other tasks. For multiple reasons, including educational influence and applications, existing standardized tests, and ease of administration, tests are common in L2 attrition studies but almost totally absent in SLA research, as they are not designed to target particular forms.

Oral Tasks. All oral tasks allow for the assessment of pronunciation, fluency, lexicon, and repair strategies. These tasks vary in amount of interaction and inherent difficulty. Oral tasks are used more frequently with younger learners than with older learners, who more often receive written tests. There is a confound in that many young learners may not be sufficiently literate to take a written exam. However, there is no reason why adult learners must complete written tasks, as the acquisition literature has numerous examples of oral language samples from adults. Spontaneous oral production (with time constraints) tends to discourage the use of explicit knowledge.

Narrative tasks are well represented in attrition studies, particularly in child L2 studies (Cohen, 1989; Olshtain, 1986, 1989; Reetz-Kurashige, 1999; Tomiyama, 1999a, 1999b, 2000, 2008; Yoshitomi, 1999). The use of *Frog, Where are you?* (Mayer, 1969)—a wordless picture book—and other *Frog* stories were used following the large narrative project in L1 acquisition (Berman & Slobin, 1994). Given their structure and clear chronological order, narratives are a good tool for the study of verb morphology (tense-aspect forms) and reference (including articles). General syntactic complexity and vocabulary may also be elicited via narratives. Narratives are monologic, which allows the learner to develop the text alone and avoids scaffolding (depending on the interlocutor).

Oral responses to situational prompts are common in SLA research, particularly in the area of pragmatics. Russell (1999a, 1999b) elicited responses to prompts from adult learners. In the studies of Hansen (1999) and Hayashi (1999), the interviewers posed as a boss or a friend to elicit responses that had to be negated (targeting both grammar and addressee level).

Conversational interviews include both interviews and open-ended conversations for the purpose of collecting language samples. Conversational interviews are interactive speech events that allow for the investigation of turn-taking, comprehension and uptake, response to talk, and communication strategies. Interviewers can respond flexibly to learners' responses and capitalize on topics of interest. Such tasks can be used with both children and adults. One issue that arises with dyadic elicitation is that learners may rely on the interlocutor or scaffold on interlocutors' contributions. Studies that collected language samples via conversations and conversational interviews include Berman and Olshtain (1983), Kuhberg (1992), Olshtain (1986), Tomiyama (2000, 2008), and Nakuma (1997).

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Language proficiency interviews are one means of collecting oral production data and rating learners' performance at the same time. The best known and the one reported to be used in attrition studies is the ACTFL Oral Proficiency Interview (OPI). The OPI was employed by Clark and Jorden (1984), Nagasawa (1999a, 1999b), and Raffaldini (1987). The OPI is a standardized procedure for the global assessment of functional speaking ability. A true OPI is administered by a certified interviewer whose ratings are consistent with those of other interviewers. It is a testing method that evaluates how well a person speaks a language by comparing his or her performance on specific language tasks with the criteria for each of the established proficiency levels described in the ACTFL guidelines. (The guidelines were revised by ACTFL in 1999, so the procedures used in these studies were based on the earlier guidelines.) Raters take into account morphology and syntax as well as communicative competence. The potential for establishing comparability across samples and populations to gauge general preattrition levels is promising, but the availability of certified raters is an issue. This method establishes a descriptive level (and is more precise than descriptions such as second-year Spanish student) but does not replace a linguistic analysis of attainment or attrition.

Grammatically and lexically focused oral elicitations are frequently used, the best known of which is the bilingual syntax measure used by Dulay and Burt (1973) with child L2 learners. Hedgcock (1991) tested the regression hypothesis, eliciting oral production data from college students learning Spanish with what he referred to as a modified bilingual syntax measure for Spanish, the text and translation of which can be found in the appendix. Other similar means included the use of illustrated cards and short tasks with first and second graders by Cohen (1974, 1975, 1986); Jordens et al. (1989) used a so-called headlines task, in which respondents make complete sentences out of bare forms, to elicit case markers from adult learners of L2 German. Moorcroft and Gardner (1987) used 11 prerecorded oral questions in French that listeners heard twice to elicit responses from high school students. Snow, Padilla, and Campbell (1988) used the speaking subtest of the Modern Language Association's Spanish Cooperative exam with high school learners. de Bot and Lintsen (1986) used an oral test designed to test aphasia with elderly attriters.

Background Questionnaires. Distinct from both linguistic assessment and self-appraisals, background questionnaires are often useful and arguably necessary in some cases as informal indicators of variables that are difficult to control. For example, it is not always possible to closely monitor participants during their residence abroad, but it is extremely valuable to have information on patterns of contact with native speakers. Almost all of the L2 studies reviewed here used some form of background questionnaire.

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Measures of Linguistic Variables

There is surprisingly little analysis of actual language in the studies reviewed here. Only 27 of the 49 L2 studies analyzed language samples, and only a small portion of those conducted interlanguage analyses comparable to those found in SLA studies. Interlanguage analyses include investigations of negation in Japanese (Hansen, 1999; Hayashi, 1999), case-marking in German (Jordens et al., 1989), and a broad comparison of L2 German acquisition and attrition by speakers of L1 Turkish (Kuhberg, 1992). Berman and Olshtain (1983) presented a close analysis of the L2 English interlanguage grammar of L1 Hebrew child returnees compared to interlanguage forms found in Israeli English-as-a-foreign-language students who had never been abroad.

Other studies measured change in the lexicon, fluency, complexity, and accuracy by using highly quantified measures. Measures of change in vocabulary include the number of different words (Cohen, 1989), lexical errors (de Bot & Lintsen, 1986), total words (Cohen, 1986; Russell, 1999a), and type-token ratios (Tomiyama, 2008) as well as words per unit, including words per response (Cohen, 1986), words per clause (Tomiyama), words per narrative (Olshtain, 1986), and words per T-unit (Cohen, 1989).

Fluency is generally measured as number of words per unit of time (e.g., syllables per second, Nagasawa, 1999a; words per minute, Yoshitomi, 1999). Filled and unfilled pauses (*uh*, *um*, and *er* vs. silence or hesitations), false starts, repairs, or repetitions are measured by the number of pauses between utterances (Moorcroft & Gardner, 1987). Other measures consist of length of unfilled pauses, ratio of length of between-utterance pauses to in-utterance pauses, repetition time, gap-filler and hesitation time, number of utterances, total number within utterance pauses, number of between-utterance pauses, number of repetitions, and number of gap fillers (Nakuma, 1997). Moorcroft and Gardner also measured elapsed time between question and response and length of speaking time. Complexity is typically measured as clauses per T-unit (Tomiyama, 2008).

Accuracy is as often measured in errors as in lack of errors. Errors may be counted as the number of errors (de Bot & Lintsen, 1986; Olshtain, 1986, 1989) or a ratio of errors per response (Cohen, 1986), errors per T-unit (Russell, 1999b), or taking the error-free perspective, as the number of error-free T-units (Tomiyama, 2008) or frequency of error-free clauses (Yoshitomi, 1999). However, analyses that focus on errors miss significant changes in interlanguage whether in acquisition (Gass & Selinker, 2008) or attrition. A rating of incorrect would classify all acquisitional stages short of the target in the same way and thus fail to document progression or attrition from one interlanguage stage to

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another. Similarly, quantitative descriptions of language at two points can describe production as faster or slower, as simpler or more complex, as having more or fewer lexical items or more or fewer errors, but these descriptions do not locate the reason for the change within the linguistic system. Word searches or paraphrases, for example, lengthen responses but may indicate reduced lexical access.

Related to both study design and measurement is scope of investigation; studies of L2 attrition are often concerned with discrete areas of competence or performance. The separate investigation of each area (which is reasonable because different areas seem to respond differently) may also diminish analytically the cumulative effect felt by the learners themselves or their interlocutors or instructors. Yoshitomi (1999) argued that small degrees of attrition in individual areas add up to effect overall linguistic performance. Yoshitomi suggested that the investigation of communicative competence through conversation would allow a larger and more accurate picture. Clark (1982) has also called for realistic measures of assessment such as highly face-valid tests of speaking, greater realism in speaking, measures of real-life performance, and an increased use of self-report data using can-do statements to help pinpoint communication difficulties.

To measure when attrition takes place is not straightforward. In spite of the surface evidence, Yoshitomi (1999) has argued that attrition starts as soon as the returnee comes home. Meara (2004) takes a very similar stand based on computer modeling of vocabulary loss. He hypothesizes that there are multiple attrition events that lead to observable attrition. Meara argues that

> *Vocabulary loss* is an observable change in the number of activated words in a vocabulary, and will always be measurable. In the simulations reported here, vocabulary loss is always triggered by attrition events [a small structural change in the vocabulary], but attrition events do not always trigger vocabulary loss events. This seems to be an important theoretical distinction which has been missed in the literature to date. (p. 145)

Meara maintains that attrition events may not lead to immediate loss but weaken the structure of the lexicon; so attrition events can build up, and it looks like one creates an "avalanche of loss" (p. 147). Meara offers at least two important points for work in any area of interlanguage: First, he reminds us that we are investigating systems. This point may be clearer in other areas of the grammar, but Meara emphasizes that the lexicon is not merely a list of words but a series of interconnected relationships, and loss in one area will impact another. This is illustrated by the compensatory strategies that learners use when they cannot retrieve a word they had previously used (Cohen, 1989; Olshtain, 1986). The second point is that attrition may have a silent

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buildup period during which loss is laying a foundation. This proposal is a very different perspective than that adopted by the plateau view advocated by Russell (1999b) and Weltens and van Els (1986). Finally, Meara's discussion reminds us that linguistic and cognitive sophistication is called for in a field of inquiry that, at times, favors nonspecialist approaches.

In summary, research design is weak in L2 attrition research compared to other areas of SLA. That said, the facts of natural attrition are rather messy. Many periods of reduced use have a stunning range of continued input, exposure, and use. Different populations are not directly comparable; partial comparisons can only be made in terms of matching variables, as we will show. The chief problem that we see, however, is the inconsistent establishment of peak attainment. Cohort or group scores are not sufficient to establish baselines for attainment against which to measure attrition. Learners must be compared to themselves in longitudinal designs, which means that the cross-sectional study that stands in for longitudinal design in acquisition studies cannot be used in attrition studies. There is no common starting point for attrition, whereas, in acquisition, the assumed starting point for all learners with the same L1 is zero (no L2 knowledge). In addition to necessary revisions to research design in attending to the variables related to learners-attriters, the tasks and analyses used in any study of attrition are crucial. Moreover, areas of investigation could be expanded to include other areas of interest in acquisition (e.g., comprehension and processing), and to investigate these areas, linguistically sophisticated judgment, interpretation, or processing tasks.

Summary of Findings

As in L1, L2 attrition does not affect all components of the interlanguage system uniformly. Many studies focus on determining which areas will be most affected: There is general consensus on a few characteristics of L2 attrition, and these reflect the skills-dominated approach to attrition in L2 studies. The following list includes findings discussed broadly in the literature (findings 1–5) and those referred to with less frequency (findings 6–8).

1. Production skills—namely, speaking and writing—are more vulnerable to attrition than receptive skills—namely, listening and reading (Bahrick, 1984a, 1984b; Hedgcock, 1991; Lowe, 1982; Scherer, 1957; Snow et al., 1988; Tomiyama, 1999a, 1999b). Receptive vocabulary (as opposed to vocabulary that is produced) and receptive grammar are also included as receptive skills (e.g., Scherer) although neither is a skill but rather a component of the L2 grammar. Vocabulary also figures in an undefined skill called understanding.

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2. Literacy supports retention and impedes attrition (e.g., Olshtain, 1986). However, there is a confound here with age (see finding 3).
3. Older children retain more than younger children because older children have L2 literacy skills (Olshtain, 1986). One study of adults who developed L2 literacy compared to those from the same cohort who did not suggests that this may hold true, eliminating the confound from child attriters (Hansen & Chantrill, 1999).
4. The lexicon has been generally found to be more likely than grammar to show attrition (Kuhberg, 1992; Moorcroft & Gardner, 1987). However, certain types of lexical entries such as formulas, conventional expressions, idioms, and high function or emotional items may be better retained (Berman & Olshtain, 1983). In contrast to studies that have concluded that grammar is more resilient than the lexicon, Yoshitomi (1992) suggested that, for lower level learners, grammar is more likely to show loss than the lexicon.
5. Motivation is implicated both during learning and during attrition (Edwards, 1976; Gardner et al., 1985; Gardner, Lalonde, Moorcroft, & Evers, 1987; Moorcraft & Gardner, 1987; Nagasawa, 1999b; Snow et al., 1988).
6. There is a decrease in fluency, which has been documented by a range of different measures (Russell, 1999a; Tomiyama, 1999b).
7. There is a decrease in vocabulary, which may relate to size (Russell, 1999a) or access. Cohen (1989) suggested that loss in vocabulary stems from a lack of access during production, but not comprehension. Similarly, Olshtain (1989) reported a reduction in access. See also Schreuder and Weltens (1993).
8. Education supports retention (this may be a confound with literacy; Hansen & Chantrill, 1999): Nagasawa (1999a, 1999b) found that a group of master of business administration (MBA) returnees who took classes did better than those who did not (see also de Bot & Clyne, 1989; Russell, 1999a).

Types of Variables

In addition to taking previous findings into account when planning new research in L2 attrition, one must also consider the linguistic and extralinguistic variables in play. Beginning with the linguistic and language-related variables outlined as part of the hypotheses reviewed here, there are level of attainment (a description of the linguistic system), area of the grammar investigated, sociolinguistic competence, receptive versus productive language use, development of L2 literacy skills, and type of lexical item. The nonlinguistic variables that influence attrition include age (at time of acquisition, cessation of acquisition, and period of attrition) and motivation. Other nonlinguistic variables that have been identified consist of variables related to instruction (intensive vs. distributed, formal instruction vs. contact learning), attitude, and very specific external variables, including, quite

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literally, whether learners undertook the study of a foreign language for God or country (as in the case of missionaries or government employees).

One of the main purposes of this review is to identify the variables that must be taken into account to develop a model of assessment of L2 attrition. To this end, the variables will be reviewed in some detail. Any variable relevant to SLA would also be relevant to, or worth investigating in, a study of attrition. We outline the most frequently discussed variables here.

Population Variables. Many populations were represented in the L2 attrition literature, including three main populations who have been the focus of multiple studies: children returning from other countries, missionaries following time abroad, and college and high school students. Additional populations consist of government employees of the United States and Canada who show some attrition while using the L2 at work (Edwards, 1976; Lowe, 1982), high school and college students in traditional (Bahrick, 1984a, 1984b; Gardner et al., 1985) or study-abroad programs (de Bot & Stoessel, 2000), children in immersion programs (Cohen, 1974, 1975, 1986, for younger children; Snow et al., 1988, for older children), elderly speakers of L2 Dutch and German immigrants to Australia (de Bot & Clyne, 1989; de Bot & Lintsen, 1986), elderly Micronesians who learned Japanese as a L2 in elementary schools established by the Japanese during their rule of Micronesia (Hayashi, 1999), and graduate students returning from training abroad (Nagasawa, 1999a, 1999b). Additionally, two studies explicitly targeted third languages (Nakuma, 1997, on third language Spanish of Ghanaian professionals, and Cohen, 1989, on third language Portuguese of Hebrew-English bilingual children), although other studies examined learners who may be third language speakers.

Different populations can be quite distinct and, depending on the characteristics they share (or do not share), one must proceed with caution when attempting to generalize findings across populations. The most studied populations are presented here as groups, but in fact each population is best defined by a series of discrete variables (see Table 1). The three most studied populations are child returnees, returning Mormon missionaries, and high school and college students returning to class after summer vacation. The children most often studied are those whose parents were graduate students or employees at international companies (Berman & Olshtain, 1983, and Olshtain, 1986, 1989, for English L2 with Hebrew L1; Reetz-Kurashige, 1999, Tomiyama, 1999a, 1999b, 2000, 2008, and Yoshitomi, 1999, for Japanese L1 with English L2; Cohen, 1989, for third language Portuguese, L2-L1 Hebrew and English) and children of migrant workers (Kuhberg, 1992, for German L2 with Turkish L1). Both older and younger children are included in this sample.

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The children who learned English as a L2 typically attended preschool and elementary school in the host country and may or may not have had English-as-a-second-language courses. Older children generally have literacy skills, whereas younger children do not. Most children are described as having achieved language competence appropriate to their age or grade level, and some children are reported to have exceeded grade level in reading. Many Japanese returnees joined special English-as-a-foreign-language courses for returnees upon their return to Japan, but these were reported to employ traditional pedagogical activities with no opportunities for communicative activities. Returning Israeli children apparently had no structured courses; younger children are described as abandoning English, whereas the older children maintained it through reading and expected to use it in school.

Returning Mormon missionaries constitute a population of adults who at the ages of 19–23 have had a 2- to 3-year mission during which they communicated daily with native speakers of the host language, most of whom are strangers. Men outnumber women in these samples, which is representative of the missionary population. Additionally, men served 24-, 30-, or 36-month mission assignments, whereas women had shorter assignments of 18-24 months. Their level of instruction prior to departure to the host country varied from no language training at all for missionaries who left prior to 1959 to 2 months after 1959. Hansen and Chantrill (1999) noted that "an unusual aspect of their experience was that, rather than being self-selected, they were directed to learn a foreign language" (p. 280); moreover, the location of service was not known to the missionary candidate at the time of application.

Hansen and Chantrill (1999) characterized the learning that takes place during the extended stay in the host country as "informal" and the peak attainment as showing "high levels of oral competence" achieved through "extensive daily use of the target language" (p. 281). Hansen et al. (2002) noted that the missionaries learn and use memorized passages, which we would hesitate to characterize as acquisition: They further explained that there are "lessons that missionaries are required from the beginning to memorize and to use repeatedly in their teaching" (p. 662). Returning missionaries have been studied when they had been home for as little as 1 year or as many as 45 years. During that time, they have had varying language experiences such as continued study, including development of literacy skills not cultivated during the experience abroad. The dominant language of the L2 attrition literature is Japanese, owing largely to the work of Hansen and her colleagues, and more recently has included L2 Chinese and Korean as well (Hansen, 1999; Hansen & Chantrill, 1999; Hansen & Chen, 2001; Hansen et al., 2002; Russell, 1999a, 1999b).

College students are a natural group for inclusion in any study of L2 attrition. Populations include college students in Europe, who typically

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Table 1. Variables at three periods for different learner populations

	Population					
Stage	Younger children	Older children	High school or university summer break	Mormon missionaries[a]	Intensive predeparture instruction	International graduate students
			Predeparture instruction			
Age	<7	>7	15–18+	20s	Adults	Adults
Aptitude[b]	+	+	±	±	±	±
Motivation or attitude	na	na	±	±	±	±
L2 instruction	na	na	+	–	+	+
Explicit knowledge	na	na	+	–	–	+
Oral	na	na	±	–	+	+
Literacy	na	na	+	–	–	+
Sociopragmatics	na	na	–	–	–	±
Attainment	na	na	Range	Low	Low	High
Use	na	na	+	–	±	±
			Host country			
Duration of stay	±	±	na	2–3 yrs	Range	2–5+ yrs
Age	< 7	> 7	na	20s	Adults	Adults
Motivation or attitude	na	Mixed ±	na	+	±	+
Instruction	–	±	na	Up to 2 mos	±	±
Explicit knowledge	–	–	na	–	±	+
Oral	+	+	na	+	±	±
Literacy	–	+	na	±	±	+
Sociopragmatics	+ (Child)	+ (Child)	na	±	±	±
Attainment	+ (Child)	+ (Child)	na	High oral	Low-mid	Mid-high
Use	+	+	na	+	±	±

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			Reduced input[c]			
Duration of disuse	0–18 mos	0–24 mos	3 mos	1–42 yrs	1–5 yrs	1–5 yrs
Age	+ 0–1 yr	+ 0–1 yr	+ 3 mos	+ 1–42 yrs	+ 1–5 yrs	+ 1–5 yrs
Motivation or attitude	–	±	±	±	±	±
Instruction	±	±	±	±	±	±
Explicit knowledge	–	±	±	±	±	±
Oral	–	–	–	–	–	–
Literacy	–	±	±	±	–	±
Sociopragmatics	–	–	–	–	–	–
Attainment or retention	–	±	±	±	±	±
Use	–	±	±	±	±	±

Note. mos = months; yrs = years; na = not applicable; + shows information was reported, – shows that it was not reported, and ± shows that it was not always reported.
[a] Recent approaches to intensive predeparture training indicate much more specific attention to the target language (Baker, 2007; Schultheiss, 2008), which means that current missionaries would have a different profile.
[b] Variables such as aptitude are not inherently binary; in such cases, binary values reflect the division of learners into high or low groups.
[c] Reduced input with intensive predeparture participants and international graduate students is estimated.

receive longer language training than in the United States and who are exposed to multiple second or foreign languages (Jordens et al., 1989; Weltens, 1989; Weltens & van Els, 1986; Weltens et al., 1989). Another group of college students are those who have participated in study-abroad programs. Nagasawa (1999a, 1999b) studied MBA graduate students who did a summer internship in Japan. Clark and Jorden (1984) studied students at Cornell University's elite, intensive full-year Asian language concentration (FALCON) program. However, the most studied group of high school and college students are those in regular programs who return to language study after the annual summer vacation. Summer vacation is only a short break from traditional instruction (generally 3 months), but, from the literature, it is evident that it is a source of concern for educators. Except for one prep school, which was very exclusive, many of the inquiries are situated in large public universities (Kennedy, 1932, for Latin; Scherer, 1957, for German; Cole, 1929, Moorcraft & Gardner, 1987, and Smythe et al., 1973, for French; Hedgcock, 1991, for Spanish). There are also studies of young children after summer vacation (Cohen, 1974, 1975). Unlike the other two major groups (returnee children and missionaries), the college students return to school in the fall, and unlike their study-abroad counterparts, they have not had host country experience in the intervening months.

These three most frequently investigated populations in the L2 attrition literature are listed in Table 1, with children divided into younger and older groups and with each group represented as a set of variables. We have also added two comparison groups about whom no studies are yet available: learners who embark on periods of study or work abroad following intensive predeparture programs and returning international graduate students. Table 1 is organized in three time periods relevant to most populations: initial instruction, time in host country, and period of reduced input and language use. Relevant variables are listed in the leftmost column. They each apply to some extent at each of the three stages, with the exception of aptitude, which we hold to be stable. Thus, it is listed only once in the acquisition period.

Individual Variables

Age. The age at time of acquisition and host country experience is one of the most salient distinctions in the literature. Child learners have a good chance of acquiring the L2, especially in host environments at levels appropriate to their age and peers, but they also have a greater chance of experiencing attrition. Although older children seem to have a better chance than younger children at retention, this effect of age is confounded by literacy. Older children develop literacy skills in school, which may help not only by anchoring the L2 during the acquisition process but also by supplying a second source of input and by providing continued input, as older children often continue reading in the L2 upon

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returning home (Olshtain, 1986). Adults may not demonstrate the same ease of acquisition as children and thus show even greater differences in attainment; however, they may have other cognitive, social, and technological resources that facilitate continued contact with the target language, which would thwart attrition and aid retention.

Aptitude. No study reviewed here has dealt with aptitude directly, although Clark and Jorden (1984) touched on it. However, the fact that some government-sponsored language programs, such as the Defense Language Institute, screen learners for language aptitude and assign learners to specific languages based on those screenings make aptitude a relevant variable for inclusion. Recent work on individual differences would be of particular use (see, e.g., Robinson, 2005).

Motivation and attitude. Motivation and attitude have been identified as important both during the period of learning and during the period of reduced input and use (Edwards, 1976; Gardner et al., 1985; Nagasawa, 1999b; Snow et al., 1988). Learners' motivation may also shift between acquisition and host country periods (Clark & Jorden, 1984).

Factors of Language Knowledge and Use

Explicit knowledge. One aspect of instruction relevant to attrition may be the introduction of explicit rules. Such rules do not constitute linguistic competence themselves but are part of explicit or conscious knowledge. Depending on the tasks that learners are asked to perform, they may draw on explicit rather than implicit knowledge. Explicit knowledge might be an aspect of instruction with positive consequences for language retention.

Literacy. Although traditional foreign language teaching often emphasized reading even at the expense of oral production and comprehension, the experience of many groups of learners may not include learning to read in the target language. Reading offers a second channel for input, and, as Bardovi-Harlig (2000) argued with respect to input that may be severely reduced in speech (such as English tense-aspect forms), written input may supply grammatical information otherwise not salient and thus unavailable to lower level learners. Seeing a word or being able to write it may help some learners secure it in memory. Literacy in children covaries with age; the youngest children do not learn how to read or write in their sojourn abroad, whereas older children do. It is worth noting that the group of Mormon missionaries studied in the literature did not receive literacy training in preparation for their missions, but many sought it out during their sojourn abroad or upon returning. Hansen and Chantrill (1999) found that the extent of a learner's knowledge of Chinese or Japanese characters was a strong predictor of maintenance over four decades; learners who were literate in a L2 maintained oral skills better than learners who had not learned to

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read and write. Observing an adult population allowed the researchers to avoid the age confound present in the studies of literacy in children. Other studies report that reading is the most stable skill for adults (e.g., Edwards, 1976; Lowe, 1982).

Oral competence. Oral competence is generally agreed to be highly susceptible to attrition. Given that many traditional approaches to foreign language do not include oral competence, it is difficult to conceive of levels of production fluency without direct testing. Oral production may be a classroom learner's weakest point and thus may be susceptible to attrition for that reason. Other learners such as some missionaries or military personnel may only have oral competence. Claims for fluency through the use of memorized texts (e.g., Hansen, 1999) must be separated from tests of creative oral production.

Sociopragmatics. Some studies evaluate learners on register use, which is part of sociopragmatic knowledge (the knowledge of how-to-say-what-to-whom-and-when; see, e.g., Clark & Jorden, 1984, and Raffaldini, 1987, for oral assessments of pragmatics). Given the early date of most attrition studies, learners are unlikely to have been exposed to explicit instruction in pragmatics. Most sociopragmatic knowledge is likely to have developed from contact with native speakers.

Peak attainment. The level of peak attainment is crucial in L2 attrition. Whereas native speakers can be assumed to learn the native language perfectly, L2 learners show a wide range of achievement. This is analogous to what Montrul (2008) has termed *incomplete acquisition* in bilinguals; levels of acquisition must be documented rather than assumed. Although attainment may closely correlate with other variables such as length of study or length of residence, it need not and is thus treated separately here. Higher attainment is held to be predictive of higher retention and lower attrition, whereas low attainment is held to be a factor in attrition. Establishing peak attainment is critical to research on attrition. Attainment must be established for any area of linguistic competence or language skills that will be tested subsequently, as grammatical components function independently.

Factors of Input

Duration and nature of instruction. The instruction variable is most grossly defined as the presence or absence of instruction. The absence of instruction is rather clear-cut. In contrast, the presence of instruction introduces a number of additional variables. Traditional instruction (particularly as far back as many of the college studies go) has not been particularly strong on developing oral competence. Other types of instruction—for example, preparation for field work (e.g., missionary, military, or international development assignments)—may not prepare learners in literacy skills, an area of strength in traditional language instruction. Moreover,

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some language teaching methods (such as cognitive approaches) promote explicit knowledge of rules, whereas others do not. Instruction is often thought to convey an advantage, but this may be because of learned knowledge about the language rather than acquired language competence. Foreign language instruction generally occurs in the predeparture period prior to an experience in the host country where the target language is spoken. The value of duration of instruction is bound to the nature of instruction; several months of classes that emphasize communication skills may outweigh several years of grammar-translation methodology in terms of predicting a degree of oral competence.

Duration and nature of immersion in the host country. Travel to a country where the L2 is spoken is not something undertaken by all learners in the attrition literature, but any such time period is an important variable because there is a probable correspondence to the degree of exposure to naturalistic input and experience of linguistic interaction. However, the duration of the stay is also tied to the nature of the immersion, which can vary in many ways. In some cases, learners may have extensive natural interaction with native speakers, whereas, in other cases, contact with native speakers may be so minimal that attrition actually sets in during this period. Following arrival in the country, formal L2 instruction may cease or learners may seek out further instruction. In the case of school-age children, literacy skills can be learned from general classroom instruction rather than from specific L2 instruction.

Duration and nature of reduced input and use. Periods of disuse reported in the literature range from as little as summer vacation to up to 50 years in Bahrick's (1984a, 1984b) retrospective studies of high school and college learners of Spanish as a foreign language. The range for the missionary returnees is 1–45 years. In contrast, production studies of children may last up to 1 year or 18 months or until the children become too embarrassed to speak the L2 (Kuhberg, 1992). The nature of the period of reduced input and use varies greatly. The case of abrupt, total withdrawal from the L2 is not as frequent in the conditions documented as it is in the L1 literature. Most authors reported that college students had no L2 contact over the summer break. However, in the cases reported (Reetz-Kurashige, 1999; Yoshitomi, 1999), many of the child Japanese returnees participated in special classes for returnee children, although the authors suggested that, due to lack of opportunities for communication, these traditional receptive-skills focused sessions may not be highly valuable. Younger Israeli returnees (Olshtain, 1986) and Turkish child returnees (Kuhberg) seem to have almost a complete lack of contact with the L2. Returning missionaries may seek out L2 courses and even become literate in the L2 after returning (Hansen et al., 2002). College students who return from abroad and enroll in courses for 80 min a week (Clark & Jorden, 1984) or immersion students who enroll in traditional courses (Snow et al., 1988) are also included in the literature.

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Even federal employees whose L2 use is part of their job are included in the attrition literature (Edwards, 1976; Lowe, 1982). Although L2 in the work environment does not disqualify a learner from an attrition study, L2 in the home environment generally does, and marriage to a target language speaker often leads to disqualification from an attrition study (Hansen et al.). One issue that arises is whether assessment interviews constitute input or use, or both, and thus disrupt the attrition process; however, this seems less pressing given the range of activities in which learners naturally engage independently of attrition studies.

TOWARD A MODEL FOR THE ASSESSMENT OF LANGUAGE ATTRITION AND RETENTION

This section outlines a model for the assessment of L2 attrition based on our review and describes two design factors that we believe should characterize any comprehensive study of L2 attrition. The first is the division of the study into discrete time periods based primarily on changing factors of input, so that quantifiable baseline data may be established against which to compare the process of attrition. The second is the identification of particular populations as sets of features that change over time, in terms of the variables we have suggested. Examples are given of four populations that may be analyzed according to this model.

Discrete Time Periods in the Acquisition-Attrition Process

Any systematic investigation of the attrition process must be tailored to the time periods involved. There are at least four relevant time periods related to attrition in L2 populations, the sequence of which varies according to the population. Not all learners will experience all periods, and what happens within each period may vary for subgroups of learners. For most populations, the first period is one of formal language instruction. This may take the form of several years of academic study or a short intensive course prior to departure to a host country. A second period may take place in a country where the language is spoken. For some learners (e.g., children whose parents are engaged in work or study abroad or aid workers in developing countries), this may be the period of initial acquisition. One time period applicable to all relevant populations is the period of attrition, which may be characterized by disuse, lack of input, or reduced input. This may be a very extended period of time, or just a few months as in the case of summer vacation for students. This stage is often called *incubation*, but we use the more transparent term *period of reduced input*. A fourth period during which

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relearning takes place may also occur, during which time it is possible to investigate the effects of reexposure. However, in some cases, this period of relearning is simultaneously a period of reduced input. For example, when learners return from an input-rich language experience abroad and enroll in traditional classes, this may constitute severely restricted input compared to the experience of daily language use abroad (Nagasawa, 1999a, 1999b). Edwards (1976) showed that federal employees in Canada who passed requisite language exams experienced attrition even while working; L1 English speakers showed attrition of L2 French at work, whereas L1 French speakers of L2 English did not. Lowe (1982) similarly reported attrition in U.S. employees of the Central Intelligence Agency based on qualifying language scores and scores on subsequent required language tests.

These periods of acquisition and attrition may sometimes be repeated in the history of an individual (such as in the case of learners who take up the study of a language more than once, as reported by Clark & Jorden, 1984). Moreover, the stages might have quite different characteristics when learners are considered as individuals or as members of certain populations. For example, during a time of reduced input, one learner may have absolutely no L2 input, whereas another may have small but significant periods of exposure. Each of these stages must be investigated to present a principled picture of the attainment and attrition of language learners as a specified group or as individuals.

Populations as Changing Sets of Variables

During each of these time periods, a number of variables are at play, both at the level of the general population being investigated and of subgroups within that population. A learner's age, aptitude, and motivation all influence the outcome of the periods both for acquisition and attrition. Motivation and attitude may change both within and between periods. In each period, a learner will also have developing, stable, or attriting competence in different submodules of the language. Explicit knowledge, literacy, oral competence, sociopragmatics, and use are components of these variables and, in turn, contribute to attainment at the time in question. Perhaps the most revealing variables for understanding the nature of language attrition are duration and nature of input, which must be described and quantified for the time periods applicable to the study. We recognize that none of these periods is likely to be completely homogenous and may actually be made up of a series of smaller periods, but these are simplified here for the purposes of generalization.

The application of our general model for the assessment of L2 attrition is represented diagrammatically in Figures 1 and 2. Figure 1 exemplifies

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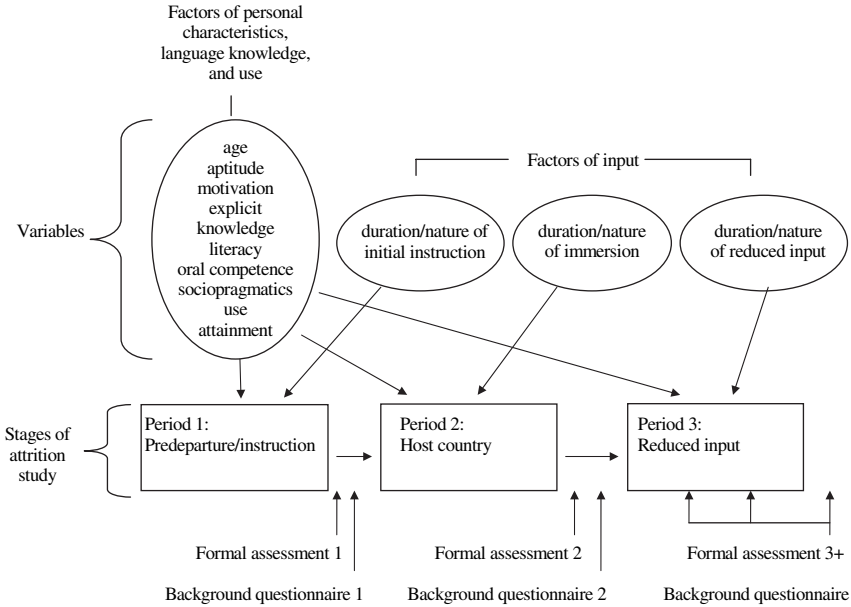


Figure 1. General model of variables and requisite schedule of assessment in tracking populations of L2 returnees.

the tracking of variables for any population, to be measured at three stages of the study by means of two types of assessment: a formal assessment that explores the actual interlanguage system of the populations in question and a background questionnaire that establishes attitudinal and motivational orientation as well as language-contact profiles in addition to the more obvious background variables (e.g., age, other languages spoken or studied, home language, further experiences in host environments). For the sake of clarity, the representation is restricted to one particular sequence of time periods: a period of instruction, a period of immersion in a host country, and a period of reduced input. Although single assessments may suffice at the end of the first two periods, multiple assessments should be made during the period of reduced input to establish baselines for comparison and to detect changes to the system.

In Figure 2, we abstract away from sets of variables to illustrate how the same general model for assessment may be adapted to different populations undergoing various stages of acquisition and attrition. The first and second examples provide a contrast between inexperienced and experienced language learners who study or work abroad following formal instruction. In the first case, labeled "intensive course," learners are exposed to the language in an intensive introductory course, which lasts perhaps 1 or 2 months, before embarking on a period of study or work abroad. Such groups are as diverse as nonlanguage majors

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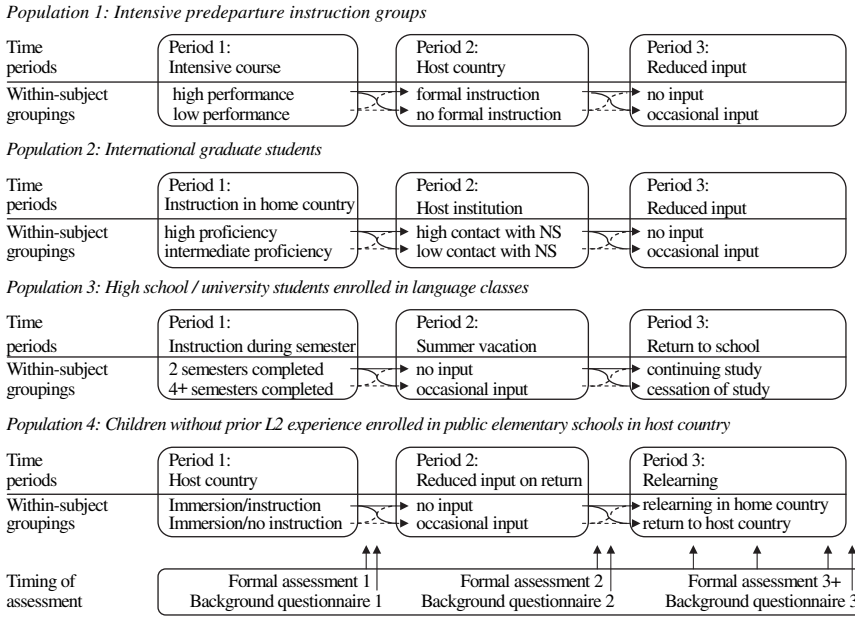


Figure 2. Examples of tracking possible subject groupings over group-specific time periods

preparing for study abroad, corporate employees prior to international postings, participants in government-sponsored international exchange programs, military personnel, and missionaries. In the second case, labeled "instruction in home country," international graduate students exemplify learners who have had many years of formal language instruction before the period of immersion in the host country.

For both of these groups, the effects of formal instruction can be assessed either prior to departure or immediately upon arrival. During Period 2, they can be divided into subgroups contrasting, for example, those who do or do not continue to have formal instruction or those who do or do not have regular contact with native speakers. For international graduate students, Period 2 might be simultaneously a period of acquisition and attrition, as they engage in daily contact with native speakers and become more proficient in both colloquial forms and in their area of academic expertise but no longer experience advanced language instruction. To measure processes of attrition and retention in specific areas of language (e.g., definite articles in syntax, phonemic contrasts in phonology, request strategies in pragmatics), it is imperative that levels of attainment be formally documented at the end of Period 2 before attrition sets in. As discussed previously, informal indicators typically used in attrition studies, such as self-reports or

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perceptions of general fluency, do not suffice. For both populations, Period 3 would be the period of reduced input following their return home. They might then be divided into groups with little or no further contact with the language and groups who experience regular, small bouts of reexposure. Such reexposure could be naturally occurring or could be induced as a means of testing the efficacy of language retention materials, depending on the nature of the study.

The third and fourth examples illustrate the flexibility of this general model of assessment with reference to two further population types. The third case is that of high school or university students in language courses who undergo varying degrees of attrition during their summer vacation. Although assessment of such students during the vacation period is often impractical, it may be possible to subsequently test for the value of occasional, controlled input during this period (e.g., by means of online homework activities), and upon their return, the attrition process could be studied by comparing those who stop studying the language to those who continue. The fourth case is that of children without prior experience of the target language who are enrolled in the public school system when their parents move to the host country for reasons of work or education. For such children, Period 1 is the period of initial acquisition, during which they may or may not have formal language support. Many return to their home countries after gaining considerable fluency in the target language, although their knowledge of the L2 is rarely assessed. In this case, Period 2 is the period of attrition, during which some children have continued access to the language—albeit with impoverished input—and some are entirely cut off from the language. In a study of this population, Period 3 is a time of relearning. The nature of this stage could differ dramatically, as some participants enroll in traditional classes at university in their home country to relearn the forgotten language of their childhood, whereas others might return to the host country as high school students or as adults to experience a more natural form of reacquisition.

These examples provide only a very general idea of the range of populations to which this model of assessment can be applied, and our discussion of these cases is in itself abbreviated. Nevertheless, we hope to have illustrated the value of discrete time periods, the conception of populations as sets of changing variables, and the importance of a schedule of both formal and informal assessments for any study of the processes of L2 attrition and retention.

CONCLUSION

The principle objective of this survey was to determine the current state of knowledge of L2 attrition, so as to elaborate a general model of

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investigation that could furnish replicable findings in this expanding domain of interest. Following a review of the most prominent hypotheses of native language loss and their status as theoretical underpinning for L2 investigations, an overview was given of research design in studies of L2 attrition, with particular attention paid to the types of tasks developed and the most widely used measures of linguistic variables. This overview provided a platform of sorts for further investigation, yet also revealed the focus on skills that has dominated research in the field up to this point; little is yet known of how specific areas of language knowledge might be differentially affected by prolonged lack of input. One particularly useful outcome of this review was that it allowed for the identification of variables by which populations may be defined as they change characteristics over time and through which comparison and replication studies may be made possible. The model delineated here suggests that populations in studies of L2 attrition are best represented as sets of features, the changing values of which may be tracked as these populations pass through discrete time periods in a general process of acquisition followed by attrition and perhaps a period of relearning.

Our focus on microassessment of particular types of linguistic knowledge leads us to an important observation. Although attrition is generally considered to be a phenomenon distinct from acquisition, experienced by specific types of populations, it might also be thought of as a normal part of the acquisition process, affecting the development of most (perhaps all) L2 learners. From a broad perspective, most learners go through periods in which their use of the language declines—for weeks, months, or years—even if the general process of acquisition subsequently continues. On closer inspection, even in periods of continuous use of the L2, not all aspects of language knowledge are regularly exercised, so that whereas gains are made in some areas, loss may be simultaneously incurred in others. Although acquisition and attrition are naturally entwined, our understanding of the latter is nevertheless likely to be enhanced through the investigation of extreme shifts in input of the type experienced by the populations discussed in this review.

The general model that we have proposed solves the major problems that surface in the attrition literature. It also incorporates the best traits of previous studies into one design for empirical research, which establishes baselines for attainment against which to measure attrition by comparing learners as individuals to themselves in longitudinal designs. In addition to supporting the fine-grained study of attrition, this model also may be used to assess the efficacy of retention materials, as both institutions and individuals strive to prevent or reverse the natural phenomenon of language loss.

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NOTES

1. Note that this overview does not subsume discussion of the special case of heritage language learning, which is outside the scope of the current survey. For insights into this vibrant field, readers may consult the upcoming special issue of the *International Journal of Bilingualism* (2009, Volume 13) on Romance languages as heritage languages, edited by Jason Rothman.

2. We focus on empirical studies of L2 attrition, but a number of earlier reviews with other perspectives may be of interest to readers (Ginsberg, 1986; Hansen, 2001; Hansen & Kurashige, 1999; Lambert & Moore, 1986; Oxford, 1982; Vechter, Lapkin, & Argue, 1990; Weltens, 1987; Weltens & Cohen, 1989).

3. This first report from the new research program in Minnesota involved a small number of participants and tested only perception, not production; Oh et al. (personal communication, November 10, 2008) plan to expand both the sample size and experimental materials.

4. Of the variants of the threshold hypothesis discussed earlier, the activation threshold hypothesis, expressed in terms of inhibition processes in declarative memory, has received scant attention so far in L2 studies.

REFERENCES

Altenberg, E. P. (1991). Assessing first language vulnerability to attrition. In H. W. Seliger & R. M. Vago (Eds.), *First language attrition* (pp. 189–206). New York: Cambridge University Press.

Ammerlaan, T. (1996). *'You get a bit wobbly': Exploring bilingual lexical retrieval processes in the context of first language attrition*. Unpublished doctoral dissertation, Katholieke Universiteit Nijmegen, Nijmegen, The Netherlands.

Andersen, R. W. (1982). Determining the linguistic attributes of language attrition. In R. D. Lambert & B. F. Freed (Eds.), *The loss of language skills* (pp. 83–118). Rowley, MA: Newbury House.

Andersen, R. W. (1983). Transfer to somewhere. In S. M. Gass & L. Selinker (Eds.), *Language transfer in language learning* (pp. 177–201). Rowley, MA: Newbury House.

As, A. (1962). The recovery of forgotten language knowledge through hypnotic age regression: A case report. *American Journal of Clinical Hypnosis*, *5*, 24–29.

Au, T. K., Knightly, L. M., Jun, S.-A., & Oh, J. S. (2002). Overhearing a language during childhood. *Psychological Science*, *13*, 238–243.

Bahrick, H. (1984a). Fifty years of second language attrition: Implications for programming research. *Modern Language Journal*, *68*, 105–111.

Bahrick, H. (1984b). Semantic memory content in permastore: Fifty years of memory for Spanish learned in school. *Journal of Experimental Psychology: General*, *113*, 1–29.

Bailey, N., Madden, C., & Krashen, S. (1974). Is there a 'natural sequence' in adult second language learning? *Language Learning*, *24*, 235–243.

Baker, W. (2007, January). *The impact of dialect and cross-language similarity on learning French and German vowels*. Paper presented at Indiana University, Bloomington.

Bardovi-Harlig, K. (2000). *Tense and aspect in second language acquisition: Form, meaning, and use*. Oxford: Blackwell.

Berko-Gleason, J. (1982). Insights from child language acquisition for second language loss. In R. D. Lambert & B. F. Freed (Eds.), *The loss of language skills* (pp. 13–23). Rowley, MA: Newbury House.

Berman, R. A., & Olshtain, E. (1983). Features of first language transfer in second language attrition. *Applied Linguistics*, *4*, 222–234.

Berman, R., & Slobin, D. (1994). *Relating events in narrative: A crosslinguistic developmental study*. Mahwah, NJ: Erlbaum.

Best, C. T. (1995). A direct realist view on cross-language speech perception. In W. Strange (Ed.), *Speech perception and linguistic experience* (pp. 171–204). Timonium, MD: York Press.

https://doi.org/10.1017/S0272263109990246 Published online by Cambridge University Press

Birdsong, D. (Ed.). (1999). *Second language acquisition and the critical period hypothesis*. Mahwah, NJ: Erlbaum.
Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.
Caramazza, A., & Zurif, E. (1978). Comprehension of complex sentences in children and aphasics: A test of the regression hypothesis. In A. Caramazza & E. Zurif (Eds.), *The acquisition and breakdown of language: Parallels and divergencies* (pp. 145–161). Baltimore: Johns Hopkins University Press.
Chomsky, N. (1959). A review of B. F. Skinner's verbal behavior. *Language*, *35*, 26–58.
Clark, J. L. D. (1981). Language. In T. S. Barrows (Ed.), *College students' knowledge and beliefs: A survey of global understanding* (pp. 87–100). New Rochelle, NY: Change Magazine Press.
Clark, J. L. D. (1982). Measurement considerations in language attrition research. In R. D. Lambert & B. F. Freed (Eds.), *The loss of language skills* (pp. 138–152). Rowley, MA: Newbury House.
Clark, J. L. D., & Jorden, E. H. (1984). *A study of language attrition in former U.S. students of Japanese and implications for design of curriculum and teaching materials: Final Project Report* [Online]. Retrieved November 1, 2008, from ERIC Document Reproduction Service, http://www.eric.ed.gov, No. ED243317.
Cohen, A. D. (1974). The Culver City Spanish immersion program: How does summer recess affect Spanish speaking ability? *Language Learning*, *24*, 55–68.
Cohen, A. D. (1975). Forgetting a second language. *Language Learning*, *25*, 127–138.
Cohen, A. D. (1986). Forgetting foreign language vocabulary. In B. Weltens, K. de Bot, & T. J. M. van Els (Eds.), *Language attrition in progress* (pp. 143–158). Dordrecht: Foris.
Cohen, A. D. (1989). Attrition in the productive lexicon of two Portuguese third language speakers. *Studies in Second Language Acquisition*, *11*, 135–149.
Cole, R. D. (1929). The effect of a summer vacation on students' knowledge of French. *Modern Language Journal*, *14*, 117–121.
Cook, V. J. (1991). The poverty-of-the-stimulus argument and multi-competence. *Second Language Research*, *7*, 103–117.
de Bot, K. (1996). Language loss. In H. Goebl, P. H. Nelde, Z. Stary, & W. Wölke (Eds.), *Contact linguistics: An international handbook of contemporary research* (Vol. 1, pp. 579–585). Berlin: Mouton de Gruyter.
de Bot, K., & Clyne, M. G. (1989). Language reversion revisited. *Studies in Second Language Acquisition*, *11*, 167–177.
de Bot, K., & Lintsen, T. (1986). Foreign-language proficiency in the elderly. In B. Weltens, K. de Bot, & T. J. M. van Els (Eds.), *Language attrition in progress* (pp. 131–141). Dordrecht: Foris.
de Bot, K., & Stoessel, S. (2000). In search of yesterday's words: Reactivating a long forgotten language. *Applied Linguistics*, *21*, 364–384.
de Bot, K., & Weltens, B. (1991). Recapitulation, regression and language loss. In H. W. Seliger & R. M. Vago (Eds.), *First language attrition* (pp. 31–51). New York: Cambridge University Press.
Dugas, L. G. (1999). *Attrition of pronunciation accuracy among advanced American learners of French*. Unpublished doctoral dissertation, Indiana University, Bloomington.
Dulay, H. C., & Burt, M. K. (1973). Should we teach children syntax? *Language Learning*, *23*, 245–258.
Dulay, H. C., & Burt, M. K. (1974). Natural sequences in child second language acquisition. *Language Learning*, *24*, 37–53.
Edwards, G. (1976). Second-language retention in the Canadian public services. *Canadian Modern Language Review*, *32*, 305–308.
Flege, J. E. (1995). Second language speech learning: Theory, findings, and problems. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 233–277). Timonium, MD: York Press.
Footnick, R. (2007). A hidden language: Recovery of a lost language is triggered by hypnosis. In B. Köpke, M. S. Schmid, M. Keijzer, & S. Dostert (Eds.), *Language attrition: Theoretical perspectives* (pp. 169–187). Amsterdam: Benjamins.
Fromm, E. (1970). Age-regression with unexpected reappearance of a repressed childhood language. *International Journal of Clinical and Experimental Hypnosis*, *18*, 79–88.

https://doi.org/10.1017/S0272263109990246 Published online by Cambridge University Press

Gardner, R. C., Lalonde, R. N., & MacPherson, J. (1985). Social factors in second language attrition. *Language Learning*, *35*, 519–540.
Gardner, R. C., Lalonde, R. N., Moorcroft, R., & Evers, F. T. (1987). Second language attrition: The role of motivation and use. *Journal of Language and Social Psychology*, *6*, 29–47.
Gass, S. M., & Selinker, L. (2008). *Second language acquisition: An introductory course* (3rd ed.). London: Routledge.
Ginsberg, R. B. (1986). Issues in the analysis of language loss: Methodology of the language skills attrition project. In B. Weltens, K. de Bot, & T. J. M. van Els (Eds.), *Language attrition in progress* (pp. 19–36). Dordrecht: Foris.
Grosjean, F., & Py, B. (1991). *La restructuration d'une première langue: L'intégration de variantes de contact dans la compétence de migrants bilingues*. [Restructuring of a first language: The integration of contact variables in the competence of bilingual migrants]. *La Linguistique*, *27*, 35–60.
Guasti, M. T. (2002). *Language acquisition: The growth of grammar*. Cambridge, MA: MIT Press.
Håkansson, G. (1995). Syntax and morphology in language attrition: A study of five bilingual ex-patriate Swedes. *International Journal of Applied Linguistics*, *5*, 153–171.
Hansen, L. (1999). Not a total loss: The attrition of Japanese negation over three decades. In L. Hansen (Ed.), *Second language attrition in Japanese contexts* (pp. 142–153). Oxford: Oxford University Press.
Hansen, L. (2001). Language attrition: The fate of the start. *Annual Review of Applied Linguistics*, *21*, 60–73.
Hansen, L., & Chantrill, C. (1999). Literacy as a second language anchor: Evidence from L2 Japanese and L2 Chinese. In P. Robinson (Ed.), *Representation and process: Proceedings of the 3rd Pacific Second Language Research Forum* (Vol. 1, pp. 279–286). Tokyo: Aoyama Gakuin University.
Hansen, L., & Chen, Y.-L. (2001). What counts in the acquisition and attrition of numeral classifiers? *Japanese Association for Language Teaching*, *23*, 90–110.
Hansen, L., & Kurashige, A. (1999). Investigating second language attrition: An introduction. In L. Hansen (Ed.), *Second language attrition in Japanese contexts* (pp. 3–18). Oxford: Oxford University Press.
Hansen, L., Umeda, Y., & McKinney, M. (2002). Savings in the relearning of second language vocabulary: The effects of time and proficiency. *Language Learning*, *52*, 653–678.
Hawkins, R. (2001). *Second language syntax: A generative introduction*. Oxford: Blackwell.
Hayashi, B. (1999). Testing the regression hypothesis: The remains of the Japanese negation system in Micronesia. In L. Hansen (Ed.), *Second language attrition in Japanese contexts* (pp. 154–168). Oxford: Oxford University Press.
Hedgcock, J. (1991). Foreign language retention and attrition: A study of regression models. *Foreign Language Annals*, *24*, 43–55.
Herschensohn, J. (2007). *Language development and age*. New York: Cambridge University Press.
Isurin, L. (2007). Teachers' language: L1 attrition in Russian-English bilinguals. *Modern Language Journal*, *91*, 357–371.
Jordens, P., de Bot, K., & Trapman, H. (1989). Linguistic aspects of regression in German case marking. *Studies in Second Language Acquisition*, *11*, 179–204.
Jordens, P., de Bot, K., Van Os, C., & Schumans, J. (1986). Regression in German case marking. In B. Weltens, K. de Bot, & T. J. M. van Els (Eds.), *Language attrition in progress* (pp. 159–176). Dordrecht: Foris.
Kaufman, D., & Aronoff, M. (1991). Morphological disintegration and reconstruction in first language attrition. In H. W. Seliger & R. M. Vago (Eds.), *First language attrition* (pp. 175–188). New York: Cambridge University Press.
Kennedy, L. (1932). The retention of certain Latin syntactical principles by first and second year Latin students after various time intervals. *Journal of Educational Psychology*, *23*, 132–146.
Köpke, B. (1999). L'attrition de la première langue chez deux groupes de bilingues tardifs [First language attrition in two groups of late bilinguals]. *Revue Parole*, *11/12*, 199–220.
Köpke, B., & Schmid, M. S. (2004). First language attrition: The next phase. In M. S. Schmid, B. Köpke, M. Keijzer, & L. Weilemar (Eds.), *First language attrition: Interdisciplinary perspectives on methodological issues* (pp. 1–43). Amsterdam: Benjamins.

https://doi.org/10.1017/S0272263109990246 Published online by Cambridge University Press

Kuhberg, H. (1992). Longitudinal L2-attrition versus L2-acquisition in three Turkish children: Empirical findings. *Second Language Research*, *8*, 138–154.
Lambert, R. D. (1982). Setting the agenda. In R. D. Lambert & B. F. Freed (Eds.), *The loss of language skills* (pp. 6–10). Rowley, MA: Newbury House.
Lambert, R. D. (1989). Language attrition. *I. T. L. Review of Applied Linguistics*, *83*, 1–18.
Lambert, R. D., & Freed, B. F. (Eds.). (1982). *The loss of language skills*. Rowley, MA: Newbury House.
Lambert, R. D., & Moore, S. J. (1986). Problem areas in the study of language attrition. In B. Weltens, K. de Bot, & T. J. M. van Els (Eds.), *Language attrition in progress* (pp. 177–186). Dordrecht: Foris.
Lardiere, D. (2006). *Ultimate attainment in second language acquisition: A case study*. Mahwah, NJ: Erlbaum.
Lenneberg, E. (1967). *Biological foundations of language*. New York: Wiley.
Lowe, P., Jr. (1982). The U.S. government's foreign language attrition and maintenance experience. In R. D. Lambert & B. F. Freed (Eds.), *The loss of language skills* (pp. 176–192). Rowley, MA: Newbury House.
Maher, J. (1991). A crosslinguistic study of language contact and language attrition. In H. W. Seliger & R. M. Vago (Eds.), *First language attrition* (pp. 67–84). New York: Cambridge University Press.
Makino, T. (1980). *Acquisition order of English morphemes by Japanese adolescents*. Tokyo: Shinozaki Shorin Press.
Maury, F. (1999). *L'adoption interraciale* [Interracial adoption]. Paris: L'Harmattan.
Mayer, M. (1969). *Frog, Where are you?* New York: Dial Press.
Meara, P. (2004). Modelling vocabulary loss. *Applied Linguistics*, *25*, 137–155.
Moorcroft, R., & Gardner, R. C. (1987). Linguistic factors in second-language loss. *Language Learning*, *37*, 327–340.
Montrul, S. (2008). *Incomplete acquisition in bilingualism: Re-examining the age factor*. Amsterdam: Benjamins.
Nagasawa, S. (1999a). The effects of initial achievement, learning experience and classroom instruction on adult attrition/retention of L2 Japanese. In P. Robinson (Ed.), *Representation and process: Proceedings of the 3rd Pacific Second Language Research Forum* (Vol. 1, pp. 287–296). Tokyo: Aoyama Gakuin University.
Nagasawa, S. (1999b). Learning and losing Japanese as a second language: A multiple case study of American university students. In L. Hansen (Ed.), *Second language attrition in Japanese contexts* (pp. 169–200). Oxford: Oxford University Press.
Nakuma, C. (1997). A method for measuring the attrition of communicative competence: A pilot study with Spanish L3 subjects. *Applied Psycholinguistics*, *18*, 219–235.
Neisser, U. (1984). Interpreting Harry Bahrick's discovery: What confers immunity against forgetting? *Journal of Experimental Psychology: General*, *113*, 32–35.
Nelson, T. (1978). Detecting small amounts of information in memory: Savings for nonrecognized items. *Journal of Experimental Psychology: Human Learning and Memory*, *4*, 453–468.
Nicoladis, E., & Grabois, H. (2002). Learning English and losing Chinese: A case study of a child adopted from China. *International Journal of Bilingualism*, *6*, 441–454.
Oh, J., Au, T. K., & Jun, S.-A. (2009). The nature of childhood language memory: Korean adoptees learning Korean as adults. In J. Chandlee, M. Franchini, S. Lord, & G.-M. Rheiner (Eds.), *Proceedings of the 33rd Annual Boston University Conference on Language Development*, (Vol. 2, pp. 391–397). Somerville, MA: Cascadilla Press.
Oh, J., Jun, S.-A., Knightly, L., & Au, T. K. (2003). Holding on to childhood language memory. *Cognition*, *86*, B53–B64.
Olshtain, E. (1986). The attrition of English as a second language with speakers of Hebrew. In B. Weltens, K. de Bot, & T. J. M. van Els (Eds.), *Language attrition in progress* (pp. 187–204). Dordrecht: Foris.
Olshtain, E. (1989). Is second language attrition the reversal of second language acquisition? *Studies in Second Language Acquisition*, *11*, 151–165.
Oxford, R. L. (1982). Research on language loss: A review with implications for foreign language teaching. *Modern Language Journal*, *66*, 160–169.
Pallier, C. (2007). Critical periods in language acquisition and language attrition. In B. Köpke, M. S. Schmid, M. Keijzer, & S. Dostert (Eds.), *Language attrition: Theoretical perspectives* (pp. 155–168). Amsterdam: Benjamins.

https://doi.org/10.1017/S0272263109990246 Published online by Cambridge University Press

Pallier, C., Dehaene, S., Poline, J.-B., LeBihan, D., Argenti, A.-M., Dupoux, E., et al. (2003). Brain imaging of language plasticity in adopted adults: Can a second language replace the first? *Cerebral Cortex*, *13*, 155–161.

Paradis, M. (2004). *A neurolinguistic theory of bilingualism*. Amsterdam: Benjamins.

Paradis, M. (2007). L1 attrition features predicted by a neurolinguistic theory of bilingualism. In B. Köpke, M. S. Schmid, M. Keijzer, & S. Dostert (Eds.), *Language attrition: Theoretical perspectives* (pp. 121–133). Amsterdam: Benjamins.

Pavlenko, A. (2004). L2 influence and L1 attrition in adult bilingualism. In M. S. Schmid, B. Köpke, M. Keijzer, & L. Weilemar (Eds.), *First language attrition: Interdisciplinary perspectives on methodological issues* (pp. 47–59). Amsterdam: Benjamins.

Prévost, P., & White, L. (2000). Missing surface inflection or impairment in second language acquisition? Evidence from tense and agreement. *Second Language Research*, *16*, 103–133.

Raffaldini, T. (1987). *Attrition of communicative ability among former year abroad students of French*. Unpublished doctoral dissertation, Indiana University, Bloomington.

Reetz-Kurashige, A. (1999). Japanese returnees' retention of English-speaking skills: Changes in verb usage over time. In L. Hansen (Ed.), *Second language attrition in Japanese contexts* (pp. 21–58). Oxford: Oxford University Press.

Robinson, P. (2005). Aptitude and second language acquisition. *Annual Review of Applied Linguistics*, *25*, 46–73.

Russell, R. A. (1999a). Lexical maintenance and attrition in Japanese as a second language. In L. Hansen (Ed.), *Second language attrition in Japanese contexts* (pp. 114–141). Oxford: Oxford University Press.

Russell, R. A. (1999b). Measuring attrition in L2 Japanese syntactic competence. In P. Robinson (Ed.), *Representation and process: Proceedings of the 3rd Pacific Second Language Research Forum* (Vol. 1, pp. 297–308). Tokyo: Aoyama Gakuin University.

Scherer, G. A. C. (1957). The forgetting rate of learning German. *German Quarterly*, *30*, 275–277.

Schmid, M. S. (2002). *First language attrition, use and maintenance: The case of German Jews in Anglophone countries*. Amsterdam: Benjamins.

Schultheiss, L. K. G. (2008). *Cross-language perception of German vowels by speakers of American English*. Unpublished master's thesis, Brigham Young University, Utah.

Schreuder, R., & Weltens, B. (1993). Attrition of vocabulary knowledge. In R. Schreuder & B. Weltens (Eds.), *The bilingual lexicon* (pp. 135–156). Amsterdam: Benjamins.

Seliger, H. W. (1991). Language attrition, reduced redundancy and creativity. In H. W. Seliger &R. M. Vago (Eds.), *First language attrition* (pp. 227–240). New York: Cambridge University Press.

Sharwood Smith, M. A. (1989). Crosslinguistic influence in language loss. In K. Hyltenstam & L. K. Obler (Eds.), *Bilingualism across the lifespan* (pp. 185–201). New York: Cambridge University Press.

Sharwood Smith, M. A., & Van Buren, P. (1991). First language attrition and the parameter setting model. In H. W. Seliger & R. M. Vago (Eds.), *First language attrition* (pp. 17–30). New York: Cambridge University Press.

Smythe, P. C., Jutras, G. C., Bramwell, J. R., & Gardner, R. C. (1973). Second language retention over varying intervals. *Modern Language Journal*, *57*, 400–405.

Snow, M. A., Padilla, A. M., & Campbell, R. N. (1988). Factors influencing language retention of graduates of a Spanish immersion program. *Applied Linguistics*, *9*, 182–197.

Tees, R. C., & Werker, J. F. (1984). Perceptual flexibility: Maintenance or recovery of the ability to discriminate nonnative speech sounds. *Canadian Journal of Psychology*, *38*, 579–590.

Tomiyama, M. (1999a). The first stage of second language attrition: A case study of a Japanese returnee. In L. Hansen (Ed.), *Second language attrition in Japanese contexts* (pp. 59–79). Oxford: Oxford University Press.

Tomiyama, M. (1999b). The later stages of natural L2 attrition. In P. Robinson (Ed.), *Representation and process: Proceedings of the 3rd Pacific Second Language Research Forum* (Vol. 1, pp. 309–320). Tokyo: Aoyama Gakuin University.

Tomiyama, M. (2000). Child second language attrition. *Applied Linguistics*, *21*, 304–332.

Tomiyama, M. (2008). Age and proficiency in L2 attrition: Data from two siblings. *Applied Linguistics*, *29*, 1–23.

Vechter, A., Lapkin, S., & Argue, V. (1990). Second language retention: A summary of the issues. *Canadian Modern Language Review*, *46*, 189–203.

https://doi.org/10.1017/S0272263109990246 Published online by Cambridge University Press

Ventureyra, V., & Pallier, C. (2004). In search of the lost language: The case of adopted Koreans in France. In M. S. Schmid, B. Köpke, M. Keijzer, & L. Weilemar (Eds.), *First language attrition: Interdisciplinary perspectives on methodological issues* (pp. 207–221). Amsterdam: Benjamins.

Ventureyra, V., Pallier, C., & Yoo, H.-Y. (2004). The loss of first language phonetic perception in adopted Koreans. *Journal of Neurolinguistics*, *17*, 79–91.

Weltens, B. (1987). The attrition of foreign-language skills: A literature review. *Applied Linguistics*, *8*, 22–37.

Weltens, B. (1989). *The attrition of French as a foreign language*. Dordrecht: Foris.

Weltens, B., & Cohen, A. D. (1989). Language attrition research: An introduction. *Studies in Second Language Acquisition*, *11*, 127–133.

Weltens, B., & Grendel, M. (1993). Attrition of vocabulary knowledge. In R. Schreuder & B. Weltens (Eds.), *The bilingual lexicon* (pp. 135–156). Amsterdam: Benjamins.

Weltens, B., & van Els, T. J. M. (1986). The attrition of French as a foreign language: Interim results. In B. Weltens, K. de Bot, & T. J. M. van Els (Eds.), *Language attrition in progress* (pp. 205–221). Dordrecht: Foris.

Weltens, B., van Els, T. J. M., & Schils, E. (1989). The long-term retention of French by Dutch students. *Studies in Second Language Acquisition*, *1*, 205–216.

Yoshitomi, A. (1992). Towards a model of language attrition: Neurobiological and psychological contributions. *Issues in Applied Linguistics*, *3*, 293–318.

Yoshitomi, A. (1999). On the loss of English as a second language by Japanese returnee children. In L. Hansen (Ed.), *Second language in Japanese contexts* (pp. 80–113). Oxford: Oxford University Press.

https://doi.org/10.1017/S0272263109990246 Published online by Cambridge University Press