Cognitive Architectures in Morphological Processing: Acquisition and Attrition

by

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ABSTRACT

In the current project I used an interdisciplinary experimental approach to investigate morphological processing in French. At issue were (1) the priorities of the language processor upon initial visual exposure to morphologically complex words: is it most sensitive to morphemic structure, or orthographic form? (2) Whether lexical processing in L1 is different from that in L2, and in L2 attrition?

To address these questions, three experiments were run. In Experiment 1, native, early L2, and early L2 speakers with attrition performed lexical decisions on targets (*CROIRE*) preceded by (1) identity (*croire*), (2) morphologically-related, inflectional (*croyais*), or derivational (*doucement- DOUCE*), and (3) unrelated primes (*écrire*). Priming occurred in the identity and the derivationally-related conditions, which was consistent with morpheme-based accounts of word representation and processing. No significant differences were found between language groups supporting the view that (1) early L2 speakers process morphologically complex words in a native-like fashion, and (2) lexical processing in attrition is not necessarily different from that in acquisition.

This same design was used in Experiment 2 with some additions: (1) more items per experimental condition; (2) an orthographic condition (*donnecte-DONNER*); and (3) a late L2 group. The latter had learned French after age 11 and used it frequently. Priming was found in the identity and the morphologically related conditions but not in the orthographic condition. As in Experiment 1, the various groups did not differ statistically with respect to priming effects, supporting arguments for similar rather than different processing patterns as a function of language experience.

In Experiment 3 participants performed gender decisions on targets (e.g., *CHEMISE*$_{fem}$) primed by a derivative of the same (e.g., *chemisette*$_{fem}$), or the opposite gender (i.e., *chemisier*$_{masc}$) in the morphological condition. In the unrelated condition, unrelated primes of the same (*tasse*$_{fem}$) or different gender (*gâteau*$_{masc}$) were used. Priming was found in the morphological conditions but there were no gender congruency effects. Morphological relatedness conveyed through a suffix, thus, seems to have an impact on lexical access, in support of evidence from Experiment 1 and 2 that morphemic structure impacts lexcical processing in native and non-native processing.

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CHAPTER 1

INTRODUCTION

BACKGROUND AND PURPOSE OF THE PRESENT RESEARCH

Evidence drawn from spontaneous speech errors in a number of natural languages has shown that inside our mental lexicon, there must be a specific architecture of lexical units that allows us to arrange words into meaningful combinations. Slips of the tongue of the type "*I thought the park was trucked*" (for *I thought the truck was parked*), where two meaningful units exchange positions, suggest that producing a complex word involves activating different units separately (Garrett, 1980). In English, as is the case with many other natural languages, complex words consist of combinations of minimal meaning-bearing units, called morphemes (Henderson, 1985, Seidenberg & Gonnerman, 2000). For example, the free morpheme (i.e., can exist on its own) *read* can be combined with the bound morpheme (i.e., cannot exist on its own)*–er* to form the word *reader*, and *reader* can be combined with the bound morpheme *-s* to form the word *readers*. Transforming *read* into *reader* represents a case of derivational morphology, and it involves a change in meaning and syntactic category between the two words (i.e., from the verb *read* to the noun *reader*). Transforming *reader* into *readers* involves an inflectional process that does not change the syntactic category, or the word meaning, rather it marks number as a syntactic feature.

Several decades of psycholinguistic research on morphological processing have shown that the human cognitive system is sensitive to the structure of complex words (Bozic & Marslen-Wilson, 2010). The process of creating new words by combining morphemes is central to understanding complexity in language production and comprehension. Although this process is automatic and effortless in healthy individuals, in individuals with neurological disorders (e.g., aphasia, an acquired language disorder after stroke) it is rather challenging (Jarema, 2008; Jarema & Kehayia, 1992; Jarema & Libben, 2006; Nasti & Marangolo, 2005). The goal of the present research is to explore morphological processing in various groups of French speakers who vary in their language experience, including age of acquisition and frequency of use. I was specifically interested in exploring processing in attrition, a non-pathological phenomenon that characterizes human language when a particular language is used infrequently over a long period of time.

Although languages vary with respect to what types of information can be encoded in their morphological systems (for example, some languages like Arabic, Hebrew, French, and German encode grammatical gender inflectionally whereas English does not), morphological structure plays an important role in the organization of the mental lexicon in many languages (Colé, Segui, & Taft, 1979; Frost, Forster, & Deutsch, 1997; Longtin & Meunier, 2005; Longtin, Segui, & Hallé, 2003; Marslen-Wilson, Tyler, Waksler, & Older, 1994, 2008; Rastle, Davis, Marslen-Wilson, & Tyler, 2000, Rastle, Davis, & New, 2004; Taft, 1994, 2003).

Several models make claims about how morphologically complex words are accessed and stored, and whether morphemes and stems in complex words are stored independently or whether these types of words are stored in their full form. Based on these claims, the models can be classified into two groups; symbolic models and connectionist models. The theoretical distinction between the two groups of models reflects a key issue in cognitive science: that is, between the classic approach of mental computation where language is viewed as a set of symbolic rules (i.e., symbolic accounts), versus connectionist accounts in which language processing occurs sub-symbolically and patterns of performance reflect the statistical properties of the sub units (Kielar, Joanisse, & Hare, 2008).

Symbolic models assume morphological structure in their models of lexical processing and representation (Baayen, Schreuder & Sprodt 2000; Domínguez, de Vega & Barber 2004; McQueen & Cutler 1998; Marslen-Wilson & Tyler, 2007). In contrast, connectionist models (McClelland & Rumelhart, 2002; Seidenberg & McClelland, 1989; Sereno & Jongman, 1997; Elman & Bates, 1996; McClelland & Patterson, 2002; Seidenberg & Gonnerman, 2000) assume that all word forms are stored in an associative lexicon where morphological structure plays no direct role in the way complex words are produced or perceived. On this view, all kinds of morphological patterns, including those that can be decomposed into stems, roots, and affixes, are claimed to be derivable from associative networks, and complex words are assumed to be stored as full forms in memory (Bozic & Marslen-Wilson, 2010). Thus, in connectionist models, words are organized according to the intersection of formal (orthographic/phonological) and semantic information, or to what is known as the "convergence of codes" (Bates & Godham, 1997; Devlin, Jamison, Matthews & Gonnerman 2004; Seidenberg & McClelland, 1989; Seidenberg & Gonnerman, 2000) rather than according to morphological families. In this sense, decomposition is not an all-or-none-phenomenon and morphology does not have any special status in the lexicon and is, therefore, not relevant to lexical representation and processing (Royle, Drury, Bourguignon, &

Steinhauer, 2010). This assumption of connectionist models also means that morphological processing should vary as a function of the degree of semantic and phonological transparency of words and according to differing morphological productivity and richness across languages (Plaut & Gonnerman, 2000).

Most symbolic accounts, (e.g., dual mechanism models, Clahsen, 1999; Pinker, 1991, 1997, 1999; Pinker & Ullman, 2002) posit two distinct representational systems and corresponding processing mechanisms for morphologically complex words. Some models assume that whole word representations are stored in memory and are directly retrieved from the lexicon during processing. Other models assume morphologically structured representations and thus use morphologically-based parsing during processing. According to the dual mechanism model, different language experiences may be reflected in morphological processing differences.

For example, according to the declarative/procedural model, a dual mechanism model proposed by Ullman (2005), processing in L1 (i.e., the speaker's first language) is based on two different memory systems. The full form route is based on declarative memory systems (situated in the temporal lobe) and assumes that some morphologically complex words are accessed via mental representations that correspond to whole word forms (e.g., the irregular past tense in English). In contrast, the de-compositional route is based on procedural[1] memory systems (located in the frontal cortex and basal ganglia),

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[1] Both systems are involved in morphological pattern learning, the declarative system specializes in associative mapping, whereas the procedural system is dedicated to the learning and use of rules. Ullman (2004) advocates an interaction between these systems

where complex words (e.g., the regular past tense in English) are accessed after being broken down into their constituent morphemes (Ullman, 2005). The existence of dual routes has received empirical support in the literature on morphological complexity (Fiorentino & Poeppel, 2007). Some researchers have argued that there are fundamental differences in the processing of morphologically complex words between first (L1) and second (L2) language speakers (Silva & Clahsen, 2008). L1 English speakers in Silva and Clahsen (2008) were found to rely more on procedural systems than L2 speakers who acquired their L2 at a relatively late age (i.e., after 11). In connectionist models, on the other hand, no differences would be predicted based on age of acquisition.

Most research on morphological processing has focused on English, a language with an impoverished system of verbal morphology compared to many other languages (such as Finnish or French). A few studies have looked at morphological priming in Dutch (Davis, Van Casteren, & Marslen Wilson, 2003; Post, Marslen-Wislon, & Tyler, 2008), German (Clahsen & Neubauer, 2009), Finnish (Lehtonen & Laine, 2003), and French (Longtin & Meunier, 2005). Thus, the various existing accounts of processing morphological complexity are very much dominated by the properties of English and may not be applicable to morphologically richer languages. Further, most research has compared representations in L1 and L2 acquisition in the typical populations (i.e., no attrition), and only a few studies (Silva & Clahsen, 2008; Gor & Cook, 2010) have looked at morphological processing in L2 speakers who acquired L2 at a relatively late age (i.e., after 11).

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during learning, arguing that "in some cases explicit knowledge of the rules themselves may help guide processing, perhaps enhancing the procedural rule acquisition" (p. 247).

Consequently, in the current research I investigated morphological processing in four groups of French speakers. I explored differences in the representation of morphologically complex words for two groups of L2 French speakers, a group who learned French before the age of 11 years and have continued to use the language on a regular basis and as such remained fluent and maintained their competence in the language (i.e., practicing L2 speakers), and a non-practicing group who learned French at roughly the same age but stopped using it over the years and as a result lost some of their linguistic skills. Performance from each of these two groups was compared to a control group of native French speakers, and to a group of practicing L2 speakers who learned French after age 11 (i.e., late L2) to see whether fundamental differences in processing exist. I also examined the question of how disuse affects morphological processing by comparing the attriting and non-attriting L2 bilingual groups who learned the language before age 11. Thus, I examined the nature of native French morphological processing and whether morphological processing in attrition[2] is different from processing in L2 acquisition. With reference to different models of lexical processing (i.e., symbolic vs. connectionist models), I argue that within these models, an interdisciplinary approach to attrition that transcends descriptions and focuses on processing rather than on retention levels will better highlight fundamental differences and/or similarities in lexical processing between attriters and non-attriters, differences and similarities that are grounded in psychological theory.

In this project, morphological processing across the four groups was studied using masked priming in a lexical decision task. In the priming task, participants were

[2] In this research I looked particularly at L2 attrition.

presented with French words preceded by primes from each of three conditions; (1) identity (e.g., croire-CROIRE[3]), (2) morphological (croyais-CROIRE), and (3) unrelated (écrire-CROIRE) (i.e., believe-BELIEVE, believed-BELIEVE, write-BELIEVE, respectively). The prediction was that, similar to previous research (e.g., Silva & Clahsen, 2008), priming effects would be found. Specifically, the response times (RTs) to the targets are predicted to be faster in the identity than the unrelated (i.e. repetition or identity priming) and faster in the morphological condition relative to the unrelated (i.e., morphological priming). A morphological priming effect would be indicative of morphological parsing processes (a de-compositional process) as it indicates that participants automatically de-compose the item first into constituent morphemes. In other words, faster responses on targets (e.g. *CROIRE*) primed by a morphologically related item (e.g., *croyais*-believed) compared to a morphologically unrelated item (e.g., *dansais*-danced) would indicate that *croyais* was decomposed into *croire*-believe plus the imperfect morpheme, and it is the fact that *croire* has already been activated that speeds up the recognition of *croyais*, rather than that the full form representation was activated in memory.

Items were categorized according to frequency (high vs. low using the database lexique, www.lexique.org, New & Pallier). The prediction with respect to frequency was that if frequency plays a role in processing, a frequency priming effect may not be found equally for high and low frequency items. In other words if high frequency words are stored in their full form, as dual route models claim (Baayen, Dijkstra, & Schreuder, 1997; Bertram, Schreuder, & Baayen, 2000; Caramazza, Laudanna, & Romani, 1988;

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[3] Primes are presented in lowercase and targets are presented in uppercase.

Pinker & Ullman 2002), there should not be a significant difference in priming between the three conditions for high frequency items (i.e., responses to the targets primed with the identity and morphological items should not significantly vary relative to the unrelated condition, except that identity priming should still occur). In contrast, for low frequency words both identity and morphological priming should be found.

In Experiment 1, three groups were tested: a native French speaking group; an early French-English bilingual group consisting of L2 speakers who still use French frequently in their daily life; and a non-practising early French L2 speakers group (i.e., those who stopped using French for the last five years or more). Performances of participants from each group were compared to draw conclusions about how they process morphologically complex words as a factor of (a) age of exposure and frequency of use of the language, and (b) frequency of the complex words and if that has any effect on whether they decompose morphologically complex words or process them as full forms. Participants filled in a language background questionnaire as well as participated in a masked visual priming lexical decision task.

In Experiment 2, four French speaking groups were tested: the same three groups from Experiment 1, plus a late bilingual group. The same stimuli from Experiment 1 were also used with more items added to each of the three conditions. A fourth condition was added where the prime shared some orthographic characteristics with the target but no morphological similarity (as in boire-CROIRE). This condition was meant to help separate morphological priming from orthographic interference and ensure that any priming effects found in Experiment 1 were indeed morphological and not a result of orthographic overlap. Thus, if RTs from the orthographic condition were significantly faster than those from the unrelated condition, that would be indicative of orthographic effects. According to connectionist models priming would not result solely from discrete morphemic units, but instead as a graded effect of semantic and formal similarity.

Thus, the aim of the current research was twofold; to advance our understanding of morphological representation in the mental lexicon first by looking at inflection versus derivation in French, a relatively richer language (morphologically) than English, but one that has not been studied as extensively, and second by studying distinct populations. By introducing different groups of French speakers and comparing the representation of morphologically complex words for native speakers, fluent L2 speakers, and non-practising L2 speakers, my goal is to contribute to our understanding of the architecture of the mental lexicon, particularly the organization of morphological complexity in native and non-native speakers. I also wanted to outline a new approach to thinking about attrition, and to investigate the question of whether attrition involves a change in lexical processing (from the procedural to the declarative).

To further understand morphological processing in these four groups, in Experiment 3 a different task was used where participants were asked to perform gender decisions on words that are (a) either morphologically related and of the same gender as their base or root morpheme (i.e., $\textit{chemisette}_{fem}$ -$\textit{CHEMISE}_{fem}$), or (b) of the opposite gender (i.e., $\textit{chemisier}_{masc}$ -$\textit{CHEMISE}_{fem}$), or (c) morphologically unrelated and either of the same ($\textit{tasse}_{fem}$-$\textit{CHEMISE}_{fem}$), or (d) opposite gender ($\textit{gateau}_{masc}$-$\textit{CHEMISE}_{fem}$). Faster responses for the morphologically related conditions (relative to the unrelated conditions) would suggest that morphologically complex gender words are decomposed into their constituent morphemes during identification. If there is an advantage for morphologically related items that have the same gender as the target words that would suggest that their gender morphemes are activated (in support of a de-compositional style).

STRUCTURE OF THE PRESENT RESEARCH

In this thesis, I review (a) theoretical approaches of the representation of morphology in the mental lexicon in native speakers and L2 acquisition literature, and (b) the literature on language attrition[4], focusing on the major findings and on the areas or questions that remain unresolved. Then, I follow with a discussion of limitations of the classic approach for understanding attrition and why a quantitative look at the processing of particular knowledge (lexical knowledge in the current case) might be more suggestive about the phenomenon of attrition than the common descriptive analysis that generally looks at what features appear to be lost or retained in a particular language group. Finally, I present the results from each experiment and a general discussion of those results. I explain the empirical findings from the perspective of the symbolic versus connectionist models arguing that the mental mechanisms and representations for processing morphologically complex words are similar rather than different in native French speakers, early and late L2 learners of French, and L2 attrition when L2 has been acquired at an early age (before 11) and used less frequently later on.

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[4] It is important to note here that most research on attrition has focused on L1.

CHAPTER 2

THE REPRESENTATION OF MORPHOLOGY IN THE MENTAL LEXICON: THEORETICAL APPROACHES

An important question often raised in conjunction with the role of morphology in lexical processing is whether morphemes and stems in complex words are stored independently, or whether these words have their own stored entries. Based on this question, models of morphological processing can be divided into two main classes; symbolic models, and associative connectionist models. In the first class are single mechanism models which postulate that all linguistic knowledge is learned, stored, and computed over a single associative learning mechanism (an associative memory) that is responsive to properties of the stimulus, such as frequency of occurrence and phonological similarity (Ullman 2001). Models such as the full listing models (e.g., Butterworth, 1983; Bybee, 1995) as well as de-compositional models (e.g., Clahsen, 1999; Giraudo & Grainger, 2000; Marslen-Wilson, Tyler, Waksler, & Obler, 1994; Rastle, Davis, & New, 2004; Taft 1979, 2004) fall under this class. Single mechanism models also include localist connectionist models such as the Interactive Activation model (IA) proposed by McClelland and Rumelhart (1981), and distributed connectionist models such as the Parallel Distributed Processing PDP model (McClelland & Rumelhart and the PDP Group, 1986).

The second class consists of dual mechanism or dual route (race) models (Baayen, Dijkstra, & Schreuder, 1997; Bertram, Schreuder, & Baayen, 2000; Caramazza, Laudanna, & Romani, 1988; Pinker & Ullman 2002) which postulate that complex forms can be processed either as whole words or through morphological decomposition.

SINGLE MECHANISM MODELS

Full listing and de-compositional models

Full listing models (e.g., Butterworth, 1983; Bybee, 1995) posit that morphologically complex words are stored separately from their derivations and inflections and accessed via mental representations that correspond to whole word forms. According to these models there is no morphemic level of representation and lexical access is fast but requires more storage space. De-compositional models (e.g., Clahsen, 1999; Giraudo & Grainger, 2000; Marslen-Wilson et al., 1994; Rastle et al., 2004, Taft 1979, 2004), on the other hand, stipulate that most classes of complex words are represented and processed in a decomposed form. They posit a level of representation at which morphologically complex words are necessarily broken down into their constituent morphemes. Irregular past tense and mono-morphemic words, for example, are accessed through the mental representations of their constituent morphemes. Lexical access is slow and more prone to error but spares storage space in long-term memory (Taft 1979). Schreuder and Baayen (1995) and Lowie (1998), for instance, argued that affixes have their own independent representations called "morphological types", which contain syntactic and semantic information and refer to information about phonological and morphological characteristics.

Connectionist models

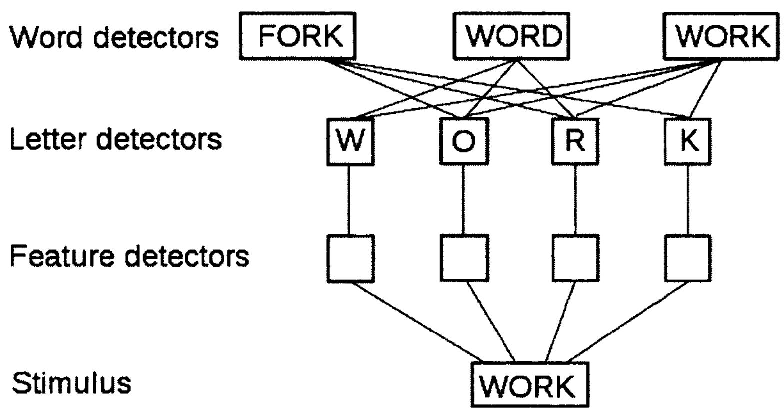
Most connectionist models assume that word forms are stored in an associative lexicon where morphological structure plays no direct role in the way complex words are produced or perceived (Bozic & Marslen-Wilson, 2010). Information is conveyed through many interconnected units or nodes. The nodes have activation levels or thresholds that can turn them on or off. All kinds of morphological patterns including those that can be decomposed into stems, roots, and affixes are claimed to be derivable from associative networks, and complex words are assumed to be stored as full forms in memory (Bozic & Marslen –Wilson, 2010). Thus in a case of word recognition, for example, the word's stimulus properties activate various nodes and their corresponding connections to produce a pattern or state of activation. Recognizing a word consists essentially of adjusting the strengths of the connections in a way that leads to the production or recognition of the desired outputs (Berko-Gleason & Bernstein-Ratner, 1998).

a-The interactive activation model (McClelland & Rumelhart, 1981)

The interactive activation model (IA), proposed by McClelland and Rumelhart (1981) was the first computational model of lexical representation (Figure 1). As a connectionist model, the IA embodies the hypothesis that word recognition is driven by a competitive activation process (Davis, 2003).

Thus, and as shown in Figure 1 below, upon exposure to the word *work* each of the stimulus letters are processed simultaneously. The first step of processing consists in recognizing the features of the individual letters (horizontal lines, diagonal lines, curves...). These features are then sent to the letter detector level, where each of the letters in the stimulus word is recognized simultaneously. The letter level then sends activation to the word detector level. The *W* in the first letter detector position sends activation to all the words that start with the letter *W* (e.g., *WORD* and *WORK*). The *O* in the second letter detector position sends activation to all the words that have an *O* in the second position (*FORK*, *WORD*, and *WORK*). While *FORK* and *WORD* have activation from three of the four letters, *WORK* has the most activation because it has all four letters activated, and is thus the recognized word (McClelland & Rumelhart, 1981).

Figure 1. The interactive activation model (McClelland & Rumelhart, 1981). Adapted from Larson (2004).



With respect to morphologically complex words, the IA model assumes that complex words activate representations of both the whole word and its constituents. Thus, morphological components are identified by matching them against lexical knowledge and the activated constituents contribute to activation of the whole word form. Constituents that are of higher frequency than the whole word achieve high levels of activation early in processing and increase the speed with which the detector for the complete word reaches threshold (Andrews & Davis, 2002). Thus, presentation of a target word results in the activation of not only the target's representation, but also the representations of orthographically similar words. Competition among these representations is assumed to result in the selection of the target and the suppression of competing words. According to this model, our knowledge of letter combinations arises from interactions between orthographic, semantic, and phonological processing (Seidenberg & McClelland, 1989; Plaut, McClelland, Seidenberg & Patterson, 1996).

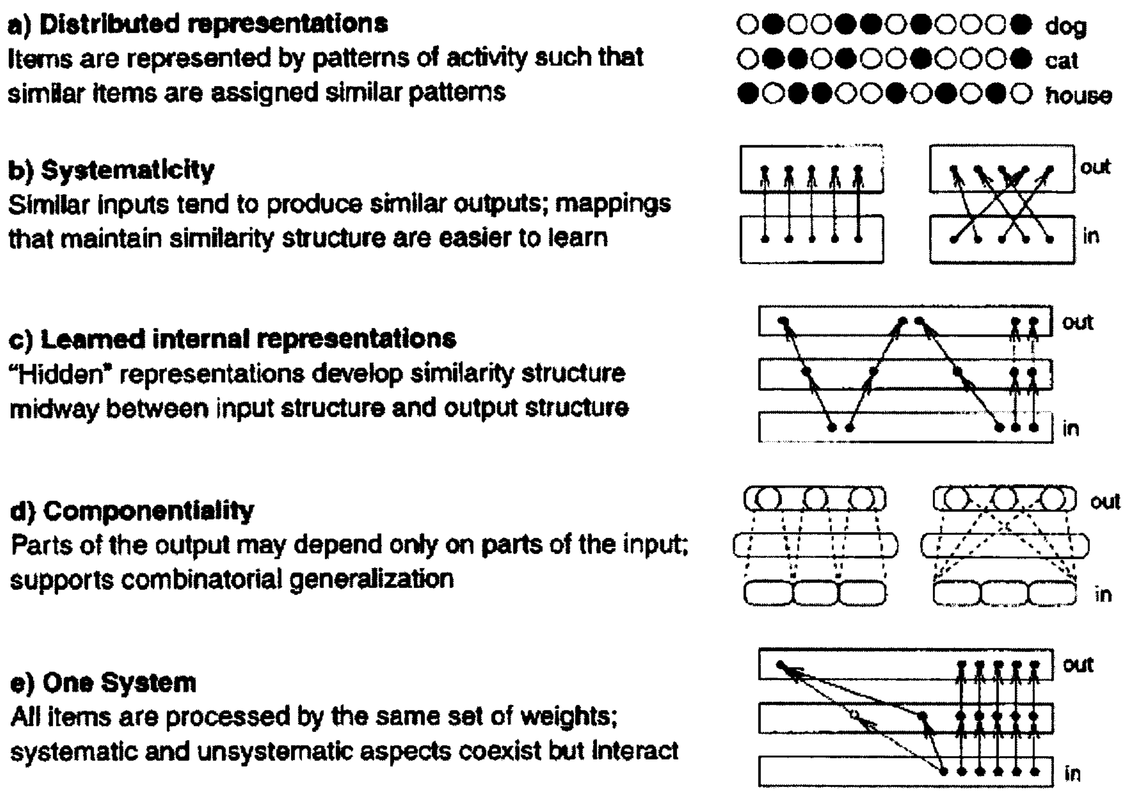
b- Distributed connectionist models: the parallel distributed processing (PDP) model

From a distributed connectionist approach, morphological structure ultimately derives from graded systematicity among surface forms of words and their meanings (Plaut & Gonnerman, 2000). Morphology, thus, reflects learned sensitivity to the systematic relationships among orthography, phonology, and semantics (Plaut & Gonnerman, 2000). In other words, morphological relations are seen as a result of correlations between orthography/phonology and semantics. Thus, a particular surface pattern that occurs in many words and maps consistently to certain aspects of meaning will be processed and represented relatively independently of the other parts of the word. In this sense priming would still occur in pairs like *boire-croire* albeit to a lesser extent as a result of lack of the semantic component typically found in identity or morphologically related pairs. As a matter of fact, Gonnerman, Andersen, and Seidenberg (2000) found that prime-target pairs with intermediate degrees of semantic or phonological transparency resulted in graded priming effects. They argued that the magnitude of priming effects that reflect morphological processing varies as a function of the degree of semantic and phonological transparency of words in support of a connectionist account.

The importance of learning is stressed in distributed connectionist models, where learning involves modifying the connection weights to reflect these correlations between form and meaning. In this sense, a distributed connectionist approach would also predict that effects claimed to be morphological in nature should vary as a function of the degree of semantic and phonological transparency, and that they could be accounted for by other lexical variables, such as orthographic, phonological, and semantic features of words (Ham & Seidenberg, 2004; Plaut & Gonnerman, 2000; Baayen, Milin, Filipović Đurđević, Hendrix, & Marelli, 2011).

Connectionist models are based on computational principles that bear various implications for morphological processing. Among these principles are (1) distributed representations, (2) systematicity, and (3) componentiality. The distributed representations principle implies that similar items are represented by similar patterns of activity (Figure 2). Systematicity reflects the tendency of the system to produce similar responses to similar inputs (for example, "cat" and "cap" are read easily in English due to the fact that they are spelled similarly, however they are not systematically related in meaning, and comprehension of "cat" does not help with comprehending "cap"). Of particular relevance to morphological processing is the principle of componentiality: "the degree to which parts of the input can be mapped independently from the rest of the input" (Plaut & Gonnerman, 2000, p 459). With respect to lexical processing in general, componentiality implies that on exposure to examples of inputs and outputs from a particular task (e.g., comprehension, or production), the network learns to map parts of the input to parts of the output in a way that will handle the systematic aspects of the task and generalize to novel forms allowing novel new combinations of familiar parts to be processed effectively (Figure 2).

Figure 2. *Principles of connectionist modelling. In the diagrams, the circles represent units and the ovals represent groups of units. The rectangles represent similarity spaces in which the points correspond to different entities; the distance between points indicates the relative similarity (overlap) of the corresponding representations. Arrows indicate mappings between representations. Adapted from Plaut and Gonnerman (2000).*



Similar to other connectionist models, the Parallel Distributed Processing (PDP) model (McClelland, Rumelhart & the PDP group, 1986) asserts that lexical representation is modelled at the neuronal level in a seemingly metaphoric relationship between nodes and neurons. Connections, rather than rules, underlie language development. The model provides a single interconnected network that accounts for all types of words (e.g. regular words, irregular words and non-words). In such a model, however, many operations can take place simultaneously or in parallel. The PDP model has been used to describe how particular grammatical structures such as the inflectional system may be acquired (Berko-Gleason & Bernstein-Ratner, 1998). McClelland and his colleagues claim that sufficient exposure will lead to the establishment of neural networks and have modeled in a computer how a child might acquire simple past tenses in English. In doing so, they argue, the processor (child or machine) simply computes the input frequencies of the phonological characteristics of word stems and the corresponding phonological patterns in the suffix. If a particular sequence is statistically likely, the model will extend previously noted regularities to the new data (Berko-Gleason & Bernstein-Ratner, 1998).

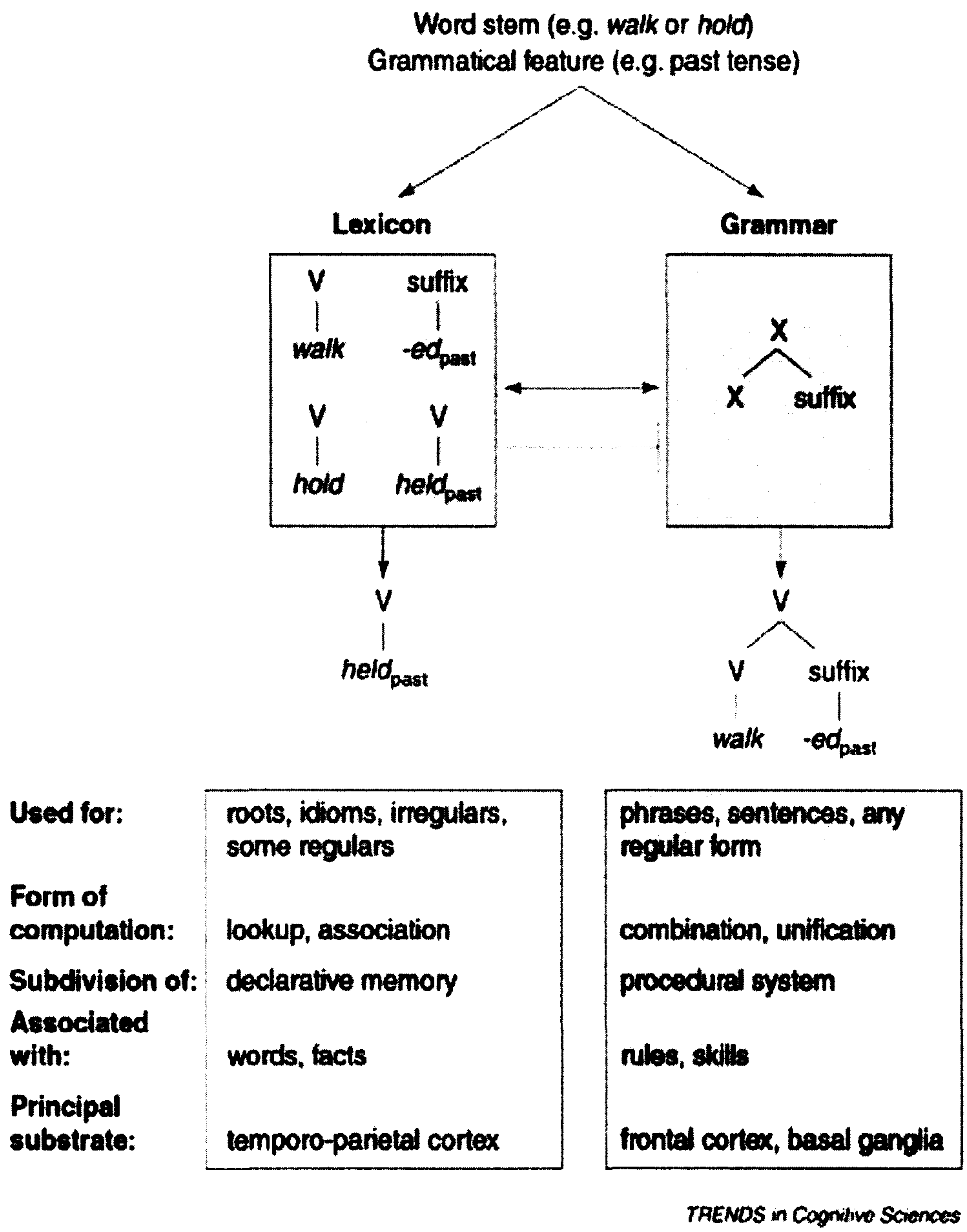
DUAL MECHANISM MODELS

The declarative procedural model

According to dual mechanism or dual route models, word recognition is achieved by the use of two separate processing pathways, where each route has its own specific functional role: (1) a full form route, where morphologically complex words are accessed via mental representations that correspond to whole word forms, and (2) a de-compositional route, where words are accessed through the mental representations of their constituent morphemes (Ullman, 2001). Parallel dual processing models propose that both the morphological storage and the storage of complex words as unified entries can exist and be activated simultaneously for different lexical items (Figure 3).

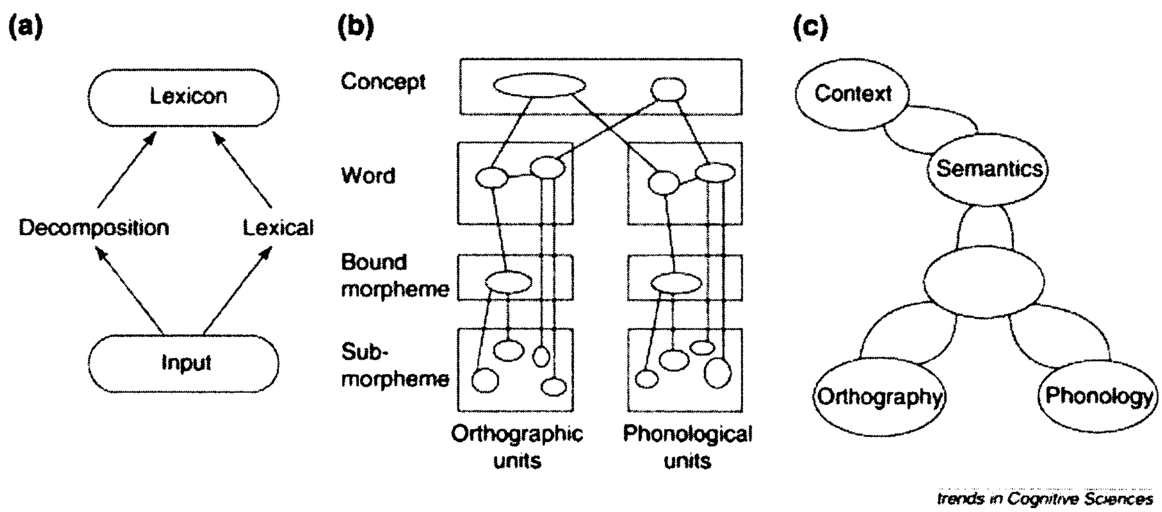
In Figure 3, below, a simplified illustration of the Words-and-Rules theory (Pinker, 1999) and the Declarative/Procedural hypothesis (Ullman, 2001) shows that when a word is to be inflected, the lexicon and grammar are accessed in parallel. If an inflected form for a verb (V) exists in memory, as with irregulars (e.g. held), it will be retrieved; a signal indicating a match blocks the operation of the grammatical suffixation process via an inhibitory link from lexicon to grammar, preventing the generation of holded. If no inflected form is matched, the grammatical processor concatenates the appropriate suffix with the stem, generating a regular form.

Figure 3. A simplified illustration of the words-and-rules (WR) theory and the declarative/procedural (DP) hypothesis. Adapted from Pinker and Ullman, (2002).



With respect to language processing in typical populations, Ullman (2001) proposed a hybrid model bringing the distinction between the procedural and the declarative systems to a more tangible level. Ullman (2001) argues that procedural systems, rooted in a network including frontal/basal-ganglia circuits, are responsible for grammatical and rule-based processing, whereas declarative systems, rooted in a network of specific brain structures including medial temporal and prefrontal cortical regions, are responsible for lexical processing. Ullman (2005) argued that L2 processing relies mainly on the declarative system and is much less dependent on the procedural system than L1. This is largely because maturational changes in childhood result in the attenuation of the procedural system (Ullman, 2005). Figure 4 summarizes the various models of morphological processing.

Figure 4. Models of morphological processing, (a) hybrid models, (b) interactive activation model, and (c) distributed connectionist models. Adapted from Seidenberg and Gonnerman (2000).



CHAPTER 3

LEXICAL PROCESSING IN ACQUISITION AND ATTRITION

NATIVE VERSUS NON-NATIVE PROCESSING

Although research on morphological complexity in the psycholinguistic field of L1 acquisition has equally supported single as well as dual mechanism accounts (Fiorentino & Poeppel, 2007), some research has argued for the existence of fundamental differences between L1 and L2 processing, presenting evidence that the two differ along the lines proposed by Ullman (2005). Silva and Clahsen (2008) compared the influence of morphological structure on lexical processing in L1 and advanced late L2 learners using a lexical decision masked priming task. Participants performed a lexical decision on a list of target items after being presented with three types of prime-target pairs: (1) identity (e.g. pray-PRAY), (2) morphological (prayed-PRAY), and (3) unrelated (bake-PRAY). Silva and Clahsen hypothesized that if L1 speakers follow the de-compositional route for morphologically complex words then they should show priming effects for the morphological condition. Priming effects would be found if RTs on the target (bare form, i.e., the root or base morpheme) were faster in the identity and morphological conditions than in the unrelated condition. Processing by L2 learners would be considered qualitatively different if they showed no such effects.

The results showed that the L2 participants were different from the L1 group: the L2 learners did not show any priming effect for past tense forms (prayed – PRAY) and reduced priming effects for the derivational, whereas the L1 group did show full priming for both morphological types. This finding supported the hypothesis that L2 learners do not make use of morphological structure during recognition of regular past tense forms.

In fact, L2 learners relied more on lexical storage and less on combinatorial processing of morphologically complex words than L1 speakers. Silva and Clahsen (2008) concluded that the distinction between procedural and declarative systems implies that L2 learners rely mainly on full form storage (i.e., declarative systems) when processing morphologically complex words. In contrast, decomposition of those words into the constituent morphemes, a process also commonly known in the literature to be involved in L1 processing (Sonnenstuhl, Eisenbeiss, & Clahsen, 1999; Rodriguez-Fornells, Munte, & Clahsen, 2002), seems to be absent in L2 processing.

Similarly, Neubauer and Clahsen (2009) found clear L1-L2 differences for irregular inflections. They looked at the processing and the representation of morphologically complex words in L2 German speakers in order to find out how non-native language processing differs from native language processing. They compared adult (i.e., late) advanced learners who acquired an L2 after puberty to native speakers. Three experiments were run where participants performed (1) an acceptability judgement task to determine preference for regular and irregular forms of non-canonical words, (2) a visual lexical decision task to examine modality-specific access representations; and (3) a masked priming task to determine whether participle forms are morphologically decomposed during early word recognition.

In their Experiment 3, native and non-native speakers made lexical decisions on regular vs. irregular German participles which were primed either by an identity prime, a morphological prime that was either in a regular or an irregular form, or an unrelated prime. The results showed that irregular participles produced the same priming patterns in the L2 as in the L1 group, whereas for regular participles, different priming patterns were found. The results showed similar frequency effects in the L2 learners of German for regular and irregular items (i.e., large frequency effects for regulars and irregulars in L2). Native speakers of German, in contrast, demonstrated a frequency effect for irregular participles and no frequency effect for regular participles. These group differences were explained in terms of reduced sensitivity for memory representations of word forms (i.e., irregular participles) in the native speakers compared to L2 learners. Besides, the fact that both regular and irregular primes shared the same formal and semantic overlap with their targets (in German the regular forms are created by adding the suffix-t, whereas the irregular forms involve the suffix-n) but did not produce the same priming effects, was taken as evidence that priming effects cannot be explained in terms of formal or semantic overlap. Neubauer and Clahsen (2009) argue that the effects are purely morphological, especially that while the –t suffix is purely combinatorial in the sense that it can be fully decomposed (e.g., *kaufen- gekauft*, buy-bought), the irregular form where the suffix –n is usually added to the base stem cannot be directly isolated as the irregular forms often undergo largely unpredictable stem changes, thus priming with this type of inflectional form is purely morphological (e.g., *gehen-gegangen*, go-gone). The authors conclude that adult L2 learners, even the advanced participants, rely more on memorization of inflected words and less on morphological decomposition than native speakers. This was also taken as evidence for a single network (in the connectionist style) to process both regular and irregular participles (for the L2 learners but not the native speakers). However, they add, more L2 processing research of different morphological systems and different languages is needed as current views on this question remain controversial.

Other studies, however, did not find any such L1-L2 differences in processing inflected words (Basnight-Brown, Chen, Hua, Kostić, & Feldman, 2007; Diependaele, Dunabeitia, Morris, & Keuleers, 2011; Feldman, Basnight-Brown, Filipovic′-Đurd-evic & Pastizzo, 2009). Basnight-Brown et al. (2007) who also used the priming paradigm to compare the performances of various English speaking groups (i.e., monolingual English speakers, Serbian-English, and Chinese-English bilinguals) on processing regular vs. irregular English inflections, reported no differences in the priming patterns of these inflection forms between native and non-native speakers of English. They concluded that adult late L2 learners with advanced proficiency levels process morphologically complex words in the same way as native speakers.

Similarly, in Feldman et al. (2009)'s study on native versus non-native processing, different findings emerged with respect to inflections (English). Only the least proficient late bilinguals showed facilitated stem recognition in L2 with masked primes from the irregular past participle (Experiment 1; taught–TEACH). Even so, facilitation was not found for participles that preserve stem letter length (fell–FALL). When compared across different proficiency levels, bilinguals displayed highly similar effects as compared to native participants (i.e., morphological effects), at least when facilitation was assessed relative to an unrelated baseline (billed–BILL vs. careful–BILL). Relative to an orthographic control condition (billion–BILL), the lowest proficient bilinguals showed no evidence for morphological effects, whereas the highest proficient participants only showed significant facilitation with regular past-participle primes (billed–BILL). Feldman et al. suggested that at relatively low L2 proficiency levels, there is a greater reliance on word forms and an impaired access to semantics.

In a more recent study on the topic, Diependaele et al. (2011) investigated the processing of suffix derivations in L1 and L2, looking particularly at whether bilinguals who reach advanced L2 proficiency relatively late make less use of morphological information in the processing of suffixed derivations (as in Silva & Clahsen, 2008). They compared masked morphological priming in English across groups of native English-, Spanish- and Dutch-speaking participants. They tested stem priming with semantically transparent suffixed primes (e.g., viewer–VIEW), semantically opaque (including pseudo-) suffixed primes (e.g., corner–CORN) and stem-embedded form control primes (e.g., freeze–FREE). Contrary to previous conclusions about the possibility of processing differences between native and non-native English speakers, they reported similar priming patterns for the native English participants and the two groups of bilinguals. Across the different participant groups priming was largest with transparent primes, smallest with form primes and intermediate with opaque primes. Thus, the empirical picture from previous studies remains fragmentary and inconclusive. More L2 processing research of different morphological systems and of different languages is needed.

THE ROLE OF FREQUENCY

With respect to morphological processing, frequency is thought to play a major role in whether words are stored as full entries or decomposed into their constituents. In some literature on the topic (Lehtonen & Laine, 2003; Meunier & Segui, 1999; Pylkkanen, Feintuch, Hopkins, & Marantz, 2004), high frequency complex words are thought to be stored as whole words. Lehtonen and Laine (2003), for instance, investigated the effect of frequency on the processing of morphologically complex words in L1 (Finnish) and whether high frequency inflected words would have full-form representations. They looked at the processing of morphologically complex words in three frequency ranges in monolingual Finnish speakers and compared the latters' performances to those from Swedish-Finnish simultaneous bilinguals. Two experiments were run. In Experiment 1, monolingual Finnish participants performed a lexical decision task on mono-morphemic as well as inflected Finnish words that belonged either to a low, medium, or high frequency range. Word lists also included non-words that were made by changing from 1 to 3 letters in an existing Finnish word in a way that did not violate Finnish phonotactic rules. The results showed a significant difference in reaction times and accuracy rates between mono-morphemic and inflected words in the low and the medium frequency ranges suggesting de-compositional processing. No such difference was found between mono-morphemic and inflected words from the high frequency range suggesting full form processing for these words (familiar morphologically complex words were processed like mono-morphemic words).

In Experiment 2, early bilingual Swedish-Finnish participants were tested on the same words from Experiment 1 and the same lexical decision task. The results showed that frequency did not matter for speed of processing nor for accuracy rate. Bilinguals processed inflected words more slowly than mono-morphemic words and this applied equally for the three frequency ranges suggesting that bilinguals employed morpheme-based access even with the most familiar words. However, the results from the monolingual group showing faster reaction times equally for high and medium frequency items than lower frequency ones seem to have been confounded by a floor effect (i.e., participants could have possibly recognized the mono-morphemic words a little sooner than the inflected ones but they could not have responded any faster physically). This was thought to be a result of the fact that the decision task was fairly easy, especially that non-words were created by simply changing one two or three letters in an existing Finnish word.

Soveri, Lehtonen, and Laine (2007) aimed to eliminate this confound (i.e., floor effect) by rendering the decision task more difficult and thereby slowing down the reaction times in general. Three experiments were run with different levels of overall processing difficulty which were added in order to see whether a difference emerged between medium and high frequency ranges as a result of overall slower reaction times. Non-words were made more difficult by (a) adding a non-existing suffix to a real stem, or (b) adding a real suffix to a non-existing stem, or (c) creating an incorrect combination of an existing stem and suffix.

The results showed decomposition for inflected words irrespective of frequency range. There was in fact a difference in reaction times between inflected and mono-morphemic words throughout all levels of frequency. Inflected words were processed more slowly than mono-morphemic words suggesting decomposition even for high frequency inflected words. However morphology seems to have a weaker effect in the high frequency range than the medium and lower ranges. Besides, error rates differed significantly only within the low frequency range with more errors in the low frequency inflected words range. However, the addition of the incorrect combination of stem and suffix in this experiment which was meant to slow down overall reaction times and eliminate the floor effect confound could have introduced another confound by leading the participants to follow a more analytical strategy that possibly resulted in morphological de-composition of even the high frequency inflected words. Thus a second experiment was added where decision latencies were slowed down by introducing a dual task paradigm where the participants performed a parallel non-verbal auditory task. The same stimuli from Lehtonen and Laine (2003) were used without manipulation of non-words as in Experiment 1. Visual presentation of letter strings was always coupled with a sound that was either high or low-pitched and the subjects were to react only to the high-pitched sound by pressing a third button after making the lexical decision. The high-pitched signal appeared only in one third of the items and only with a filler or a non-word item. The results supported those from Experiment 1 and showed again that inflected words elicited significantly longer decision latencies than their mono-morphemic control words through the whole frequency range. Unlike the results obtained by Lehtonen and Laine (2003), these results do not support the conclusion about full form representation for high frequency inflected words.

However, because both Experiment 1 and 2 indicated that morphology has a weaker effect in the high frequency range compared to the low and medium ranges, Soveri et al. (2007) ran a third experiment with a focus on the high frequency words. The main question was whether the difference in reaction times between inflected and mono-morphemic words would vanish among the very high frequency words. New target words were selected to the high frequency range based on both corpus frequency values and subjective estimations of frequency to reach as good an estimation of a word's "true frequency" as possible. The topmost frequency range was divided into two subcategories: high frequency words and very high frequency words. The same dual task paradigm was used to avoid floor effects in reaction time. The results suggested that the most common inflected Finnish words had indeed full-form representations.

Another study by Ullman, Babcock, Stowe, and Brovetto (2008), found that frequency effects showed a different pattern between regular and irregular verb forms in L1 speakers of English and two groups of L2 speakers (with Chinese or Spanish as their L1). In a speeded production task on English past tense forms, L1 speakers showed larger frequency effects for irregular than for regular verb forms, whereas the L2 data revealed frequency effects that were similar for regular as well as irregular verb forms. Ullman et al. (2008) interpreted these results as evidence for a greater reliance on memorization of all inflected forms (both regular and irregular verb forms) in the L2 than in the L1.

LEXICAL PROCESSING IN ATTRITION

INTRODUCING ATTRITION

Attrition is a linguistic phenomenon that involves the deterioration of language skills either of an individual or of a speech community. Köpke and Schmid (2004) define attrition as "the non-pathological decrease in proficiency in a language that had previously been acquired by an individual" (p. 5), whereas Montrul (2008) defines it as the "loss of linguistic abilities at the individual level and across generations" (p. 299). Attrition equally affects L1 and L2 and is not limited to a specific language group or a particular age. In the elderly, attrition is often referred to as language loss. Gürel (2002) defines L1 attrition as a multi-dimensional linguistic phenomenon that has been studied from more than one perspective (e. g., sociolinguistics, psycholinguistics, etc.) and that results in the restructuring or incorporation of L2 rules into L1 grammar. In this proposal I look at L2 attrition in particular.

In what follows, I review the literature on language attrition from the last two decades, focusing on the major findings related to the lexicon. Then, I follow with a discussion of limitations of the classic approach for understanding attrition and why a qualitative look at the processing of particular knowledge (lexical knowledge in the current case) might be more revealing about the phenomenon of attrition than the common descriptive analysis that generally looks at what features appear to be lost or retained in a particular language group.

THE CLASSIC APPROACH TO STUDYING ATTRITION AND ITS LIMITATIONS FOR UNDERSTANDING LEXICAL REPRESENTATION

According to Lambert and Freed (1982) the phenomenon of language attrition can be explained in terms of linguistic as well as extra-linguistic variables. Based on a distinction between criterion variables, such as lexical and morpho-syntactic influence from the dominant language, and predictor variables such as motivation for language maintenance, age and frequency of use, Lambert and Freed (1982) came to the conclusion that certain components of language (mainly lexical components) are more vulnerable to decline and eventually loss.

Following Lambert and Freed (1982), research on language attrition has become an established subfield of applied linguistics. General hypotheses have since been proposed which were based on descriptions and analysis of attriters' speech from case studies of particular language groups or individuals. These hypotheses fall into two categories of explanations about attrition. A large number focuses on the idea of simplification (Andersen 1982; Cohen, 1975; Olshtain, 1989; Seliger, 1991; Seliger & Vago, 1991) as a major characteristic of language in attrition (i.e., the reduction hypothesis, the markedness hypothesis, the interference hypothesis), and a few tried to integrate psychological theories (Köpke, 2004; Köpke & Schmid, 2004) to better understand what causes attrition. However, with the exception of the threshold hypothesis that is centered on the idea that what is least vulnerable to deterioration is not what is learned first but what is learned best (Bardovi-Harlig & Stringer, 2010), all other hypotheses seem to be highly inter-related. One of the limitations of the classic approach to studying attrition, in addition to the fact that none of the studies looked at the representation of the attriter's mental lexicon, is that the borderlines between most hypotheses (i.e., the simplification hypothesis, the markedness hypothesis, and the interference hypothesis) remain fluid. For example, Gürel (2008) finds that while morpho-syntactic attrition in mature L1 grammars of Turkish-English bilinguals seems to follow a selective pattern (due to interference effects), the pattern is characterized by a general tendency toward reduction of complexity and loosening of restrictions, otherwise known as the simplification hypothesis.

Another example that illustrates the difficulty in teasing apart hypotheses about attrition comes from the work of Hansen and Chen (2001). They proposed that frequency of occurrence and degree of markedness (i.e. degree to which a particular form is less universal and more specific in a particular language) contribute to the order of acquisition as well as order of attrition of specific language components (markedness hypothesis). They also found that English-speaking adults used numeral classifiers (i.e. morphemes which occur adjacent to numerals and categorize the noun referent based on semantic features such as animacy, shape, size, arrangement, and function) in the attrition language (Japanese or Chinese in this case) in an order that was opposite to the order in which they were acquired (regression hypothesis).

Whether approaching the topic from the point of view of one or multiple perspectives (i.e., with focus on one or multiple hypotheses), previous research has made two claims that are particularly relevant to the current study. One is that attrition is selective (Schmid, 2001; 2006; Seliger, 1991), in the sense that certain areas of morpho-syntax[5] are more vulnerable. And the other claim is that attrition emerges as a result of a process of oversimplification. In what follows I present an overview of the literature that focused on these two major claims in relation to some of the above mentioned hypotheses that are most relevant to the current study. This overview will lead to a discussion of why a look at the organization of the mental lexicon (and more specifically, morphological processing) in attrition might be one way to approach this phenomenon.

The reductionist/ minimalist approach

Within the reductionist approach, attrition whether it affects one's L1 or L2, results from a process of oversimplification. In the case of L1 attrition for example, less complex L2 features replace more complex L1 features whereas unmarked L2 forms replace more marked (irregular) forms in L1 (Andersen 1982; Cohen, 1975; Olshtain, 1989; Seliger, 1991, Seliger & Vago, 1991). For example, Olshtain (1989) found that Hebrew-English bilinguals (with Hebrew as L1) overused past tense morphemes of irregular verbs producing the Hebrew equivalents of the forms *gived*, *eated* and *waked up*. Similarly, Seliger and Vago (1991) found that German language attriters (with German as L1) produced the forms *er wisst*, *er schleichte*, and *er nimmte* instead of the forms *weiss*, *schlich*, and *nahm* (knew, slunk, and took, respectively). However, as is the

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[5] The study of morpho-syntax is concerned with inflectional morphemes and their phrase-level or sentence-level functions, (Clahsen, Felser, Neubauer, Sato, & Silva, 2010).

case with numerous studies on attrition, it is unclear whether incomplete acquisition of a L2 learned at a later age played a role in such generalizations as well, especially those generalizations relating to L2 attrition.

Minimalist approaches to attrition (Hansen, 2001; Hansen & Chen, 2001; Filiaci, 2004; Tsimpli, Sorace, Heycock, & Filiaci 2004; Sorace, 2004, among others) posit that some linguistic features are inherently more problematic (i.e., more likely to show attrition effects). For example, morphological similarity between an L1 and L2 seems to be resistant to attrition whereas syntactic similarity increases attrition, possibly because it results in competition between L1 and L2 rules that are linguistically comparable (Altenberg, 1991; Gürel, 2004, 2008). In fact, there is considerable evidence for cross-linguistic influences on morphology and the possibility of a positive transfer effect from a bilingual's L1 to L2 (Lowie, 2000; Silva & Clahsen, 2008; Tyler & Nagy, 1989). Lowie (2000) argues that, in acquiring a L2, a learner can be guided by the morphological system of his L1. For example, a Dutch learner of English may benefit from the fact that the affixes *-able* and *-baar* (Dutch) have much in common both in terms of the corresponding syntactic and semantic aspects (i.e. that they both form adjectives based on transitive verbs and that they convey the meaning "that can be *verb*-ed", when attached to particular stems, for example "understandable" conveys the meaning "that can be understood"). L1 and L2 similarity was also found to be beneficial in numerous studies (e.g., Franceschina, 2005; Sabourin & Haverkort, 2003; Sabourin & Stowe, 2008; Sabourin, Stowe, & de Haan, 2006). Thus, in areas where similarity is beneficial between two languages (morphology in English vs. Dutch) one would expect to find less attrition effects. On the other hand, areas of morphology where little is shared between two languages (gender morphology between French and English) might be more problematic. Whether it is for reasons of simplification or simply because of convergence or code switching that certain areas of the morpho-syntax are more prone to attrition (Gürel, 2008) identifies some of these unstable aspects: case morphology, gender marking, adjective/ noun convergence, allomorphic variation, verbal agreement, use of lexemes instead of bound morphemes to encode grammatical relations, simplification of word order), it is obvious that attrition has to be looked at from more than one angle. One of the major questions that remain unresolved about attrition is whether attrition involves total loss of linguistic representations from the brain or whether the problem is one of access to such representations. This question taps into the issue of storage and retrieval processes. In what follows, I discuss this unresolved issue and lead to why morphological processing could be one way to look for possible answers.

AN INTERDISCIPLINARY APPROACH TO ATTRITION

The relevance of psychological theory and implications of models of lexical access

The contribution of psychological theories to the study of language attrition has been quite a controversial issue. Although Weltens (1987; Weltens & Grendel, 1993) has argued that such theories have little to contribute to the study of attrition, Ecke (2004) argued that psychological research on forgetting is helpful for forming hypotheses about language attrition. Suggesting an interdisciplinary approach to studying attrition, Ecke (2004) refers to terminology from memory research where forgetting is defined as failure in one of the three basic components of remembering: encoding, storage, and retrieval.

Köpke (2004) also argued for the relevance of psychological theory to the study of attrition. Köpke explored major factors involved in attrition with respect to the neuro-linguistic aspects of this phenomenon: the role of age at onset of bilingualism and attrition, and the effect of L2 on L1. Although the above mentioned aspects of morpho-syntax that are more prone to attrition (i.e., case morphology, gender marking, adjective/ noun convergence, allomorphic variation, verbal agreement, use of lexemes instead of bound morphemes to encode grammatical relations, simplification of word order) were not a major focus of Köpke's paper, Köpke argued lexical retrieval can be accounted for through Paradis' Activation Threshold Hypothesis (Paradis, 1993), since delayed retrieval can be seen as an indication of the raising of activation threshold of the items used less frequently. This hypothesis proposes that for a particular linguistic item to be activated (whether it is complex or not) a sufficient amount of positive neural impulses has to reach its neural substrate. The activation threshold is, thus, the amount of impulses necessary to activate the item. The activation threshold of any particular item is lowered every time the item is activated, leading to fewer impulses required to reactivate it. In this sense attrition is the result of long term lack of stimulation of linguistic items in a less frequently used language. In addition, Green's inhibitory control model (Green, 1986) is also suggested as a possible explanation of this phenomenon since the latter involves aspects of lack of resources in the less frequently used language.

With respect to language attrition in aging individuals (often referred to as language loss), Salthouse (1988) suggested that a general reduction in resources for cognitive processing comes with aging and explains the lower performance of older adults on tasks that measure reasoning, attention, and memory for words and for discourse. Others (Kemtes & Kemper, 1997) claimed that working memory limitations could account for age-related differences in performance. Burke (1997) attributes retrieval deficits to a biological decline that leads to a weakening of connections between conceptual semantic representations and phonological representation, a hypothesis that was originally proposed in Burke (1991) to account for the tip of the tongue phenomenon during word production, and that is commonly known as the Transmission Deficit Hypothesis (TDH).

In the context of the TDH hypothesis, which suggests that retrieval difficulties are caused by a deficit in transmission of activation from the semantic component of the target word to its phonological component, one might suggest that the idea of retrieval deficits might apply similarly to attrition in the younger populations, albeit for non-biological reasons. In other words, lexical difficulties in attrition can also be a result of slowed down search and retrieval processes due to the weakening of connections between semantic and phonological representations. However, with attrition the slowdown seems to be due to lack of use rather than to a biological decline in resources. Hence, the first sign of attrition is not the loss of a particular item but rather an increase in the length of time needed to retrieve it, a phenomenon known in the literature as "hesitation" or "attriter speech" (De Bot & Weltens, 1995).

In De Bot and Weltens (1995), attriters seem to be aware of this slowdown and as a result they report this as a major decline in proficiency even when their performance on tests hardly showed any sign of attrition. This is to say, they know that their retrieval is slowed down when they (rightly) say that they have experienced language attrition in their second language. De Bot and Weltens (1995) argue that for these reasons "the whole process of attrition can be explained by a change in processing procedures" (p. 157). In other words, and with reference to the procedural/declarative model mentioned above, attrition could involve a change in processing from being based mainly on the procedural systems to being based on the declarative systems.

Lexical processing in attrition and the relevance of the procedural/ declarative model

Little is known in the literature about lexical processing in attrition and the organization of the mental lexicon. Although the conclusions made above about the possible L1-L2 differences in lexical processing bear interesting implications for the possible differences between processing in L2 vs. processing in L2 attrition, the literature on attrition still lacks empirical evidence for whether these differences exist. In fact, only one study (so far) has tested L1 and L2 morphological processing from the normal and attriting populations within the same paradigm. Goral, Libben, Obler, Jarema, and Ohayon (2008) appear to be the only researchers who compared lexical performance on a primed lexical decision task between older and younger bilinguals (all native speakers of Hebrew). They tested three groups of Hebrew-English bilinguals using compound words and pseudo-words from both languages. Two groups were bilinguals living in New York City; one group consisted of older speakers between 55 and 64 years and the other group consisted of younger speakers between 19 and 38 years old. A third group were young speakers who lived in Israel. They found that while the older group (who had lived in NYC for a much longer period than their younger peers) showed overall slower RTs in their L1, they did not show those same effects in their L2. Because these older participants did not show slower RTs in their L2, it was suggested that the slower RTs in L1 were not likely to have resulted from age-related slower performance but rather were interpreted as signs of attrition processes for L1 due to persistent use of L2. In addition, compared to the group living in Israel, the two groups living in NYC had overall slower RTs in Hebrew. This was taken as evidence of the latter's L1 attrition.

Although this study clearly compares lexical performance between older and younger bilinguals, the older group consisted of only 12 participants (compared to 37 and 35 from the other two groups). Besides, this group (being between 55 and 64 years old) seems to be relatively young with respect to the loss effects often cited in the literature on age-related attrition and lexical processing. Much of the slowed down performances and the lexical retrieval difficulties reported in the literature from language loss cases were actually found in the population beyond age 65 (Obler & Albert, 1982, 1989; Olshtain & Barzilay, 1991; Salthouse, 1996). Moreover, Goral et al. acknowledge incomplete acquisition of the English system for the group of participants living in Israel. Incomplete acquisition of particular language components, however, remains but one of the many challenges that researchers of both L1 and L2 attrition encounter.

In a review article on the psycholinguistics of attrition, De Bot (1998) calls for a processing approach to studying this phenomenon. Knowing that little attention has been paid so far to the psycholinguistic aspects of language loss, De Bot calls for a look at what changes in linguistic processing occur in a language loss situation. Over half a decade after this, Ecke (2004) still draws attention to the lack of such research and the need for an interdisciplinary approach to the phenomenon of attrition.

To account for attrition as possibly involving a change in processing from the procedural to the declarative type, De Bot (1998) makes reference to Anderson's theory

(1982) on skill acquisition, a theory also proposed to account for L2 acquisition. According to this theory a distinction is made between controlled and automatic information processing. To acquire a particular cognitive skill, learners go through a declarative stage and a procedural stage. Through the declarative stage isolated facts are learned, and processing is slow and more or less open to conscious manipulation. Through frequent use these facts get formalized and processing becomes faster and beyond conscious control leading to what is known as the procedural stage. This assumption implies that the processing of grammar will depend on age and length of exposure to the language since a language that has been used less frequently (i.e., has been less automatized by the speaker) is more likely to be processed declaratively. De Bot (1998) argues that what applies to learning general cognitive tasks can similarly apply to acquiring a language. Hence, if learning and frequent use of a language involves the change from the declarative knowledge to the procedural, lack of use/ attrition might imply the opposite, (i.e., a change from the procedural to the declarative). However, to date, this perspective remains lacking in empirical evidence.

Of specific relevance to the topic of attrition and language loss here, is the fact that knowledge of a procedural nature is more stable and less vulnerable to loss than knowledge of a declarative nature. Although this distinction between the declarative and the procedural systems seems to theoretically validate the common findings in the literature about deterioration effects being larger for lexical retrieval than for grammatical processing (Köpke, 2006), this idea has not yet been empirically tested and the link between attrition and the procedural/declarative distinction has not been explicitly made.

Why morphological processing might be one way to look at lexical representation in L1/L2 and attrition

As far as syntactic knowledge is concerned, one of the implications the procedural/declarative model might offer to the study of attrition is that the inconsistency in the literature about what is lost and what is retained is highly related to the fact that languages vary a lot with respect to their morpho-syntactic systems. This variability implies that while certain languages have very regular rule-based systems to mark their gender, number, or case, for example, others are highly dependent on declarative procedures, and as a result they remain unsurprisingly more vulnerable to attrition. For instance, in most varieties of spoken Arabic, pluralisation can hardly follow rules. Unlike English, for instance, where adding one morpheme often works to mark the plural (generally the plural morpheme –s, with few exceptions), forming the plural in Arabic involves either (1) adding a suffix or (2) making structural changes to the body of the word (i.e., an irregular stem modifying process similar to umlauting in pairs like "foot-feet" in English), or (3) both. While the process of adding a suffix, which is often referred to as the "sound" form of plural in standard Arabic, applies to only a minority of the forms in the lexicon (Plunkett & Nakisa, 1997), adding structural changes, which is often referred to as the "broken" plural, is less regular and applies to the majority of forms (McCarthy & Prince, 1990).

Forming the plural in French is not less problematic. For example, while the singular *journal* (newspaper) translates to the plural form *journaux*, forming the plural for a similar word such as *festival* (festival) does not require more than adding a suffix (s) as in *festivals*.

From a dual-route perspective, lack of systematicity and regularity in forming the plural in Arabic implies that a majority of plural forms is stored as whole forms, and require direct retrieval from memory. In this sense, one would predict more deterioration effects for plurals with an attrition group of Arabic speakers, than in an English-language attrition group.

Another example often cited in the literature with respect to cross-linguistic variability on the level of the morpho-syntax involves the assignment of gender. For instance, in English (a language with no grammatical gender) only animate nouns are assigned to gender classes, often based on semantic categorization (a girl is referred to as "she" while a boy is referred to as "he"). In contrast, in French, Italian, German, as well as Arabic, inanimate nouns are also assigned to a masculine or feminine gender (or neutral in the case of German). In most cases the assignment of gender to inanimate classes in these languages is highly arbitrary and is rarely semantically motivated. In French, no more than 10% of nouns are assigned grammatical gender that is semantically motivated (Meunier, Seigneuric, & Spinelli, 2007). Knowing the lack of systematicity and arbitrary nature of gender assignment in such languages, learners have to memorize these nouns. This lack of semantic connection implies that speakers of these languages must rely on declarative systems procedures for the storage and retrieval of these words. In this sense, findings on gender in attrition in one language cannot be generalized cross-linguistically unless we looked at the nature of processing of gender words rather than retention levels.

It is this connection to the procedural/declarative model that renders morphological processing an attractive venue for the study of processing in L1 and L2 acquisition and in attrition. Morphologically complex words provide a particularly useful tool for investigating the precise way in which morphemic constituents contribute to lexical processing and retrieval in attrition. Although morphological processing has been extensively used for studying differences and similarities between L1 and L2 lexical processing, the attrition literature still lacks empirical evidence on the relevance of this model.

Accordingly, in the current research I tested groups of current speakers of French who live in the same linguistic environment as comparable French L2 speakers who show attrition. And, to test the hypothesis that L2 processing differs from L1 processing in being more reliant on declarative/ non-decompositional procedures, I included an early bilingual group to find out whether the early L2 speakers behave more like native monolingual speakers in their L2 and differently from late L2 speakers. Finally to test the hypothesis of whether processing in attrition is less native-like (i.e., more dependent on declarative procedures) I compared L2 speakers with attrition effects in French to native French speakers as well as to L2 speakers with no attrition effects. Hence, four groups between age 18 and 35 were tested: (1) native French native speakers (with L2 English) and with no language attrition effects (NS); (2) early L2 French speakers with English as L1 (i.e., those who learned French before age 11) and with no attrition effects (EB); (3) a language attrition group consisting of French L2 speakers who acquired French at a young age (before 11) and show attrition effects (LA); (4) late L2 French speakers (i.e., those who learned French after age 11) and with no attrition effects (LB).

CHAPTER 4

TESTING THE MENTAL LEXICON

MASKED PRIMING

Masked priming is a technique commonly used in the field of visual word recognition to investigate lexical access mechanisms and basic questions related to the phenomena of perception without awareness (Davis, 2003). In the masked priming paradigm a visual target word is presented on a computer screen (usually in upper case) preceded by a prime (lower case) which is masked by the prior presentation of a masking stimulus (typically consisting of a row of hash marks, ######). The time from presentation of the prime to the presentation of the target (known as the "stimulus onset asynchrony" (SOA) is typically between 32 to 60 milliseconds (ms). A participant is expected to respond in some way to that target (for example, make a decision on the lexical status of the target in a particular language or on its gender category). A second mask sometimes precedes the target (and thus increasing the SOA) in order to reduce and even abolish visibility of the prime (Forster, Mohan, & Hector, 2003). The prime is presented for such a short time that participants are often unaware of it. Priming is said to occur when the prime, sharing features with the target on a single information parameter (such as phonology, or orthography), enhances performance and facilitates access and thus response to that target relative to a specific baseline, an unrelated control condition (Johnston & Castles, 2003).

Five types of masked priming effects that depend on the relationship between the prime and the target have been reported in the literature (Forster et al., 2003). (1) *Identity* or repetition priming, the largest effect among those five types of priming (Morton, 1981), occurs as a consequence to repeated access to a lexical entry (i.e., when the prime is the same word as the target such as in nature-NATURE). Thus, later experiences of a repeated stimulus will be processed more quickly by the brain. This phenomenon also explains (2) *morphological* priming because morphemes can prime the words that include them (e.g., walk-WALKED). (3) *Form* priming is found when the prime and the target share form similarity without being necessarily identical (Altman, 1990). Hence, the prime can be either a word (e.g., mature-NATURE) or a non-word (e.g., zature-NATURE). Form priming can be found also with letter transposed primes (e.g., attiutde-ATTITUDE). When the prime and the target words are from the same semantic category (e.g., wolf-DOG) (4) *semantic* priming effects are found. Semantic priming occurs because once a specific item from a particular category is processed, similar items are stimulated by the brain. Moreover, (5) *associative* priming can occur when two words with a high probability of appearing together without being necessarily related in semantic features are used as prime and target (e.g., paper-ROCK, or rock- SCISSORS).

WHY USE MASKED PRIMING?

Masked priming is a useful paradigm in visual word recognition because the use of masked primes reveals certain forms of effects that are normally very difficult to obtain with visible primes. When primes are fully visible to the participant, the relationship between prime-target pairs becomes obvious. Thus, priming effects might be a result of the use of strategies by subjects. In contrast, when the prime is masked, the presence of the mask prevents information about the prime from reaching consciousness, and any observed priming effects cannot be a result of any conscious perception of the relationship between the prime and the target stimulus. Moreover, the close temporal proximity between the prime and the target makes the effects of the prime on the processing of the target stimulus, which reflect early automatic components of word processing, readily available (Forster & Davis, 1984). In early research on word recognition where primes were visible (e.g., Colombo, 1986; Martin & Jensen, 1988) words that overlapped orthographically (e.g., mother-bother) failed to show reliable priming, but when the prime was masked (Forster & Davis, 1984; Forster, Davis, Schoknecht, & Carter, 1987), reliable facilitation effects were obtained. This finding was taken as evidence that the masked priming technique taps very early processes in the perception of a word that would not be noticeable if processing of the prime is carried through to conscious perception (Johnston & Castles, 2003).

VARIABLES IN MASKED PRIMING MORPHOLOGICAL PROCESSING RESEARCH

Semantic and orthographic overlap

The use of masked priming in research on the processing of morphologically complex words has focused on identifying the extent to which morphological information facilitates access to the target word. Facilitation in processing the target word when preceded by an inflected or derived word is taken as evidence that the morphemic unit common to the prime and the target has been activated. The morphemic unit, in this sense, is what governs the lexical access process (Frost, Deutsch, Gilboa, Tannenbaum, & Marslen-Wilson, 2000). Most researchers agree that morphological information becomes available during early stages of processing a complex word (Shoolman & Andrews, 2003). However, because primes and targets often share some orthographic similarity, as well as semantic and phonological information, determining the individual contribution of each of these variables is not completely straightforward. Current research with the goal of distinguishing morphological priming from orthographic priming, on the one hand, and semantic priming, on the other, remains inconclusive and full of controversies with respect to the relative contribution of the different types of overlap between words in producing facilitation effects.

Using the masked priming paradigm, a number of studies presented evidence for the existence of morphological effects that do not seem to be reducible to the joint influence of semantic and orthographic similarity (e.g., Fowler, Napps & Feldman, 1985; Grainger, Colé & Segui, 1991; Napps, 1989; Napps & Fowler, 1987, Stolz & Feldman, 1995; Stolz & Besner, 1998). Grainger et al. (1991) found that morphological relatives in French effectively prime each other. Using the stem and the derived version of a word (as in the English pair *hunt–HUNTER*) as primes and targets, they found that prefixed and suffixed target words were primed equally well by their stems and other derived words with the same stem (as in the English pair *hunter–HUNTING*). In contrast, under the same conditions, unrelated primes that are equally similar to the target on orthographic dimensions (as in the English pair *scandal-SCAN*) have little or no effect on target identification.

Conversely, other research in the field showed evidence that, to some degree, morphological priming and target word decomposition are influenced by the semantic transparency of the prime (Davis, van Casteren, & Marslen-Wilson, 2003; Giraudo & Grainger, 2001; Marslen-Wilson, Tyler, Waksler, & Older, 1994; Plaut & Gonnerman, 2000; Rastle, Davis, Marslen-Wilson, &Tyler, 2000; Rueckl & Raveh, 1999). A morphologically complex word such as “unhappy” is said to be semantically transparent because its meaning can be derived directly from the combined meaning of its stem and affix. In contrast, meaning in semantically opaque words such as “department” cannot be directly derived from the combined meaning of the constituent morphemes. Using a cross-modal repetition paradigm, Marslen-Wilson et al. (1994) reported robust priming effects for stem-target pairs that were morphologically related and semantically transparent (e.g., hunter-HUNT) but not for pairs that were semantically opaque (department-DEPART). This finding led the authors to suggest that decomposition is only applied to morphologically complex words that are semantically transparent.

However, more recent research has reported findings in favour of the argument that the visual word recognition system handles semantically opaque and semantically transparent words in the same way. Priming effects for semantically opaque pairs have now been reported in a number of studies (Kazanina, Dukova-Zheleva, Geber, Kharlamov, & Tonciulescu, 2008; Longtin & Meunier, 2005; Longtin et al., 2003; Marslen-Wilson, Bozic, & Randall, 2008; see Rastle & Davis, 2008, for a review).

Using the masked priming paradigm, Marslen-Wilson et al. (2008), for instance, found morphological priming effects for prime-target pairs of different semantic transparency levels, but no effects of orthographic relatedness. They found priming effects for semantically transparent pairs (such as bravely-brave), pairs that were weakly related in meaning (barely-bare) and pairs that were semantically opaque (archer-arch). These results were taken as evidence that morphological priming happened independently of the activation of semantic information and beyond pure orthographic priming. Morphological priming is an independent early process where possible stems, affixes, and other elements of morphological structure are identified as soon as orthographic and phonological information starts to accumulate (for example, the suffix "er" is automatically stripped and then processed both in words like "archer" as well as "hunter"; Neubauer & Clahsen, 2009). Marslen-Wilson (2007) identifies this early stage as "one of the highest priorities" of the system (p. 189). Taken together, these findings from masked priming suggest that morphological structure is a priority of the lexical processor.

Similarly, with respect to the orthographic variable, findings in the literature on the topic are also controversial. Dominguez, Segui, and Cuetos (2002) used masked primes (Spanish) with 32 and 64 ms SOAs as well as unmasked primes with 250-ms SOA to investigate the role of orthographic overlap (and semantic transparency) in whether or not complex words undergo decomposition. They found equivalent facilitation at the 32 ms SOA for orthographically and morphologically related pairs. At 64 ms, both the morphological primes and the orthographic primes again produced facilitation, but the effect was greater for the morphological primes. In contrast, at short SOAs there were no semantic priming effects whereas at 250 ms, they obtained facilitation for the morphological and semantic primes, but inhibition for the orthographic primes. Because of the effects they found for both orthographically and morphologically related pairs (at the 32 ms SOA), Dominiguez et al. (2002) argued that the results suggest that morphological segmentation might be influenced by orthographic information, lending support to the morpho-orthographic view on lexical processing (Orfanidou, Davis, & Marslen-Wilson, 2010). However, Longtin, Segui, and Halle´ (2003) used French pseudo-derived primes (mono-morphemic words that could be parsed into existing morphemes such as "baguette-BAGUE") and reported significant priming from both transparent derived primes (similar to baker–BAKE in English) and pseudo-derived primes (e.g., corner–CORN) but no orthographic priming with a prime duration of 46 ms.

Therefore, there are still some inconsistencies in the empirical data concerning the relative strength of priming from transparent and opaque morphological primes as well as the different time courses of these priming effects and the effects of orthographic form overlap. According to Marslen-Wilson, Bozic, and Randall (2008), one explanation for the inconsistencies across experiments is that the question of whether morphological factors provide an independent principle for lexical organization and processing is both an empirical methodological question and a theoretical one. It is methodological in the sense that experimental studies have to rule out confounds due to possible form and meaning overlaps, and theoretical in the sense that it is a question about lexical representation in general (i.e., whether morphological effects are subsumed under the effects of orthographic/phonological, and semantic factors acting independently or in interaction with each other) .

Priming with short SOAs

Previous research on the processing of morphologically complex words during lexical processing supported the argument that priming with short SOA levels cannot be a result of either phonological/orthographic or semantic relatedness between primes and targets (Marslen-Wilson et al., 2008; Rastle, Davis, Marslen-Wilson & Tyler, 2000; Rastle, Davis & New, 2004; Sonnenstuhl, Eisenbeiss, & Clahsen, 1999). Using SOAs of 50 ms, Sonnenstuhl et al. (1999) examined German participles in a cross-modal lexical priming experiment and found that participles (gekauft-Kaufe "bought-buy") prime their targets as much as does an identity prime. They however, reported less priming with irregular German participles that share the same phonological/orthographic and semantic relatedness with their targets as the regular participles (e.g., gelaufen-laufe "walked-walk"). Thus, priming at short SOAs appears to capture morphological, rather than semantic or phonological relatedness between primes and targets. Semantic and phonological relatedness might come into play at later stages of processing.

Consistent with these conclusions, Rastle et al. (2000) found priming effects for morphologically related primes that cannot be reduced to the formal or semantic overlap between the primes and their targets. Using a masked priming paradigm, they compared priming effects at short prime exposure durations (SOAs of 43, 48, and 72 ms) for English opaque (e.g., corner-corn) and transparent (e.g., darkness-dark) pairs. They reported robust priming of transparent targets (e.g., dark) by morphologically related words (e.g., darkness) relative to unrelated controls. However, there was no priming of opaque targets by pseudo-suffixed words (e.g., corner-corn). The priming effects found from morphologically related words were greater than those found for purely semantically related (e.g., cello–VIOLIN) or purely orthographically related (e.g., electrode–ELECT) primes. They also found priming for semantically opaque, morphologically related primes at the shortest SOA (e.g., apartment–APART). The conclusion was made that the priming effects were indeed morphological rather than semantic or orthographic.

Similarly, Rastle et al. (2004) found no priming effects for orthographic target words that shared orthographic characteristics with their targets (e.g., brothel-broth).

These data, along with the results of Rastle et al. (2000), support the argument that a morphologically-structured level of representation plays a central role in visual word recognition, and suggest that early morphological effects can be obtained independently of semantic relatedness. The latter is thought to affect morphological priming only at longer prime durations (Morris et al., 2007).

Boudelaa and Marslen-Wilson (2005) examined lexical processing of morphologically complex words across different SOAs to see at which level orthographic and semantic priming is used. Six conditions were used in this study with morphologically complex items from Arabic. In condition 1 the prime and target were morphologically related in the sense that they share a word pattern, (e.g *faaøilun* in the first pair and *faøiilun* in the second). In condition 2, which was designed to provide an orthographic control, primes and targets shared an orthographic relationship that mimics the kind of form overlap found between word pairs sharing a word pattern. Conditions 3 and 4 probed the effects of the consonantal root. In condition 3, the prime and target pairs shared a root and a transparent semantic relationship (e.g., presidency-president). In condition 4, the prime and target shared a root, the same structural unit as in condition 3, but their underlying semantic relationship is opaque. One of the critical questions conditions 3 and 4 were meant to address is whether root morpheme priming will evolve irrespective of the semantic transparency or opacity of the forms involved. Another question relates to whether root and the word pattern priming effects will have comparable profiles over time.

To provide a fuller context for interpreting possible root effects in conditions 3 and 4, two more conditions were added. Condition 5 consisted of word pairs that are orthographically but not morphologically related, sharing two to three consonants that do not constitute a common root. If the priming effects hypothesised in conditions 3 and 4 are due to the orthographic overlap in any two surface forms sharing a root unit, then the word pairs in condition 5 should show facilitation effects comparable with those in conditions 3 and 4. Finally, condition 6 consisted of word pairs which are strongly semantically related but do not share either roots or word patterns. Such pairs fail to yield any facilitation in masked priming at short SOAs, but can prime at longer SOAs (Rastle et al., 2000).

Morphological priming was found at SOAs of 32, 48, 64, and 80 ms whereas orthographic and semantic priming were only found at 80 ms. Boudelaa and Marslen-Wilson (2005) concluded that there is an early word recognition stage at which morphologically complex words are unconsciously and automatically decomposed into their morphological constituents prior to the activation of semantic information. Thus, although most of these studies seem to support a morpheme based account for L1 processing, more research is needed in the context of L2 and L2 attrition.

CHAPTER 5

PROCESSING OF INFLECTIONS AND DERIVATIONS

Inflection and derivation are two word formation processes that have been traditionally separated as two distinct linguistic phenomena (O'Grady & Archibald, 2004). Common to many languages (including English and French), the combination of an affix with an existing word, either through pre-fixation or suffixation is a major mechanism that defines word formation both in inflection as well as in derivation. Although a definition of a precise boundary between the two remains controversial, there are some basic properties specific to each of these word formation processes that are considered essential to understanding and theorizing about morphological processing. In inflectional morphology, for example, one of these basic functional properties, meaning preservation, has implications for the organization of the mental lexicon in the sense that inflectional changes do not typically lead to a change in the word's semantic category; hence they do not require new lexical entries (Marslen-Wilson, 2007). Inflectional morphology is defined as indicating the grammatical function of words and is exclusively syntactic in its function as it generally leaves the meaning of lexical items and their word class intact (Beard, 1995). Plural formation (e.g., the change from *singer* to *singers*), for example, does not result in a new word or word class (both singer and singers are nouns and their semantic content remains the same). Other prototypical inflectional functions (e.g., marking number, tense, aspect, gender, case and so forth) produce new forms of the same word and not new different words (Stump, 1998).

Derivational morphology, on the other hand, involves forming new words from existing words or word roots. The process does result in the creation of new words with new meanings and typically involves a change in the word class as well. In light of this dichotomy, the change from *sing* to *singer*, a morphological phenomenon known as agentive formation, is seen as derivational in nature. The process involves the formation of a new word (i.e., *singer*) that is different in meaning and crosses the boundary from a verb to a noun.

Another key characteristic of derivational morphology that has implications for theories of lexical processing is its productivity. Derived forms such as affordable, for example, can feed further derivational processes (*unaffordable*, *unaffordability*), whereas a regularly inflected form such as *walked* cannot undergo any further word formation (Clahsen, Felser, Neubauer, Sato, & Silva, 2010). Inflections, on the other hand are responsive, in a regular and predictable way, to the properties of the grammatical environment in which they occur (Anderson, 1992). Both French and English (among many other languages), for example, express agreement through third person inflectional morphemes in a predictable rule based way, albeit to a lesser extent in French (i.e., only in some verbs and some tenses in French) because of the existence of a three group conjugation system, (i.e., a system where verbs belong to 1 of 3 different groups depending on how the verb ending changes to mark tense, mood, aspect, and number). In English, this is clear in the verb he *walks*, where the morpheme *–s* marks the third person singular (present tense).

In various accounts of morphological processing (Marslen-Wilson et al., 2007; Clahsen et al., 2010) these inherent differences between inflection and derivation are reflected in the properties of the language processing system. This is partly because the inflectional morpheme does not have a lexical entry, whereas the derivational morpheme does. The processing of inflection has been extensively studied in the psycholinguistic literature (e.g., Sonnenstuhl, Eisenbeiss, & Clahsen, 1999; Pastizzo & Feldman, 2002; Meunier & Marslen-Wilson, 2004; Tsapkini, Jarema & Kehayia, 2002; Kielar, Joanisse, & Hare, 2008). Some studies have found priming differences between regular and irregular inflection in different languages.

Using the masked priming paradigm (and cross-model repetition priming) to examine the representation of regular and irregular inflectional forms in French, Meunier and Marslen-Wilson (2004) raised the question of whether these two verb forms can be accommodated by a single representational mechanism. In one experiment, they used a cross-modal repetition priming paradigm where participants heard a spoken prime (such as *aimons* , "we love") immediately followed by lexical decision to a visual probe (such as *aimer* , "to love"). They used four different types of French verbs, varying in the regularity and degree of allomorphy of their stem once inflected[6]: (i) fully regular prime-target verb pairs (*aimons-AIMER*, "we love/to love") (ii) regular verbs that undergo minor and phonologically predictable allomorphic changes (*sèment-SEMER* , "they sow/to sow") (iii) irregular verbs exhibiting sub regularities (*peignent-PEINDRE* , "they paint/to paint") and (iv) irregular verbs with idiosyncratic alternations (*vont-ALLER* , 'they go/to go'). The infinitive forms of these verbs were presented as targets in three prime conditions, preceded either by a regular form, an allomorphic form (i.e., a variant form of a morpheme that can vary in sound without changing meaning) except for the fully regular verbs), or an unrelated prime. Morphologically related primes significantly facilitated lexical decision responses for all four verb classes, irrespective of regularity

[6] Inflectional morphemes can be the same, in many cases orthographic and phonological changes to the stem are involved.

and allomorphy. The same pattern of results was observed in a second experiment using a masked priming paradigm. Meunier and Marslen Wilson (2004) concluded that regular and irregular verb forms prime their infinitive forms equally, which was interpreted as evidence for a single representational system. These results contrasted with results found for English, where regularly inflected verbs prime their stems but irregular verbs do not (Pastizzo & Feldman, 2002). The authors also argued that the pattern of results reflects cross-linguistic differences in the morpho-phonological decomposability of French irregular forms. This study, however, did not include an orthographic overlap condition, thus limiting the conclusions that were drawn.

Pastizzo and Feldman (2002) have suggested that it may not be regularity that accounts for processing differences or determines whether or not morphological priming can be obtained, but rather the level of form overlap that is usually shared between regular prime target inflectional pairs (such as walked-WALK). Pastizzo and Feldman (2002) examined the influence of form-overlap in morphological priming across past tense and present tense forms of regular and irregular verbs. Using the masked priming paradigm with an SOA of 48 ms they found that significant facilitation for irregular forms that had a high degree of overlap with the target (fell - FALL), but not for irregular pairs that shared lower degrees of form relatedness (taught-TEACH).

However, some research (Tsapkini et al., 2002; Kielar et al., 2008) found essentially opposite patterns. Looking at the processing of inflections in Greek, Tsapkini et al. (2002) used verbs from four different categories (two regular categories and two irregular categories), and manipulated degree of form overlap across present and past tense forms. At the short SOA (35 ms), no differences emerged in performance on the present tense target words from these different categories. When priming effects on the past tense were compared across the different verb categories (and relative to unrelated primes), priming did not interact with morphological category (i.e., with regularity or lack of it). The conclusion was made that in Greek, regular and irregular past tense forms appear to be equally efficient primes for the corresponding present tense targets. Although in this research I look at both the inflectional and derivational morpheme, a comparison between the two is beyond the scope of this work.

THE SYSTEMS OF DERIVATION AND INFLECTION IN FRENCH

In common with English and many other languages, French has two modes of affixal word combinations: inflectional and derivational. Both English and French have been greatly influenced by Latin and, as a result, they share a large number of affixes. French, with over 80% of its vocabulary originating from Latin, has about 170 affixes although only about 50 affixes are in common use (Duncan, Casalis, & Colé, 2009). This is because many affixes of Latin or Greek origin are used only in scientific or technical terminology (Crystal, 2003).

As is the case in many other languages, derivational morphology in French restricts the type of basis or stems affixes can attach to. The French adverbial suffix –*ment* (*ly*), for example, freely attaches to adjectival[7] bases, as in *douce-ment* (i.e., quietly, gently) or *rapide-ment* (i.e., quickly), but not to nouns or verbs[8] (e.g. *voiture+ment or *marche+ment). This property is often treated as a sub categorization property: affixes are said to subcategorize for specific bases they apply to (Lieber, 1981; Olsen, 1986 cited in Janssen, Wiese & Sclesewsky, 2006). The bases must satisfy the sub categorization

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[7] Adjectives ending in a vowel or that are already inflected forthe feminine.
[8] There is a nominal suffix –ment which attaches to verbs.

information of the affix, in particular morpho-syntactic, semantic, or phonological properties.

AN OVERVIEW OF FRENCH INFLECTIONAL MORPHOLOGY:

In comparison to English, French verbal morphology is considerably more complex. In French, a stem-based language, inflections such as tense markers attach to a stem rather than to the complete word (e.g., French *cherch-* + *-e*, 1st pers. sing., present tense of *look for*, *search*). In English, on the other hand, a word based language, inflections are attached to an existing word (e.g., English: *jump-* + *-s*, 3rd pers. sing., present tense). This means, that unlike English, omission of the inflection morpheme in French leaves a non-word, that is, the stem (Royle, 2007).

Complexity of the French inflectional system can also be seen in the existence of three verbal inflectional classes that are grouped according to their infinitive form, and their conjugation in the imperfect form (i.e., the way they inflect to mark the imperfect tense according to mood and the subject's person and number); (1) 1st group verbs, those verbs ending in *–er* (except the verb *aller*, i.e., *go*), (2) 2nd group verbs, verbs ending in –*ir*, with the gerund ending in *–issant*, (3) 3rd group verbs and they consist of three subgroups: (a) 1st subgroup consists of verbs ending in *–ir* with the gerund ending in –*ant*, (b) 2nd subgroup consisting of verbs ending in –oir, and (c) 3rd subgroup consisting of verbs ending in *–re*. French verbs are composed of two distinct parts: the stem (or root), which indicates which verb it is, and the ending (inflection), which indicates the verb's tense and mood and its subject's person and number (though many endings can correspond to multiple tense-mood-subject combinations) (Grévisse, 1993).

With approximately 4000 verbs, group 1 represents the major conjugation class (Grévisse & Goose, 1980). It consists of verbs with infinitives ending in *-er* (such as *aimer*, 'to love', *voler*, 'to fly'). This is the most productive class and is fully regular, with practically no stem allomorphy (only one verb ending in *–er*, *aller* "to go" is irregular). This group contains most of the French loanwords (e.g., *chatter* "to web-chat"), neologisms (*tchorer* "to steal"), denominals (*fumer* "to smoke") and onomatopoeia (*ronronner* "to purr") — which are all indications of this conjugation's role as the default regular paradigm (Royle, 2007). French-speaking children from France are also known to typically over regularize irregulars into this group (Grégoire, 1937; Guillaume, 1927, 1973; and Hiriarteborde, 1973, cited in Royle, 2007). When certain inflections are applied, many French verbs belonging to the first group (i.e., those ending in *–er* in the infinitive form) show internal spelling changes (Bescherelle, 2006). Thus, in the verb *parlaient (1st group)*, the stem *parl-* indicates that the verb is *parler* (to speak) and the ending *–aient* marks the 3rd person plural in the imperfect indicative tense. Consider, for example, the following transformations where the infinitive form (left) undergoes spelling alteration before it is inflected to mark the present tense (right):

a. m*e*ner - (il) m*è*ne (i.e., *he holds, carries*)

b. c*é*der - (que tu) c*è*des

c. essu*y*er - (tu) essu*i*es

d. Je*t*er - (Je, il) je*tt*e

e. pla*c*er - (nous) pla*ç*ons

These spelling changes are predictable and they depend on phonological properties of the affix that is being applied.

The second conjugation group is formed by verbs that have an infinitive ending in *-ir* and imperfect in *-iss-* (such as *finir*, "to finish", *salir*, "to make dirty"). It is a smaller class than group 1 (consists of 300–350 verbs together with group 3, Bescherelle, (2006)) and it is no longer productive, but it is sub-regular (i.e. partially regular). The regular verbs from this class maintain a consistent stem throughout the paradigm (e.g., *finir* "to finish", *je finis* "I finish"), and add *–iss* to the stem in certain forms (e.g. *je finissais*, "I finished"). Irregular verbs ending in *-ir* exhibit stem allomorphy (e.g., *venir* "to come", *vient* "come").

The third conjugation group contains verbs with infinitives ending in -ir and imperfect inflection that does not end in *-iss*, as well as verbs with infinitives ending in –*oir(e)*, -re (such as *dormir*, "to sleep", *boire*, "to drink", *peindre*, "to paint") and the verb *aller*, "to go". Verbs from this group undergo stem changes as a result of being inflected and are, thus, highly irregular (e.g., *resoudre* transforms to *resolvais* with the first person singular in imperfect tense). Their inflection usually involves vowel changes and the realization of latent consonants, or even stem allomorphy such as in *boire-j'ai bu*, "to drink-I drank"). As no new forms are coined in this group, it is not productive. Traditional French grammar books usually assign each 3rd group verb anywhere from one to six stem forms (Grévisse, 1993). Thus, in the verb *acquérait* (3rd group), the stem *acquér-* indicates that the verb is *acquérir* (to acquire) and the ending *–ait* marks the 3rd person singular in the imperfect indicative tense. Whereas in the verb *finissons* (3rd group) the stem fin- indicates that the verb is finir (to finish), the suffix –iss follows it, and the inflection –ons marks the 1st person plural indicative. More examples are shown below for other verbs and their stems:

a. partir has stems par-, part

b. savoir has stems sai-, say-, sau-, sach-,

c . apercevoir, concevoir, décevoir, percevoir, recevoir have stems in -çoi, -cev-, -çoiv-.

d. contredire, dédire, dire, interdire, médire, maudire, prédire, redire have stems in -dis-, -di-, -d-

As can be seen from these descriptions, the stem/base form of the French verb (infinitive) always ends in a suffix such as *–er*, *-ir*, *-re*, *-oir*, and cannot appear without a suffix as is the case with English infinitival forms (e.g., want) (Bescherelle, 2006).

French verbs are typically inflected for seven moods (indicatif, subjonctif, conditionnel, imperative, infinitive, participle, and gerondif) (Bescherelle, 2006). Each of these moods has two forms of tense (present, and past[9]) with the indicatif and the conditionnel allowing future tense inflections as well, and the subjonctif allowing the parfait and the plus que parfait inflections[10]. Verbs are also inflected differently according to six forms of person[11]: 1st person singular (*je*, "I"), 2nd person singular (*tu*, "you"), 3rd person singular (*il/elle*, i.e., "he"/ "she"/ "it"), 1st person plural (*nous*, i.e.,

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[9] There are forms that are the same, for example the subjunctive and the present have the same form for all regular verbs, as well as the gerundive and the present participle.

[10] Not all of these tenses are used in contemporary French. For example, le plus que parfait subjonctif is only used in formal speech or written language (mainly in literary writing).

[11] 1sg and 3sg are the same for regular verbs, 1sg and 2sg are the same for irregular verbs.

"we"), 2nd person plural (*vous*, i.e., "you"), 3rd person plural (*ils/elles*, i.e., "they$_{masc}$" / "they"$_{fem)}$.

THE FRENCH "IMPERFECT" TENSE (*INDICATIF IMPARFAIT*)

The French *imparfait* (imperfect) is a descriptive past tense which needs a reference point in time. It is used to describe events, habitual situations, or actions that were repeated or continued over a certain period of time. It is also used to describe what was going on at an indefinite time in the past or what used to happen when the beginning and end of the state of being or action are not indicated. The imperfect can be translated in English as "was", "was _____ing", or "would" when it implies "used to" (e.g., *Pendant mon enfance, je lisais beaucoup.* "During my childhood I read (used to read, would read) a lot"; *Je regardais la télé quand le téléphone a sonné.* "I was watching TV when the phone rang"). The imperfect is a simple tense that does not require a helping verb (i.e. an auxiliary verb such as "was" or "has" in English). Although verbs from different groups have variant stems as they undergo different inflections for different tenses, the stem of the imperfect indicative is always invariant for a single verb. It is derived from the first person plural of the present indicative (except for the verb *être*). Thus, it is formed by dropping the *-ons* ending from the present tense *nous* form of the verb and adding one of the following endings (shown in the table below) according to the subject's person.

Table 1: The French Imperfect Tense

Jouer	**Finir**	**Vendre**
nous jou ~~ons~~	*nous finiss ~~ons~~*	*nous vend ~~ons~~*
je jouais	*je finissais*	*je vendais*
tu jouais	*tu finissais*	*tu vendais*
il jouait	*il finissait*	*il vendait*
nous jouions	*nous finissions*	*nous vendions*
vous jouiez	*vous finissiez*	*vous vendiez*
ils jouaient	*ils finissaient*	*ils vendaient*

Verbs ending in *-cer* change *-c* to *-ç* before *-a* to maintain the soft *c* sound in the *je* (I), *tu* (you_{sing}), *il* (s/he), and *ils* (they) forms (e.g., *La voiture avançait lentement.* "The car was advancing slowly"). Verbs ending in *-ger* insert a silent *-e* between *-g* and *-a* to maintain the soft *g* sound in the *je* (I), *tu* (you_{sing}), *il* (s/he), and *ils* (they) forms (e.g., *Il mangeait si vite.* "He was eating so quickly"; *Nous mangions toujours dans ce restaurant.* "We always ate at that restaurant"). The imparfait of irregular verbs follows the same rules for the formation of the imperfect as do regular verbs. Thus, to form the imperfect for 3rd group verbs, simply drop the *-ons* and add the imperfect endings given earlier.

As can be seen from this brief description of the French morphological system, an important fact about the French inflectional morphology that bears significant implications for the different theories of lexical processing is its unique form of irregularity. As explained above, and with the exception of auxiliaries and models where the stem and the inflection can be indistinguishable from one another (as in English irregulars), irregularity in French involves two processes: a) stem selection and b) stem inflection. This fact suggests that inflection of French irregular verbs could involve regular rules as well as memory-based stem retrieval (Royle, 2007). It perhaps explains why several studies that looked at regular versus irregular morphological processing in French found priming effects that can be accounted for from both a connectionist as well as a dual mechanism model (Meunier & Marslen Wilson, 2004).

With these facts about the French inflectional morphology in mind, the rationale behind choosing the *Imparfait* tense in this study is twofold: (1) stem preservation, compared to any other tense: as mentioned earlier, although verbs from different groups have variant stems as they undergo different inflections for different tenses, the stem of the imperfect indicative is always invariant for a single verb. (2) its higher degree of systematicity: the *imparfait* of irregular verbs follows the same rules for the formation of the imperfect as do regular verbs. Thus, to form the imperfect for 3rd group verbs, simply drop the *-ons* and add the imperfect endings given earlier. Both factors will hopefully lead to solid conclusions about lexical processing of morphologically complex words.

CHAPTER 6

EXPERIMENT 1

Experiment 1 was designed to investigate how native French speakers make use of morphological structure during lexical processing, and whether differences or similarities exist between native speakers and L2 learners. A second goal was to examine how processing might differ with French L2 speakers who use the language less frequently and thus show some attrition effects in their L2 (French). Participants from three groups (between age 18 and 35) were tested; (1) a French native speaker group (L1 group), (2) an English-French bilingual group with French as L2, and (3) an English-French bilingual group with French as the L2 attrition language. Participants were presented with morphologically complex French words preceded by primes from each of three conditions; (1) identity (e.g., *croire-CROIRE*), (2) morphological (*croyais-CROIRE*), and (3) unrelated (*écrire-CROIRE*) (i.e., believe-believe, believed-believe, write-believe, respectively). The targets were either from the inflectional imperfect tense or the derivational (adverbial) morpheme *-ment*.

All groups were expected to show repetition priming. Specifically, the RTs to the target were predicted to be faster in the identity than in the unrelated condition. Of particular interest is whether the masked priming paradigm yields such effects in a dormant language (a language that has not been used on a frequent basis, and thus was subject to attrition effects). Morphological priming (i.e., faster RTs for the morphological condition than the unrelated condition) would be indicative of morphological parsing processes (de-compositional style) because it indicates that participants automatically decompose the item first into constituent morphemes, rather than access its full form representation from memory.

Thus, the first hypothesis is that a morphological priming effect would be found for participants from the L1 group (i.e., RTs would be faster in the morphological conditions than in the unrelated condition). Native speakers are known in the literature to rely more on procedural systems for lexical processing than L2 speakers. In Ullman (2005) this pattern is thought to occur because maturational changes that occur in childhood lead to the attenuation of the declarative system. Thus, from a symbolic decompositional perspective, the second hypothesis is that L2 speakers who acquired French before age 11 will show native-like trends (i.e. similar priming effects will be found between the L2 and the native speakers with respect to the conditions mentioned above). Further, if lexical processing in attrition is different from that in acquisition, significant interactions between group and priming condition should be found. Particularly, morphological priming effects will be found for the L1 group but not for the attrition group. If frequency has an effect on the way these types of words are processed (i.e. in their full form vs. de-compositionally), high frequency words would show no significant effect between conditions whereas low frequency words will show an effect (i.e. a significant frequency by condition interaction). Finally, if groups differ in their sensitivity to frequency, between conditions effects would be found for some of the groups but not the others. In attrition infrequent use is often accompanied with processing slow down thus the attrition group is expected to show different patterns from the other two groups. With respect to accuracy, the first two groups (the natives and the early L2) will be similar overall but different from the language attrition group. The language attrition group will have the lowest scores.

Participants

Thirty-five individuals participated in this experiment (some received course credit for participating). There were three language-experience groups: native French speakers with no language attrition effects (i.e., L1 group, n = 8, 4 males, mean age = 20, SD = 1.5); French L2 speakers with no attrition effects (i.e., L2 group, n = 13, 4 males, mean age = 19, SD = 1.4) and; French L2 speakers with some attrition effects (i.e., LA group, n = 14, 1 male, mean age = 21, SD = 4).

Participants were recruited through announcements posted on bulletin boards across the University of Ottawa and Carleton University's campuses. Recruitment from the Carleton University psychology pool took place through the SONA system (a web-based subject recruitment system). Each participant filled in a background questionnaire which was meant to reflect the status of their competence and use of the French language (please see Appendix A for the language background questionnaire). The questionnaire helped in identifying which participants belonged to which group by means of a detailed list of background questions eliciting general biographical information and participants' language learning history, self-rating of language proficiency, as well as information about current language use.

Self ratings of language proficiency (reflected in the "can-do" tests) were adapted from Schmid's (2004) attrition test battery. They consisted of statements about linguistic abilities that were rated on a scale of 1 to 5 with 5 being the highest score and being equivalent to "I can do this without any difficulty at all" (Appendix A). An example of these statements is "I can use language flexibly and effectively for social and professional purposes". The statements were categorized into different language skills categories (i.e., reading, listening, speaking, and writing proficiency).

Native French speakers are defined as those who had spoken French from birth. Three had also acquired English simultaneously with French, and one reported having been exposed to another language before the age of four. Early L2 speakers are defined as those who were enrolled in an early French Immersion program and who were first exposed to French before age 11. While the Early L2 speakers reported current native competence in both English and French, the attrition group consisted of those who learned French before age 11, and who reported not having spoken French on a daily basis within the last 5 years. They also reported performance difficulties in the French language and performed poorly on the French language "can-do" part.

Table 2. Experiment 1: proficiency per group.

			Age (range)		"Can do"	
Language Group	*N* (males)	Age at Initial Exposure to French	*M*	*SD*	*M*	*SD*
Native S	8 (4)	From Birth	20(18-22)	1.5	95	8
Early L2	13 (4)	Between 4 and 9	19(18-22)	1.4	75	15
Attrition	14 (1)	Between 4 and 9	21(18-32)	4	41	12

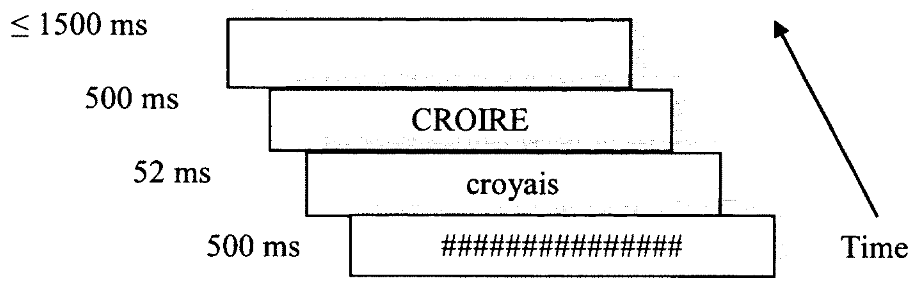
Similar to the early L2 group, the language attrition group had acquired French before age 11 and in formal settings (school) primarily because they had been enrolled in early French immersion programs. French immersion classes are introduced as early as age 5 (senior kindergarten) in Canadian schools and continue to represent a high percentage of the mandatory part of the curriculum at the elementary and secondary levels of education. This means participants from the early L2 group, as well as those from the attrition group had on average a minimum of 10 years of instruction in French. The early bilingual group performed well on the "can do tests" (a summary of each group's performance on the "can do" tests is summarized in table 2 above). Although both groups are assumed to have been exposed to the same amount of schooling in French, the fact that assessing the proficiency level they reached prior to experiencing attrition effects was not possible at the time of testing remains a problematic issue in attrition research in general.

Procedure and stimuli

Procedure

After filling out the language questionnaire, participants completed the masked visual priming lexical decision task in French. Each participant was tested individually. The standard three-field paradigm was used (based on the procedure used by Forster & Davis, 1984). On each trial, a pattern mask (i.e., ######) appeared as a fixation point on a computer screen for 500 ms, followed by the prime word. Each prime word was displayed in lower case for 52 ms, and was immediately followed by the target word displayed for 500 ms in upper case to ensure that the two stimuli are physically distinct. The following diagram (Figure 5) illustrates the sequence of events for the morphological condition:

Figure 5. A schematic diagram of the visual masked priming paradigm. The prime was forward masked by a visual noise pattern and backward masked by the target so that participants were not consciously aware of the prime.



Participants were instructed to decide, as quickly and as accurately as possible, whether the target stimulus was a word in French by pressing a *yes* or *no* button on the keyboard. The experiment began with a practice session consisting of 10 prime-target pairs, which were not included in the analysis. The experiment took an average of 13 minutes and consisted of two break intervals. The first item after each break was excluded from the analysis. Instructions appeared on the screen before each experiment and if there were no questions the experimental procedure was started (Appendix H for more details). Stimuli presentation and the timing and recording of all stimuli responses and response times were controlled using the *Presentation* stimulus delivery and experimental control software (Neurobehavioral Systems –version 14.9.07.19.11). Stimuli were presented on a Dell computer running Microsoft Windows XP (SP3, 2012). Three types of prime target pairs were generated: (1) identity (e.g., *croire-CROIRE*), (2) morphological (*croyais-CROIRE*), and (3) unrelated (*écrire-CROIRE*) (i.e., believe-

believe, believed-believe, write-believe, respectively). Each participant from each group saw words from each category, however, the stimuli were designed in such a way that no one participant saw any target word more than once (see Appendix C for the list of stimuli items used for Experiment 1).

Stimuli

The stimuli consisted of a total of 61 morphologically complex French words from two morphological categories. There were 25 items from the inflectional target category (the *imparfait* morpheme "*ais*" was used which is a descriptive past tense used to describe events and habitual situations in the past and is similar to the English construction was + v + ing). All target items were in the bare/infinitive form of the verb and were primed by 25 items from each of the three conditions (25 from the identity condition, 25 inflectional and 25 unrelated). Using the infinitive form as targets in a masked prime paradigm has the added advantage that participants are never consciously exposed to morphologically complex stimuli, and therefore cannot adopt strategies that might be particular to this type of stimulus.

The second category included French adverbs (36 items) with the derivational morpheme *–ment* (i.e., the equivalent of the English morpheme *-ly* that attaches to adjectives to make adverbs) plus 36 primes in each of the three conditions (identity, morphological, unrelated). Each condition list consisted also of 61 filler items that were pseudo words. The latter were made by combining an existing morpheme with an existing stem in a way that did not actually exist as a one word in French, (for example *TROUVAGE*, see Appendix D for the complete list of stimuli). Items in each condition were classified as high or low in terms of frequency. There were 27 items in the high frequency category (mean frequency = 285, *SD* = 183) and 34 items in the low frequency category (mean frequency = 157, *SD* = 85). Three lists were generated from items in each condition such that each participant saw each target only once, with one prime type.

Items in both morpheme types were matched on average for number of letters and neighborhood density. Items in the inflectional category had a mean number of letters = 6, *SD* = 1 (mean neighborhood density =5, *SD* = 5). Items in the derivational category had a mean number of letters = 6, *SD* = 1.7 (mean neighborhood density = 5, *SD* = 4). Because both French and English have been influenced by Latin, and thus share a large number of words, various factors were taken into consideration before a final list of items was selected. Among these factors is cognate status; words that have a cognate in English were avoided (e.g., liberté/liberty). False cognates were also avoided (i.e., words that exist in English albeit with a different meaning: *actuel-actuellement* vs. actual-actually). Similarly, words that share orthographic form but might exist in less formal English were eliminated (e.g., *sec*-dry vs. sec as in "wait a sec").

Results

The inflectional and derivational morpheme types were analyzed separately. Response times (RTs) and accuracy were analyzed in two repeated measures ANOVAs with three factors: 2(frequency type: high vs. low) x 3(priming condition: identity, morphological, unrelated) x 3(language group: native French speakers, French L2 speakers, attrition group). Post hoc pairwise comparisons were also performed between means for each of these variables using the *Bonferoni* test with .05 alpha correction level. Only correct responses were used in the RT analyses.

Prior to the calculation of lexical decision times, incorrect responses (i.e., non-word responses to existing words and word responses to non-words) and extreme reaction times that exceeded two standard deviations from a participant's mean per condition were excluded from further analysis. This resulted in the removal of 2.3 % of the native speakers' responses, 1.4 % of the early L2 group responses, and 2.3 % of the attrition group responses.

The inflectional morpheme

Response times

Participants responded to high frequency items significantly faster (599 ms) than to low frequency items (620 ms), $F(1, 32) = 4.57, p = .04, \eta_p^2 = .13$. There was also a significant main effect of priming condition, $F(2, 64) = 3.87, p = .026, \eta_p^2 = .11$. Participants responded to items in the identity condition (594 ms) more quickly than in the unrelated condition (621 ms, p =.007). The identity condition also showed a trend towards being significantly faster than the morphological condition (613 ms, p =.088). There was, however, no significant difference between the morphological and unrelated condition (p =.439).

The results also showed a significant effect of group, $F(2, 32) = 4.6, p = .018, \eta_p^2 = .22$. There were no significant differences between the native speakers (579 ms) and the practicing L2 speakers (568 ms), whereas the attrition group responded more slowly than both the native speakers (681 ms, p =.035) and the practicing L2 speakers (p =.008). The interaction of priming condition and language group was not significant at the .05 alpha level, but showed a trend towards significance, $F(4, 64) = 2.19, p = .079, \eta_p^2 = .12$. A summary of significant effects is presented in Table 3 below. Descriptive information for group means is included in Appendix F.

Table 3. Significant effects: Experiment 1- inflectional

RTs	*F*	*Df*	*Sig.*	η_p^2
Frequency*	4.57	1	.040	.13
Condition*	3.87	2	.026	.11
Language Group*	4.60	2	.018	.22
Condition by Language Group	2.19	4	.079	.12
Accuracy				
Condition by Language Group*	2.89	4	.029	.15

Note. * Significant at $p < .05$;

Accuracy

There were no significant main effects of frequency or group, Fs < 1, or condition, $F\,(2, 64) = 1.8, p = .17$. The interaction between language group and priming condition was significant, however, $F\,(4, 64) = 2.89, p = .029$, $\eta_p^2 = .15$. The results from the pairwise comparisons for language group by condition show that while there was no major variation across conditions in accuracy scores between the native speakers group and the early L2 speakers, the attrition group showed lower accuracy in the morphological condition (92%) compared to the two other conditions (97% each). No other effects were significant.

The derivational morpheme

Response times

Participants responded to high frequency items (615 ms) faster than to low frequency items (727 ms), $F(1, 26) = 64.75$ $p < .001$, $\eta_p^2 = .71$. Latencies varied with priming condition, $F(2, 52) = 20.91$, $p < .001$, $\eta_p^2 = .45$, such that participants responded most quickly in the identity condition (630 ms) compared to the morphological condition (675 ms, $p = .003$) and slowest in the unrelated condition (709 ms, $p < .001$). The morphological condition was also significantly faster than the unrelated condition (p = .009), supporting arguments from the decompositional account (Table 4).

Response latencies did not vary across the three groups of participants, $F(2, 26) = 2.19$, $p = .13$, and the interaction of priming condition by language group was not significant, $F(4, 50) = .42$, $p = .66$. Thus, all three groups showed significant repetition-priming effects (i.e., faster RTs for identity than for unrelated control primes). This finding shows that the masked priming technique yields priming effects not only for L1 and practiced L2 speakers (as found in previous research) but also for speakers of L2 who show attrition. No other effects were significant.

Table 4. Significant effects: Experiment 1- derivational

RTs	*F*	*Df*	*Sig.*	η_p^2
Frequency**	64.75	1	< .001	.71
Condition**	20.91	2	< .001	.45
Accuracy				
Frequency**	45.57	1	< .001	.59
Language Group*	3.23	2	.053	.17
Freq by Condition by Language Group	.14	4	.086	.12

Note. * Significant at $p < .05$; ** Significant at $p < .001$.

Accuracy

Participants responded more accurately on high than on low frequency items (93% vs. 72%), F (1, 32) = 45.57, $p < .001$, $\eta_p^2 = .59$. Accuracy also varied with language group, F (2, 32) = 3.23, $p = .05$, $\eta_p^2 = .17$. As expected, the native speakers had the highest accuracy scores. The difference between the native speakers (89%) and the L2 attrition group, who had the lowest accuracy score (76%), was significant ($p = .016$). The L2 speakers were not significantly different from the native speakers (81%, $p = .15$). There were no significant interactions.

Discussion

In this experiment, I compared morphological processing across three French speaking groups: native speakers, currently active L2 speakers, and L2 speakers who were not active language users (i.e. attrition group). For the derivational morpheme type, effects of stimulus type were consistent with previous research (i.e., showing effects of repetition priming and word frequency and an advantage for morphologically related items), while there were no significant differences in how the three groups responded to the morphological structure of the target words. This pattern is consistent with the first hypothesis that non-native lexical processing when L2 has been acquired at an early age might not be fundamentally different from native processing.

The absence of significant effects from the interaction language group by priming condition in the derivational type (the results only showed a trend towards significance in the inflectional morpheme type) suggested that L2 participants, who unlike those from Silva and Clahsen (2008) have learned their L2 before maturational changes have presumably taken effect, were probably as sensitive to the morphemic structure of morphologically complex words as the native speakers. However, more L2 participants have to be tested before this can be confirmed (Experiment 2 and 3).

Previous research in the field of second language acquisition (Silva & Clahsen, 2008; Ullman, 2005) found that second language learners rely more on declarative procedures in lexical processing than native speakers. Silva and Clahsen, using a lexical decision task with morphologically complex words, found no priming effects with late L2 learners (those who acquired their L2 after age 11) between the identity and the unrelated conditions, whereas native speakers showed significant effects between the two conditions. The absence of such an effect between groups in the derivational type of the current study suggests absence of fundemental differences in the way an L2 is processed when it is acquired early in life versus later in life.

However, although the ANOVA results show no significant differences between the groups with respect to priming effects, a look at the actual data shows that the attrition group showed quite a different pattern. The latter showed identity priming effects in the inflectional type only at a low frequency level (but for both levels in the derivational). So even though the ANOVA only highlights the overall slower RTs and lower accuracy effects in the attrition group (compared to the native speakers), it remains unclear whether the lack of significant morphological priming in the attrition group is a result of the rather small sample size of participants, or an indication of absence of fundamental differences between the groups. Because all three groups in the current experiment acquired French before age 11, the ANOVA results seem to suggest that lack of use of a language that was learned early enough (before age 11) does not seem to influence how these types of words are processed. However, these conclusions have yet to be confirmed with certain modifications to the current experiment, namely increased sample sizes, and an increased stimulus list that includes more items in the inflectional as well as the derivational condition. These issues are further explored in Experiment 2 where I included a late L2 group to determine whether the differences between the present findings and those of Silva and Clahsen reflect age-of-acquisition effects.

The results from the inflectional morpheme type also showed no significant differences between groups with respect to identity priming. Also similarly to the derivational results, the attrition group's performance was the slowest. However, with respect to morphological decomposition, the results showed a slightly different pattern from the derivational morpheme type. There was no significant difference between the morphological condition and the unrelated condition. There are two plausible explanations for the lack of a morphological priming effect with this morpheme type. First, that lack of priming effects might be a result of limited sample sizes for items from the inflectional category (there was a total of 25 compared to 36 from the derivational). Second, inflectional morphemes might be processed differently from derivational morphemes. Several studies have specifically addressed the issue of existing differences in processing inflectional vs. derivational morphemes. Stanners, Neiser, Hernon, and Hall (1979) reported stronger priming effects for regular inflections than for irregular inflections and derived words. Similarily, Shriefers, Friederici, and Graetz (1992) found greater priming effects for derived than inflected words.

Taken together, the results from both morpheme types suggest that whereas some effects were found to be consistent with previous research (i.e., RTs were generally faster for the identity condition than for the unrelated condition, and for the morphological than the unrelated condition for the derivational type), lack of morphological priming effects with the inflectional type calls for further research before a conclusion can be made as to whether these three groups process morphologically complex words similarly. The finding that is of particular interest to the field of attrition is that the masked priming paradigm yields repetition priming effects in the L2 attriter.

The role of frequency

A second research question was whether frequency affects lexical processing in the same way or differently in native versus non-native speakers, as well as non-native speakers with attrition effects. The results revealed a significant effect of frequency for all groups. Responses were faster for high than for low frequency words. There was no significant effect for the frequency by condition interaction, which means that priming occurred for all types of words.

Priming effects with short SOAs

The effects found with the current study with respect to morphological processing (derivational type) do not seem to be a result of semantic or orthographic overlap because the SOA between prime and target was short 52 ms. Short SOAs used in masked priming of morphologically complex words are used to reduce the likelihood of a participant using episodic memory or any predictive strategies such as recognizing shared orthography (Neubauer & Clahsen, 2009). Even though some of the inflectional forms in the current study shared phonological/orthographic or semantic overlap with their targets, the priming effects reported here are unlikely to be due to this overlap because of the short SOA of 52 ms[12]. Nevertheless, I added one more condition in Experiment 2 where the prime was only related to the target orthographically. I also added more inflectional items from the regular verbs category and more derivational morphemes.

Conclusion and further experimental research

In Experiment 1, I compared and contrasted morphological processing across three French speaking groups: L2 speakers who were not active language users, and thus showed attrition, native speakers, and currently active L2 speakers. For the derivational morpheme, I found that, whereas some effects (i.e., repetition and morphological priming) were found to be consistent with previous research (e.g., RTs were generally faster for the identity condition than for the unrelated condition, and RTs from the morphological condition were faster than the unrelated), there were no major differences in how these three groups responded to the morphological structure of the target words. Although previous research (Silva & Clahsen, 2008) found significant differences between native speakers and L2 learners in processing morphologically complex words, my research suggests that L2 learners who acquired their second language early in life do not seem to process these words fundamentally differently from native speakers.

Although these findings confirm most of the predictions set out above, the absence of significant morphological priming effects with the inflectional type and the absence of group effects calls for some changes before a conclusion can be made as to whether these three groups process morphologically complex words similarly; first, increasing the group sizes and adding more stimuli to each morphemic category, and

[12] One participant mentioned that he saw some "word like" characters before some of the words, but could not illicit an example when asked if he remembered any.

second, adding an orthographic control condition. Thus in Experiment 2 of this thesis, I recruited at least 20 participants in each group. I added a late-bilingual group to see how they compare to native speakers and early L2 with respect to morphological processing. I also added a control priming condition where the prime was only related to the target orthographically (e.g., *donnecte* as a prime for *DONNER* where *–ecte* is not a legal morpheme in French even though it appears in many word endings such as in the verbs *infecte*, *connecte*, *suspecte*, *injecte*), These stimulus changes were meant to ensure that the effects found in Experiment 1 were not due to orthographic overlap. If the effects are indeed morphological, RTs on the orthographic condition should not prime the target (i.e., should not differ significantly from the unrelated condition).

CHAPTER 7

EXPERIMENT 2

Experiment 2 was designed to further investigate the question of how morphologically complex words in L1 are treated by the language processor at an early stage of processing, and whether morphology is a priority of the processor relative to other factors (such as orthography). A second purpose was to find out whether fluent L2 speakers and L2 speakers with attrition make use of morphological structure differently from native French speakers during lexical processing. To further understand and isolate attrition effects from proficiency effects, a late L2 learners control group was added to the three groups used in Experiment 1.

A third goal was to examine how processing might differ across groups with respect to the two different morphological types; inflectional vs. derivational, and how frequency might affect processing. Hence, various modifications were introduced in Experiment 2. This involved increasing participant group sizes as well as increasing the number of stimuli in each condition. An orthographic condition was also added in order to find out whether other factors (that are not necessarily morphological in nature) might have contributed to the effects found in Experiment 1 (namely, orthographic overlap). Thus, a control priming condition, an orthographic condition, where the prime is only related to the target orthographically was added (e.g., *donnecte* as a prime for *DONNER* where *–ecte* is not a legal morpheme in French even though it appears in many word endings such as in the verbs *infecte*, *connecte*, *suspecte*, *injecte*),

The predictions were that if priming effects were found for the morphological condition (but not for the orthographic one) relative to the unrelated condition, this pattern can be interpreted as evidence for morphological parsing processes because it indicates that participants automatically decomposed the item first into constituent morphemes rather than accessed its full form representation from memory. In contrast, from a connectionist perspective, which denies the existence of separable stems and inflectional morphemes, no such morphological priming effects are expected to be found regardless of whether the language is an L1 or L2 based on the argument that inflected forms are processed and represented as overlapping whole forms sharing certain semantic and phonological similarities (e.g., Rumelhart & McClelland, 1986; McClelland & Patterson, 2002).

With respect to native versus non-native processing, a symbolic account would predict that native speakers should show morphological priming (i.e., RTs in the morphological condition should be significantly faster than the unrelated) whereas RTs from the orthographic primes should not prime the target significantly compared to the unrelated condition. However, based on previous research comparing morphological processing in native speakers versus late L2 acquisition (Clahsen et al., 2009; Silva & Clahsen, 2008), I predicted that individuals who acquired French after age 11 will not show morphological priming. This prediction is based on the model in which these speakers rely more on the declarative system and thus their representations are affected by attenuation of the declarative system as a consequence of maturation (Ullman, 2005). In contrast, early L2 (particularly because they have learned French before age 11) will show priming patterns that are similar to those of native speakers.

Little is known about the differences and similarities between native language lexical processing versus lexical processing in attrition. In experiment 1 of this research, it was found that the masked priming paradigm yields repetition priming effects in the L2 speaker with attrition (as is often the case with the native speaker). Because I am looking at L2 attrition in this research (particularly attrition in an L2 that was acquired at an early age), it is important to understand processing in other L2 populations without attrition (i.e., early and late L2). Moreover, the question of whether or not L2 attrition involves a fundamental switch from relying on the procedural system to the declarative one is very much dependent on understanding processing in the native speaker and how it compares to non-native processing in all three L2 groups.

Finally, if frequency has an effect on the way these types of words are processed (i.e., in their full form vs. de-compositionally), high frequency words would show no significant effect between conditions whereas low frequency words will show an effect. If language experience shapes the lexical processor's sensitivity to frequency, between conditions effects would be found for some of the groups but not the others (generally the native speakers and the early L2 speakers) would show similar priming effects based on the assumption that if the language was acquired before age 11, it would be processed as if it were a first language).

Participants

A total of 93 participants (22 males) were tested. One male and one female were excluded for scoring 0 on the French proficiency test and not adequately filling in required information on the questionnaire form (especially about the amount of French they have learned). The data from one early L2 participant were not further analyzed because his lexical decision times were extremely fast and accuracy on non-words was very low (< 10 %), suggesting he simply responded that every stimulus was a word. Due to a technical problem, data from an L1 participant were lost for Experiment 2. A second L1 participant had indicated not feeling well throughout the experiment, and failed to proceed properly after taking a long break, thus his data were also excluded. Finally, participants who were identified as outliers (due to their low accuracy < 30 %) in each group were excluded (2 from the native speakers group, 1 from the early L2 group, and 1 from the language attrition group).

The remaining 84 participants (21 males) had an average age of 22.46 years (*SD* = 4.36). According to their performance on the language background questionnaire and the "Can do" test, participants were classified into 4 groups: French native speakers (n = 23, 4 males, mean age = 22.21, *SD* = 3.55); Early French L2 speakers (n = 26, 8 males, mean age = 23.11, *SD* = 5.18); Late French L2 speakers (n = 19, 3 males, mean age = 22.75, *SD* = 4.84); and language attrition (n = 16, 6 males, mean age = 21.41, *SD* = 3.10, see Table 4 for more details). Participants from the first three groups (the native speakers, the early L2, and the late L2) indicated that they still use French on a frequent basis, and thus should not be in a state of attrition. The fourth group participants (i.e., the attrition group) indicated experiencing some deterioration in their French language skills as a result of lack of use (for a minimum of the 5 past years).

Participants were recruited through announcements posted on bulletin boards across the University of Ottawa and Carleton University's campuses. Recruitment from the Carleton University psychology pool took place through the SONA system (a web-based participant recruitment system).

French proficiency assessment

As in Experiment 1, each participant filled in a language background questionnaire (Appendix A). Results from the questionnaire's "can do" sections, were used to place participants into the appropriate language experience group (see Experiment 1 for more details). Based on their language history from the questionnaire and their performance on the "can do" tests, participants were classified into four groups reflecting the status of their competence and use of the French language (Table 5 below).

All participants also completed a language proficiency cloze test designed by Tremblay (2011; Appendix B). In the cloze test, participants were presented with a page long narrative in French where they were asked to provide appropriate missing words (total of 45) that best fit into the context. Tests were graded using the answer key provided by Tremblay (also Appendix B), and the number of correct responses were counted and converted to a Proficiency Score out of 100.

Tremblay's (2011) proficiency test was designed with a number of performance factors and variables in mind. It was a product of a large scale sampling of university students taking French language courses and as such, it took into consideration factors such as number of years of instruction, duration of time spent in an immersion environment, and current use of French. Tremblay's (2011) participants were defined as; (1) low proficiency (Level I) if they scored between 6.7 and 28.1%, (2) mid-low proficiency (Level II) if they scored between 31.1 and 48.9%; (3) mid-high proficiency (Level III) if they scored between 51.1 and 68.9%; and high proficiency (Level IV) if they scored between 71.1 and 93%.

Using this measure of proficiency in the current study provided an objective way of making sure participants are situated correctly in their respective groups. And because self ratings about one's language skills are not always accurate (for example, in attrition people generally tend to over rate the deteriorating status of their linguistic skills[13], MacIntyre, Noels, & Clement, 1997), the proficiency test was used to assess whether the statements from the "can do" tests about one's linguistic skills reflect the participant's actual proficiency.

Table 5. Experiment 2: Proficiency per group

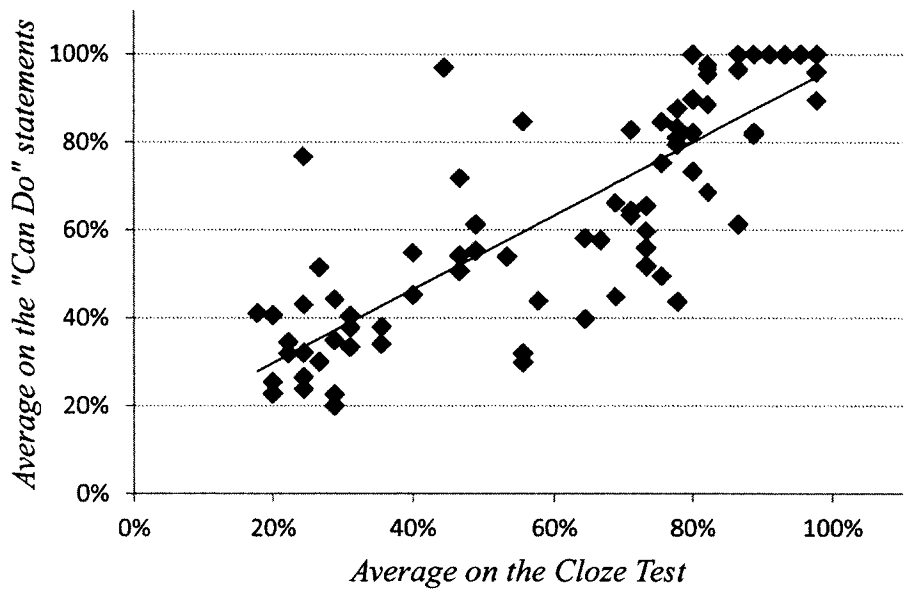
Language Group	*N* (males)	Age at Initial Exposure to French	Age (range) *M*	*SD*	"Can do" *M*	*SD*	Cloze Test *M*	*SD*
Native S	23 (4)	From birth	22 (18-30)	3.6	94	8	88	7
Early L2	26 (8)	Between 4 and 9	23 (18-35)	5.2	70	17	70	14
Attrition	16 (6)	Between 4 and 9	21 (19-34)	3.1	35	9	28	6
Late L2	19 (3)	11 or later	22 (19-28)	4.8	47	19	49	23

The cloze test and the "can do" scores correlated (Figure 6) (r (82) = .83, $p <$ .001). Participants who rated their skills as very poor in the "can do" test also scored low on the cloze test. Similarly, those who scored high on the proficiency cloze test also had a high score on the "can do" test. However, two participants who claimed attrition on various parts of the questionnaire, and failed to take the cloze test were excluded as it was

[13] People tend to think they are worse than they actually are.

not clear (based on results from the two measures) whether they had indeed learned French in the first place[14].

Figure 6. Proficiency data showing a correlation between self rating "Can Do" statements and performance on the cloze test.



Native French speakers are defined as those who had spoken French from birth. Sixteen of the the 23 spoke English as well (as a L2); eight indicated they learned it at age 9 or after and eight had acquired French and English simultaneously from birth. Two of the eight participants who acquired English after age 9 reported having been exposed to a different language (other than French) before the age of four.

[14] In this sense the cloze test was useful as a back up tool to validate participation from the university pool of participants (although the online recruitment announcement did specify the requirements, some participants, such as the two mentioned above, seem to have shown up just for credit).

Early L2 speakers are defined as those who were enrolled in a French Immersion program and who were first exposed to French before age 11. The Early L2 speakers reported current native competence in both English and French. They still used French on a daily basis and they performed well on the "can do tests" (A summary of each group's performance on the "can do" tests and the proficiency cloze test is summarized in table 5).

Late L2 speakers included individuals who had enrolled in late French immersion (i.e., grade 6 or 7, or after age 11, $n = 15$) and those who decided to take French at a later age ($n = 4$). All of the late L2 participants reported current use of French either in an academic or work environment. Three individuals considered themselves to be functionally bilingual and also reported very frequent current use of French in certain contexts. These three late L2 rated their French proficiency level as "advanced". Overall, the other participants in this group rated their own French proficiency from very low to advanced.

The *attrition* group consisted of those who learned French before age 11 and in formal settings (i.e., those who took early French Immersion[15]), but who reported not having spoken French on a daily basis within the last 5 years. They also reported performance difficulties in the French language and performed poorly on the French language proficiency test and the "can-do" part. Thus, early L2 and the attrition group

[15] French immersion classes are introduced as early as age 5 (senior kindergarten) in Canadian schools and continue to represent a high percentage of the mandatory part of the curriculum at the elementary and secondary levels of education.

had similar early experiences with French, but the attrition group no longer used French very often.

The cloze test performance was analyzed in a one-way ANOVA by language group, F (3, 80) = 63.46, $p < .001$, $\eta_p^2 = .70$. Each of the four groups differed significantly from the other three groups in terms of how proficient in French they were. The native speakers had the highest score (88%, SD = 7), followed by the early L2 group (70%, SD = 1.4), the late L2 group (49%, SD = 2.3), and the attrition group (28%, SD = 2.6). Thus, the proficiency data is consistent with the grouping based on language exposure (early or late) and self-reported language experience.

Procedure and stimuli

Procedure

After filling out the language questionnaire and the language proficiency test, participants completed the masked visual priming lexical decision task in French. The apparatus and procedure was the same as that used in Experiment 1. The experiment took an average of 16 minutes and consisted of three break intervals. Four types of prime target pairs were generated (see Appendix D for the experimental lists): (1) identity (e.g., *croire-CROIRE*), (2) morphological (*croyais-CROIRE*), (3) unrelated (*écrire-CROIRE*), and (4) orthographic (*donnecte- DONNER*) (i.e., believe-believe, believed-believe, write-believe, believen*-believe, respectively). Each participant from each group saw words from each category, however, the stimuli were designed in such a way that no one participant saw any target word more than once.

Stimuli

The target stimuli consisted of a total of 96 root forms of French words from two morphological categories; 48 from the inflectional type and 48 from the derivational. Each condition (there was a total of 4 conditions per each morpheme type) consisted of 12 items. In the inflectional type half of the items in each condition (i.e., 6) were from the first conjugational group (most regular), whereas the other half was from the third group (least regular). All 48 target items in the bare/infinitive form of the verb were primed by 48 items from each of the four conditions (48 from the identity condition, 48 inflectional (the *imparfait* tense was used), 48 unrelated, and 48 orthographic). Four lists were generated from items in each condition such that each participant saw each target only once, with one prime type from each of the four prime conditions.

The second category of targets included French adverbs (48 items) with the derivational morpheme *–ment* (i.e., the equivalent of the English morpheme *-ly* that attaches to adjectives to make adverbs). Two other derivational morpheme types were added (that were not used in experiment 1); the morpheme *-ité* (i.e., the equivalent of the English morpheme *-ity* that attaches to adjectives to make nouns), and the morphemes *-esse* (i.e., the equivalent of the English morpheme *-ness* that attaches to adjectives to make nouns) plus 48 primes in each of the four conditions (identity, morphological, unrelated, and orthographic).

Each final target list (consisting of 48 items from each morpheme type) consisted also of 61 filler items that were pseudo words. The latter were made by combining an existing morpheme with an existing stem in a way that did not actually exist as a one word in French, (for example *TROUVAGE*). See Appendix D for the complete list of stimuli items. Items in each condition (except non-words) were classified as high or low in terms of frequency (frequency was determined as in Experiment 1). Half of the items in each condition were high frequency and the other half were low frequency. There were, in total, 48 items in the high frequency category and 48 items low frequency (mean frequency = 113; *SD* = 89).

Items in both morpheme types were matched on average for number of letters and neighborhood density. Items in the inflectional category had a mean number of letters = 6.3, *SD* = 1.4 (mean neighborhood density = 4, *SD* = 4). Items in the derivational category had a mean number of letters = 6.1, *SD* = 1.7 (mean neighborhood density = 3, *SD* = 3). Because both French and English have been influenced by Latin, and thus share a large number of words, various factors were taken into consideration before a final list of items was selected (please refer to Experiment 1 for more details).

Results

Prior to the calculation of lexical decision times, incorrect responses (i.e., non-word responses to existing words and word responses to non-words) and extreme reaction times that exceeded two standard deviations from a participant's mean per condition were excluded from further analysis. This resulted in the removal of 3.6 % of the native speakers' responses, 3.0% of the early L2 group responses, 2.5 % of the late L2's responses, and 2.2 % of the attrition group responses. Missing data for a few conditions were filled in with the condition average from the group that a participant belonged to. This accounted for less than 0.03% of the data. In order to understand processing in native speakers, an ANOVA was run on the L1 group separately.

Processing in L1

RTs and accuracy were analyzed in two repeated measures ANOVAs with two factors: 2 (frequency type: high vs. low) x 4 (priming condition: identity, morphological, unrelated, and orthographic). Post hoc pairwise comparisons were also performed between means for each of these variables using the Bonferroni test with .05 alpha correction level.

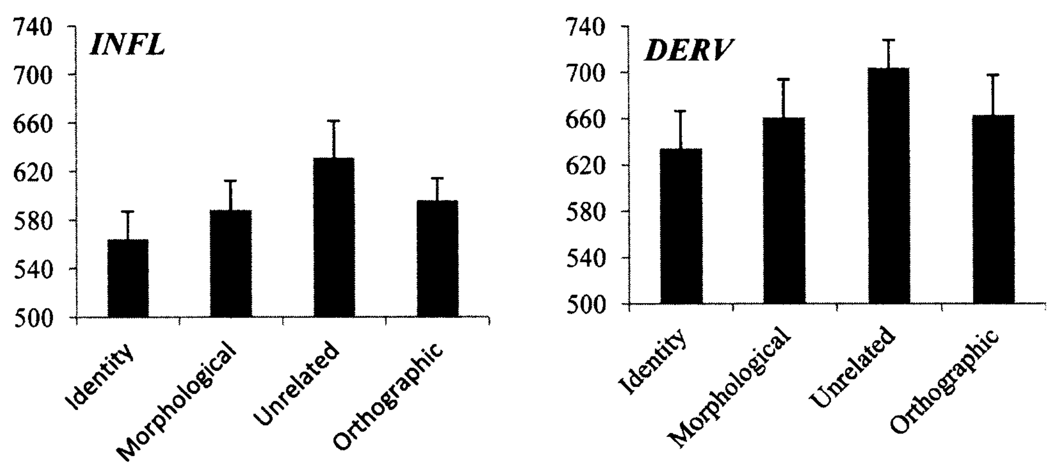
Inflectional morphology

Response times

The results revealed a significant main effect of frequency, $F(1, 22) = 14.12, p = .001, \eta_p^2 = .39$, with high frequency items being responded to significantly faster (580 ms) than low frequency items (610 ms). There was also a significant main effect of priming condition, $F(3, 66) = 10.22, p < .001, \eta_p^2 = .32$. Participants responded to items in the identity condition (564 ms) faster than in the unrelated condition (631 ms, mean diff = 67 ms, $p < .001$). RTs from the morphological condition (588 ms) were also significantly faster than those from the unrelated condition (mean diff = 43 ms, $p = .005$). Moreover, the difference between the orthographic condition (596 ms) and the unrelated was not statistically significant (mean diff = 36 ms, $p = .311$) thus, ruling out the effect of orthographic form at such an early stage of processing. RTs for the orthographic condition did not differ significantly from the morphological condition (mean diff = 7 ms, $p = .1$). Finally, the difference between the identity condition and the morphological, showed a trend towards significance (mean diff = 24, $p = .062$) which suggests that the latter (morphological priming) may differ from identity priming. Likely, a few more participants may need to be tested to ascertain if this effect becomes significant at the .05

level or if no differences are found. These data support the hypothesis that native speakers automatically decompose items from the inflectional category. Figure 7 displays these results.

Figure 7. RT data showing latencies per priming condition for the inflectional and the derivational morphemes from Experiment 2. Error bars show standard error.



Accuracy

With respect to accuracy, the results showed a significant effect of frequency $F(1, 22) = 12.50$, $p = .002$. $\eta_p^2 = .36$. Participants' responses were more accurate for the higher frequency words (99%) than lower frequency (97 %). No other significant effects were found.

Derivational morphology

Response times

Latencies varied according to frequency, $F(1, 22) = 30.39$ $p < .001$, $\eta_p^2 = .58$, and priming condition, $F(3, 66) = 5.02$, $p = .003$, $\eta_p^2 = .19$. Participants responded to high frequency items (631 ms) faster than low frequency items (700 ms). Pair-wise comparisons revealed that participants responded significantly more quickly in the identity condition (634 ms) compared to the unrelated condition (704 ms, mean diff = 70 ms, $p < .011$). However, responses on the morphological condition (661 ms) were not significantly faster than the unrelated condition (mean diff = 43 ms, $p = .308$). There was no significant difference between the morphological and the orthographic condition (663, mean diff = 2 ms, $p = 1$). Differences in priming effects between the orthographic condition and the unrelated condition were not significant either (mean diff = 41 ms, $p = .228$). A summary of the RT effects related to predictions is presented in Table 6 below. Descriptive information for group means is included in Appendix H.

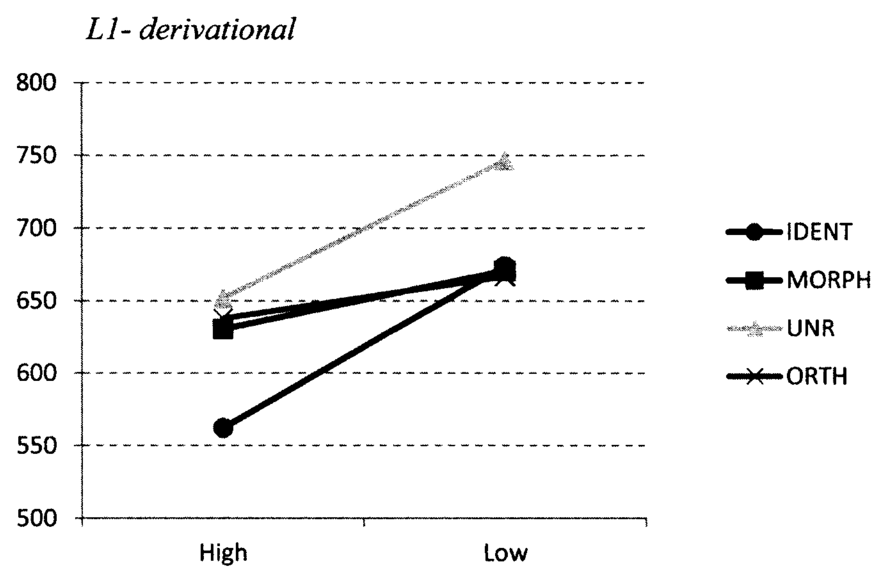
Table 6. Significant effects: Experiment 2 (L1).

Inflectional Morpheme	*Mean diff*	*Sig.*	*Std. Error*
Low freq- High Freq*	29	= .001	7.82
Unrelated-Identity**	67	< .001	12.24
Unrelated-Morphological*	43	= .005	11.05
Unrelated-Orthographic	36	= .31	17.28
Morphological-Identity	24	= .062	8.65
Derivational Morpheme			
Low freq- High Freq**	69	< .001	12.56
Unrelated-Identity*	70	= .011	19.60
Unrelated-Morphological	43	= .308	20.89
Unrelated-Orthographic	41	= .228	18.58
Morphological-Identity	27	= .485	14.60

Note. * Significant at $p < .05$, ** Significant at $p < .001$

The interaction between frequency and priming condition is significant, $F(3, 66) = 2.80, p = .047, \eta_p^2 = .1$. When plotted (Figure 8 below), the data showed that while partial priming was found at high frequency (i.e., identity priming), at low frequency all three conditions were faster than the unrelated.

Figure 8: RT data showing latencies from the derivational morpheme. Experiment 2. L1



Accuracy

The results for the accuracy scores showed a significant main effect of frequency, $F(1, 22) = 32.72, p < .001, \eta_p^2 = .60$. Participants responded more accurately to high (98%) than to low frequency items (84%). Accuracy also varied with respect to priming condition, $F(3, 66) = 3.72, p = .016, \eta_p^2 = .15$ (please see Appendix F for means). No other effects were found.

Discussion

The results from the L1 group showed a significant effect of frequency (both from RT and accuracy data) and priming condition (RTs) in both morpheme types. Participants responded faster and more accurately to high frequency items (in the two morpheme types). Morphological effects found in the inflectional type support the hypothesis that lexical processing of these types of words is affected by morphemic structure in a native language. However, the results from the derivational type showed different priming patterns. While identity priming effects were found at both levels of frequency, morphological effects were only found at the low frequency level. The fact that orthographic effects were also found at this level, however, suggests that at low frequency level priming effects might not be purely de-compositional as has been claimed in some literature.

Native and non-native processing

The inflectional and derivational morpheme types were analyzed separately. Response times (RTs) and accuracy were analyzed in two repeated measures ANOVAs with three factors: 2(frequency type: high vs. low) x 4(priming condition: identity, morphological, unrelated, and orthographic) x 4(language group: native French speakers, Early French L2 speakers, Late French L2 speakers, and L2 attrition). Post hoc pairwise comparisons were also performed between means for each of these variables using the *Bonferoni* test with .05 alpha correction level. Only correct responses were used in the RT analyses.

Inflectional morphology

Response times

The results revealed a significant main effect of frequency, $F(1, 80) = 26.64, p < .001, \eta_p^2 = .25$, with high frequency items being responded to significantly faster (620 ms) than low frequency items (643 ms, mean diff = 23.55 ms, $p < .001$).

There was also a significant main effect of priming condition, $F(3, 240) = 20.91, p < .001, \eta_p^2 = .21$. Participants responded to items in the identity condition (598 ms) more quickly than in the unrelated condition (663 ms, mean diff = 65.15, $p < .001$). RTs from the identity condition were also significantly faster than those from the morphological condition (625, mean diff = 27.47 ms, $p = .003$) as well as those from the orthographic condition (640, mean diff = 41.97 ms, $p < .001$). RTs from the morphological condition were also significantly faster than those from the unrelated condition (mean diff = 37.67, $p = .001$). Moreover, there was no significant difference between the orthographic condition and the unrelated (mean diff = 23.18, $p = .143$) thus, ruling out the effect of orthographic form at such an early stage of processing. RTs for the orthographic condition did not differ significantly from the morphological condition (mean diff = 14.50 ms, p = .22).

The results showed no significant effect of language group, $F(3, 80) = 1.69, p = .175$. In addition, and importantly for the current study, the interaction between priming condition and language group was not significant, $F(9, 240) = .48, p = .89$. Also, related to the issue of automatic decomposition versus lack of it, there was no significant interaction between frequency and condition, $F(3, 240) = .61, p = .61$, meaning that sensitivity to the morphemic structure was not limited to the higher frequency words. A summary of significant effects is presented in Table 7 below. Descriptive information for group means is included in Appendix F.

Table 7. Comparison of effects: Experiment 2.

Inflectional Morpheme	*Mean diff*	*Sig.*	*Std. Error*
Low freq- High Freq	24*	< .001	4.56
Unrelated-Identity	65*	< .001	7.64
Unrelated-Morphological	38*	.001	9.31
Unrelated-Orthographic	23	.143	10.06
Morphological-Identity	27	.003	7.64
Derivational Morpheme			
Low freq- High Freq	63*	< .001	7.83
Unrelated-Identity	54*	.001	13.27
Unrelated-Morphological	36	.048	13.25
Unrelated-Orthographic	36	.117	15.23
Morphological-Identity	18	.1	14.30

Note. * Significant at $p < .05$

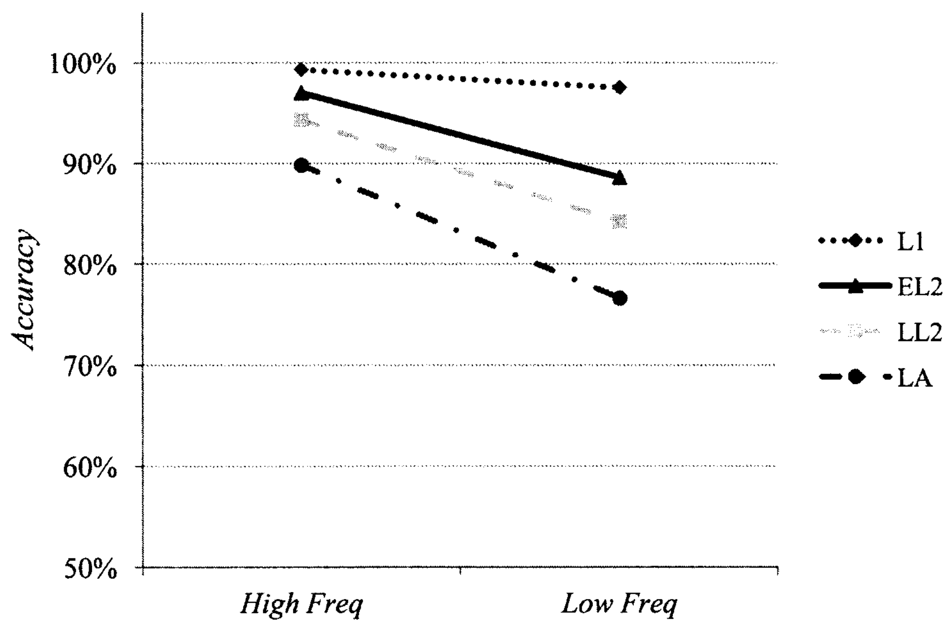
Accuracy

With respect to accuracy, the results showed a significant effect of frequency, F (1, 80) = 80.90, p <.001. $\eta_p^2 = .5$, priming condition, F (3, 240) = 2.86, p = .038. η_p^2 = .035, and language group, F (3, 80) = 16.29, p <.001, $\eta_p^2 = .38$. Participants' responses were more accurate for the higher frequency words (95%) than lower frequency (87%, mean diff = 8.4%). Participants scored as accurately for the identity condition as the morphological (92% each). The lowest accuracy scores were found in the orthographic condition (89%).

With respect to language group, the native speakers group had the highest accuracy scores (98%) and significantly differed from the early L2 group (93%, mean diff = 5.6%, p =.035); the late L2 group (89%, mean diff = 9.1%, p <.001), and the attrition group (83%, mean diff = 15.2%, p <.001). The late L2 group did not differ significantly from the early bilingual group, nor did they differ from the attrition group in terms of how accurately they responded. The early L2, on the other hand, showed a significantly higher accuracy score than the attrition (mean diff = 10%, $p < .001$).

Finally, the results showed a significant interaction between frequency and language group, F (3, 80) = 6.67, $p < .001$, $\eta_p^2 = .2$, with the native speakers showing comparable accuracy results on the two types of frequency relative to the other groups (Figure 9).

Figure 9. Accuracy data showing accuracies on the inflectional morpheme for the various groups. Experiment 2.



Finally, as can be seen from the significant interaction between frequency, condition, and language group, F (9, 240) = 2.14, p = .027, η_p^2 = .07, and as expected, the highest accuracy scores were provided by the native speakers for the identity condition from the higher frequency category, whereas the lowest scores were given by the attrition group for the orthographic condition in the lower frequency category.

Derivational morphology

Response times

Latencies varied according to frequency, F (1, 80) = 65.57 p < .001, η_p^2 = .45, and priming condition, F (3, 240) =5.14, p = .002, η_p^2 = .06. Participants responded to high frequency items (664 ms) faster than low frequency items (727 ms, mean diff = 63.38). Pair-wise comparisons revealed that, as expected, participants responded significantly more quickly in the identity condition (674 ms) compared to the unrelated condition (727 ms, p = .001). Responses on the morphological condition (691 ms) were also significantly faster than the unrelated condition (727.11, mean diff = 36.02, p =.048). As was the case with the inflectional morpheme type, there was no significant difference between the morphological and the orthographic conditions. Similarly, the orthographic condition (690 ms) did not differ significantly from the unrelated condition.

Response latencies did not vary significantly across the four groups of participants, F (3, 80) = 1.52, p = .22, and the interaction of priming condition by language group was not significant, F (9, 240) = .53, p = .85. Thus, all four groups showed significant repetition and morphological priming effects (i.e. faster RTs for identity and morphological primes than for unrelated control primes). This finding shows that the masked priming technique yields priming effects not only for typical L1 and L2 speakers (as found in previous research) but also in an L2 acquired late and in an L2 that was not used as frequently. No other effects were significant.

Although the attrition group showed faster response times for the orthographic condition, this seems to be more of a speed/ accuracy trade off effect than an effect of orthographic priming. Unlike any other group, the attrition group showed a total accuracy score of less than 50% for the orthographic condition (i.e., 46%).

Accuracy

The results for the accuracy scores showed a significant main effect of frequency, F (1, 80) = 159.72, $p < .001$, $\eta_p^2 = .66$. Participants responded more accurately on high (85%) than on low frequency items (65%, mean diff = 20%, $p < .001$). Accuracy also varied with respect to language group, F (3, 80) = 22.75, $p < .001$, $\eta_p^2 = .46$ (please see Appendix F for means). Pair wise comparisons indicated that native speakers (91% accuracy) were significantly different from the early L2 (78 % accuracy, $p = .001$, mean difference = 13%), the late L2 (71 % accuracy, $p < .001$, mean difference = 20%), and the language attrition group (61% accuracy, $p < .001$, mean difference = .30). The early L2 group differed significantly from the attrition group (mean diff = 17%, $p < .001$) however, they did not differ significantly from the late L2 (71 % accuracy, mean difference = 07, $p = .39$). Finally, the language attrition differed significantly from the late L2 (mean diff = 10%, $p = .040$).

There was a significant interaction between frequency and language group, F (3, 80) = 3.50, $p = .019$, $\eta_p^2 = .12$, suggesting that although the frequency factor contributed relatively equally to how accurate participants' responses were across the different language groups (i.e., all groups provided lower accuracy scores for lower frequency items), the language attrition showed overall the lowest scores for both frequency types

Discussion

In this experiment, I compared morphological processing across four French speaking groups: native speakers, currently active early L2 speakers, currently active late L2 speakers, and early L2 speakers who are not active French language users, and thus showed attrition effects. At issue were the priorities of the language processor upon initial visual exposure to morphologically complex words: is the language processor most sensitive to the morphemic structure of the words at an initial stage of processing (as in Diependaele, Sandra, & Grainger, 2005; Frost, Forster, & Deutsch, 2007; Rastle & Davis, 2008, Taft, 1979, 1994), or are the orthographic features equally as important. A second question was how different is lexical processing in a native language compared to processing in a non-native language, and to processing in a non-native language that is not used as frequently (attrition). I, therefore, discuss the results in light of these two dimensions: a) – the role of orthographic form vs. morphological structure in lexical processing of morphologically complex words and their implications for the retrieval architecture of morphemic entities; b) - lexical processing in native vs. non-native speakers and whether it supports the argument for a substantially stronger reliance on the procedural system with native speakers.

Orthographic form versus morphemic structure

For the inflectional morpheme type, pair wise comparisons revealed repetition (identity) priming as well as morphological priming effects. The results (especially from the inflectional morpheme type) are in line with previous research that supports a de-compositional account of lexical processing where morphemic structure rather than orthography is a key factor upon initial visual exposure to morphologically complex words. However, RTs from the the orthographic condition, although slower than those from the morphological condition were not statistically so.

Various studies using prime exposures of around 60 ms (e.g., Drews & Zwitserlood, 1995; Forster, Davis, Shocknecht, & Carter, 1987; Frost, Forster & Deutsch, 1997; Grainger Cole′ & Segui, 1991) have found that whereas morphologically related primes facilitate processing relative to unrelated word primes, orthographically related primes tend to inhibit target word processing, generating longer RTs and/or more errors (Drews & Zwitserlood, 1995; Grainger & Ferrand, 1994; Segui & Grainger, 1990). These inhibitory effects resulting from orthographic priming, argue Grainger et al. (1991) and Drews and Zwitserlood (1995), reflect competitive processes acting across whole-word representations. Although inhibition effects of this type were not found in the current research, with increased sample sizes, it would be interesting to confirm whether and how inhibition effects of this type would manifest across the groups.

One of the main hypotheses in this study is that if L2 French speakers process morphologically complex words in a native-like fashion, similar priming effects between the three conditions should be found across the native and the non-native speakers groups. Second, if lexical processing in attrition is different from that in acquisition, priming effects between the three conditions will be found for the native speakers and the early L2 group but not for the attrition group.

From both morpheme types (derivational and inflectional) the identity and morphological effects were coupled with the finding that no group effects were statistically significant for the RT data. With respect to the decompositional models of processing, this implies that when L2 speakers have acquired their L2 before age 11, they do not differ fundementaly from the native speaker in terms of sensitivity to morphological structure. In other words, they automatically decompose morphologically complex words to their constituent morphemes. This result is different from Silva and Clahsen (2008) who tested participants who learned L2 after age 11 and found out that L2 English learners tended to rely more on declarative procedures (i.e., no automatic de-composition) than native speakers.

Taken together, the results from both morpheme types suggest that whereas some effects were found to be consistent with previous research (i.e., RTs were generally faster for the identity condition than for the unrelated condition, and for the morphological than the unrelated condition), lack of a significant between groups priming effect implies that regardless of when an L2 was learnt, and whether its use is limited, processing morphologically complex words in word recognition seems to favour a decompositional style at an initial stage of exposure. Some previous research in the field of second language acquisition (Silva & Clahsen, 2008; Ullman, 2005) found that unlike native speakers, second language learners rely more on declarative procedures in lexical processing. Silva and Clahsen, using a lexical decision task with morphologically complex words, found no priming effects with late L2 learners (those who acquired their L2 after age 11) between the identity and the unrelated conditions, whereas native speakers showed significant effects between the two conditions.

The results from the current study are consistent with more recent research (i.e., Diependaele et al., 2011) who investigated the processing of suffix derivations in first and second language, looking particularly at whether bilinguals who reach L2 proficiency relatively late make less use of morphological information in the processing of suffixed derivations. They reported similar priming patterns for the native English participants and the two groups of bilinguals, contrary to previous conclusions about the possibility of processing differences between native and non-native English speakers (i.e., Silva & Clahsen, 2008). Results from Diependaele et al. (2011) showed that across the different participant groups priming was largest with transparent primes, smallest with form primes and intermediate with opaque primes.

The absence of a significant effect for the interaction between priming condition and language group in the current study suggests absence of significant differences in how sensitive L2 speakers are to the morphemic structure of complex words (regardless of when the L2 was acquired, and even as it starts to deteriorate, i.e., in attrition[16]). Because three of the four groups in the current experiment acquired French before age 11, lack of use (attrition) in a language that was learned early enough (before 11) does not seem to involve a radical change in the way these types of words are processed. There was no evidence for a change in processing from the procedural to the declarative with attrition.

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[16] Results from an independent samples *t* test indicated that morphological priming effects in native speakers ($M = 43$, $SD = 53$, $N = 23$) did not differ significantly from those in non-native speakers ($M = 36$, $SD = 91$, $N = 61$) both in the inflectional type, t, $(82) = .46$, $p = .65$, and the derivational type ($M = 43$, $SD = 100$, $N = 23$, and $M = 33$, $SD = 124$, $N = 61$ respectively), t, $(82) = .38$, $p = .71$.

However, the finding that the attrition group showed priming effects for the orthographic condition in the derivational type and for low frequency in the inflectional type lays the groundwork for future research and leaves interesting and important factors for further investigation. One possible question in this context is whether orthographic form is of priority to the L2 speaker with attrition effects.

These results are in line with some insights from research on aphasia which investigated morphological impairment in aphasic patients. Some research (Delazer & Semenza, 1998) revealed that aphasia patients may retain knowledge of a word's morphological sturcture even when they cannot access that word. Others, (e.g., Nasti & Marangolo, 2005) have shown that patients with aphasia produced more errors with multi-morphemic words than with mono-morphemic words, and that even though they were unable to process morphologically complex words with ease, they seem to have retained sensitivity to morphological status and morphological structure of words.

These results parallel the findings from the current study that the attrition group had the lowest accuracy rates on the morphologically complex words without showing evidence for a reduced sensitivity to the morphemic structure of words (relative to native speakers and L2 speakers who use the language on a more frequent basis). This can be seen in the fact that no significant differences were found across the four language groups, nor from the interaction language group by condition.

The fact that accuracy rates for the attrition group were higher for the higher frequency words, suggests that the latter might benefit from some training that focuses on morphologically complex words not only to improve the processing of multi-morphemic words, but also to benefit from the hierarchical morphemic structure of the lexical store and retain access to traces of what they have previously acquired of linguistic knowledge, and maximize their overall lexical potential.

Although overall findings from Experiment 2 confirm most of the findings from Experiment 1, lack of some effects in the latter (i.e., inflectional priming in Experiment 1) can be explained in terms of differences between English and French with respect to the two morpheme types. While the French derivational morpheme *–ment* is somehow functionally similar to the English adverbial *–ly,* there is no particular morpheme in English that clearly reflects the inflectionsl French morpheme for the "imparfait" tense, hence the difference in priming effects in the two types. However, a more feasible explanation for lack of priming effects in the inflectional morpheme type in Experiment 1 has to do with low item numbers in this type compared to the derivational (see stimuli section for more details). This explanation is supported by the fact that once item numbers were increased (in Experiment 2), inflectional priming was found.

The role of frequency

A second research question was whether frequency affects lexical processing in the same way or differently in acquisition and attrition. Previous research that looked at the effect of frequency on the processing of morphologically complex words (such as Soveri, Lehtonen, & Laine, 2007) mainly looked at whether high frequency inflected words would have full-form representations.

Results from the current study revealed a significant effect of frequency for all groups across the various conditions. Responses for the higher frequency conditions were overall faster than those for the lower frequency. As there was no significant effect for the frequency by condition interaction, this implies that regardless of frequency automatic decomposition happened with all four groups throughout the different four conditions although to a lesser extent with the higher frequency items.

Except for the fact that higher frequency resulted in faster RTs and higher accuracy, it doesn't seem that participants have treated the higher frequency items any differently from the lower frequency ones. In some previous research (Bodner & Masson, 2001; Bodner & Masson, 2003; and Masson & Bodner, 2003) significant morphological priming effects were found for the lower frequency words unlike the higher frequency ones, suggesting that the latter might be stored in their whole forms. In the current study, this argument is not supported since the interaction between frequency and priming condition was not significant. The only difference was that they responded generally faster and more accurately to items from the higher frequency category.

Frequency remained an equally important factor in how fast and how accurate a response was made (for both morpheme types), but it did not contribute to whether a morphologically complex word was decomposed, or whether it was accessed as a whole entry. It remains unclear, however, whether proficiency level contributes to how morphologically complex words are stored in L2.

To answer this question, all L2 speakers were regrouped according to their L2 proficiency (as reflected in their cloze test score). A Pearson's correlation test was run on the two variables; proficiency and morphological priming. The results revealed that proficiency level and morphological priming were not significantly related, $r = -.018$, N = 84, $p = .87$.

CHAPTER 8

PROCESSING GRAMMATICAL GENDER

THE MORPHOLOGY OF GENDER IN FRENCH

Grammatical gender is a noun class system which describes the syntactic phenomenon according to which some nouns fall into different classes (generally feminine, masculine, and neutral; Holmes & Segui, 2006). In most languages grammatical gender is assigned to nouns arbitrarily, thus, nouns can have different genders across different languages. For example, the word for *sea* is masculine in Italian (*il*$_{masc}$ *mare*), feminine in French (*la*$_{fem}$ *mer*), and neuter in German (*das*$_{neuter}$ *meer).*

French is a language with grammatical gender and thus every French noun is associated with a gender class (either masculine or feminine). Few nouns can be both masculine and feminine, and a category change generally implies a meaning change as well (e.g., *le livre* "book"–*la livre* "pound"). In languages with grammatical gender, nouns trigger specific types of inflections in syntactically associated words leading different parts of speech in an utterance to change form in order to agree with the noun's gender (Spalek & Scriefers, 2008). Thus, in the French sentences *Lui, c'est un grand acteur* (i.e., *He* is a great actor) and *Elle, c'est une grande actrice* (i.e., *She* is a great actress), almost every word changes to match the gender of the subject. The gender morphemes–*rice* in *actrice* replaces the masculine morpheme *–eur* to change the word from masculine to feminine. Similarly the feminine suffix *–e* added to the indefinite determiner *un* and to the adjective *grand* (i.e., great) changes the words from masculine to feminine.

As is the case in many other languages, gender categorization in French is arbitrary and seems to be only partially semantic. Although nouns referring to males are masculine and nouns referring to females are generally feminine (e.g., *le père* "the father"–*la mère* "the mother"), only 10.5% of French nouns belong to semantically motivated gender categories. For the remaining 89.5%, the assignment of a gender category is not based on any general rule (e.g., *le bureau* "the$_{Masc}$ desk"–*la table* "the$_{Fem}$ table", Colé et al., 2003). Thus, the native French speaker has to memorize the arbitrary assignment of gender.

Nevertheless, in spite of the arbitrariness and lack of systematicity in the French gender classification system, a number of phonological and orthographic regularities between noun endings and gender have been detected. Taft and Meunier (1998) describe French as a pseudo-regular language in the sense that some noun endings are strongly associated with a particular gender whereas some endings show a rather small predictive value (i.e., nouns with these endings are about equally distributed across the two gender classes, such as the ending *-al(e)* (*ovale*—oval$_{\mathrm{Masc.}}$, *sandale*—sandal$_{\mathrm{Fem.}}$). According to the database lexique (www.lexique.org, New & Pallier), 81% of all French nouns ending in /kl/ (like *cercle*, circle) and 86% of all French nouns ending in /ez/ (like *fraise*, strawberry) have masculine grammatical gender. In the current study I used words that end in *-e* which is an ambiguous predictor of gender (Colé et al., 1997), in order to eliminate a potentially confounding phonological rather than morphological variable.

Other sub-lexical regularities are morphological in nature. Holmes and Segui (2004) argue that most gender-typical endings have derivational morphemic status. For example, all nouns ending in the morpheme *-isme* are masculine (e.g., *tabagisme* 'smoking), whereas all nouns ending in the morpheme *-esse* are feminine (e.g., *vitesse* 'wisdom'). Other morphological endings still show some strong associations with one or the other gender but in a less systematic way. Thus *domaine* 'domain' which ends in the morpheme – *aine* is, unlike most other words ending in this morpheme, masculine. Some morphemes are associated frequently with both genders, for example, nouns ending in -*ique* are feminine about 60% of the time (Holmes & Segui, 2004).

Various studies suggest that French speakers are capable of detecting these regularities and putting them to work in recognizing nouns. Holmes and Segui (2004) argue that morphological regularities often help a native speaker of French determine the gender of nouns. Holmes and Segui (2004) used endings defined either as suffixes (e.g., -*ité*, *-ment*), or as rimes of final syllables that were orthographically similar to suffixes (e.g., *-ate*, *-ile*), or as simple final phoneme (e.g., *-ie*, *-eau*). These authors also noted that most gender-typical endings have derivational morphemic status. This assumption supports the idea that the gender predictive ending effect could in fact reflect a morphological effect.

Meunier et al. (2007) looked at the mental representation of morphologically complex gender words in French. In a series of experiments, they tested whether gender categorization of morphologically complex nouns is affected by the gender of their embedded morphemes. In the first experiment, participants were asked to perform a gender decision task on words that were either of the same gender of their base or root or of the opposite gender. The stimuli consisted of masculine or feminine word pairs where each word belonged to one of two conditions; a congruent condition where the word in question would share gender with its base, and an incongruent condition where the word in question would have a gender that is different from its base. The results showed that gender decision was affected by the gender of the base morpheme. Responses were faster for the gender congruent condition suggesting that morphologically complex gender words are decomposed into their constituent morphemes during identification, and that their gender morphemes are activated.

Because of the potential effect of base frequency and the possibility that higher frequency bases could be extracted from their derived words more easily than lower frequency ones, all words were checked for their base frequency. Most bases in the congruent condition had a lower frequency than the ones in the incongruent condition. In Experiment 2, pairs of morphologically complex words were selected such that both the masculine and the feminine part of the pair were derived from the same base. For example, both *chemisette* (feminine), and *chemisier* (masculine) were derived from the word *chemise* (feminine). Results showed again that responses were faster for the gender congruent condition than in the gender incongruent condition. Also there were fewer errors in the gender congruent condition than in the gender incongruent condition. These findings corroborate those found in Experiment 1, that morphologically complex gender words are decomposed into their constituent morphemes during identification, and that their gender morphemes are activated. It remained unclear though, whether the effect seen in Experiments 1 and 2 was in fact morphemic and not merely orthographic or resulting from the orthographic overlap between two words. Thus, Meunier et al.

conducted a third experiment to test the morphemic nature of the effect observed in the two previous experiments.

In a third experiment, non-morphological pseudo-derived words were used (words like *baguette*). The word *baguette*, for example, can be parsed into the base-morpheme *bague* (ring) and the suffix *-ette*, however the two morphemes are not semantically related. These words were chosen to see whether decomposition occurs when words look like morphologically complex but do not have any semantic relation with their pseudo-base. The results were particularly interesting for these types of words namely that they showed that morphological decomposition occurs even when the target noun is pseudo-morphologically complex. Control words were also used which showed partial orthographic overlap and consisted of shorter words embedded in longer ones like *mer* in *merle* (i.e., sea, blackbird). Unlike the pseudo-derived words, these words did not end in a suffix. The results showed no gender congruency effect for these types of words, unlike true or pseudo-morphologically complex words where in-congruency between the gender of the base and the gender of the target noun delayed gender access. This was taken as evidence for the role of the morpheme in lexical processing.

PROCESSING GRAMMATICAL GENDER IN ATTRITION

The little known about processing grammatical gender in attrition comes from lexically based accounts on the selective nature of attrition. Bolonyai and Dutkova-Cope (2001) argued that certain areas of morpho-syntax are more prone to attrition. They argued that not all verbal agreement features in fusional inflections (i.e., those that involve more than one grammatical feature in a single morpheme) are equally vulnerable in L1 attrition. Thus, person and number, which require the least complex agreement procedure and display the least cross-linguistic contrast in terms of verbal and nominal features in subject-verb agreement, were the most robust features and the least vulnerable across both data sets. On the other hand, L1-specific features of gender and definiteness, which require more complex computations and agreement procedures in the L1, are more likely to be affected. This supports the idea that what is marked (less universal) is more prone to attrition. This has particular implications for the current study because French is a language that requires gender agreement. Gender assignment in French is more complex (than say English) because, unlike English, all French nouns have either masculine or feminine gender which –as mentioned previously- is assigned arbitrarily (in the sense that there is nothing in *le camion* (truck, masculine), for example, that requires it to be masculine rather than feminine). Grammatical gender in lexical hypotheses is an intrinsic part of the lexical representation of a word, and as such, gender information is always available upon noun retrieval (Cubelli et al., 2005; Paolieri et al., 2011). From a lexical account perspective, this assumption implies that an L2 learner will have to store these words in memory with their gender so that they can apply the rule for gender agreement. This means these words will require more computations and processing time where gender agreement is required. When the language is used less frequently, information about words' gender might be less available, thus gender agreement might be more vulnerable, as is the case with other forms of knowledge that are acquired based on declarative systems (i.e., rule based forms of knowledge). What makes gender agreement more complex in French is that some of the nouns can also change gender sometimes following addition of particular morphemes (for example, *(le) camion* which is masculine changes to feminine *(la) camionnette* after addition of the diminutive suffix *ette*). Little is known in the literature about morphological processing in French, especially where morphological complexity is coupled with grammatical gender issues.

EXPERIMENT 3

With focus on grammatical gender processing, Experiment 3 was designed to further explore how the language processor treats morphologically complex words at an early stage of processing. The rationale behind choosing grammatical gender is that the French language offers some unique and interesting morphological combinations. A morphologically complex word that is a derivative of a specific root, for instance, can, in fact change gender when a particular suffix is stripped off (exp., *chemise*$_{fem}$- *chemisette*$_{fem}$- *chemisier*$_{masc}$). An interesting question that fits in the framework of morphological processing in L1 acquisition is whether gender categorization of morphologically complex nouns is affected by the gender of their embedded morphemes. The study of grammatical gender is also intuitive for research on attrition as it remains one of the most problematic areas in case studies on language breakdown and attrition (Bolonyai & Dutkova-Cope, 2001; Cacciari & Cubelli, 2003).

In the French-English bilingual, grammatical gender is also one of the few areas of the morpho-syntax with little possible L1-L2 transfer effects. As mentioned earlier, L1 and L2 similarity was found to be beneficial in a number of studies (Franceschina, 2005; Sabourin & Haverkort, 2003; Sabourin & Stowe, 2008; Sabourin, Stowe, & de Haan, 2006). Because English does not have grammatical gender, the possibility that transfer effects might confound the results is eliminated.

Thus, in Experiment 3 I looked at: a) gender priming with native speakers of French compared to L2 speakers with and without attrition; and b) the role of frequency in gender decision tasks.

The same participant groups that took part in Experiment 2 also participated in this experiment (half of the participants started with Experiment 2, and the other half started with Experiment 3 first). The predictions were that, for any particular group, if the morphologically related condition items significantly primed targets relative to a congruent condition that is morphologically unrelated, this effect can be interpreted as evidence for the existence of morphological parsing processes (i.e., decomposition), as it reflects automatic de-composition of the item first into constituent morphemes to access the gender of the root morpheme rather than access its full form representation from memory.

Thus, if processing in native speakers relies more on procedural systems, a morphological priming effect would be found (RTs would be faster in the morphologically-related congruent condition than in the other three conditions). Second, if an L2 acquired after age 11 relies more on the declarative system, as in Silva and Clahsen (2008) and as a result of maturational changes in childhood that lead to the attenuation of the declarative system (Ullman, 2005), processing in the late L2 learners group should show different effects from the native speakers and the early bilingual group. On this same principle, the early L2 group (particularly because they have learned French before age 11) will show more native-like trends.

Little is known about the differences and similarities between processing in active usage versus that in attrition. Thus, with respect to these two groups (the native speakers and the language attrition), if lexical processing in attrition is different from that in active usage, morphological priming effects should be found for the native speakers group and possibly the L2 speakers who acquired L2 before 11, but not for the attrition group. Finally, if frequency has an effect on the way these types of words are processed (i.e. in their full form vs. de-compositionally), high frequency words would show no significant effect between conditions whereas low frequency words will show an effect. And if groups differ in their sensitivity to frequency, between conditions effects would be found for some of the groups but not the others (perhaps the native speakers and the early L2 speakers). With respect to accuracy, the native speakers will show the highest accuracy scores, while the language attrition group is expected to have the lowest scores.

Participants

A total of 93 participants were tested (22 males). However, the data of 23 participants was excluded as follows: (a) Two participants were excluded for scoring 0 on the French proficiency test and not adequately filling in required information on the questionnaire form (especially about the amount of French language they have learned); (b) One L1 participant, who had indicated not feeling well throughout the experiment and failed to proceed properly after taking a long break, was excluded; (c) Another L1 participant who scored less than 60% overall accuracy was excluded; (d) across the L1 and the early L2 active users groups, 10 participants who scored less than 60 % on any one condition were also excluded, one from the native speakers group, and nine participants from the early L2 group. The rationale behind choosing the less than 60% level as a basis for exclusion is that a score of over 60 % accuracy is expected for L1 and early L2 speakers as they both had an overall proficiency score of over 70% in the cloze test. On this same rationale, and knowing that the late L2 group had a mean proficiency score of about 50 % (based on the cloze test and the "can do"score), five participants from the late L2 group who scored 50 % or lower on any one condition were also excluded for fear that their data were based on guessing. Although this basis of exclusion did not seem to fit with the attrition group whose accuracy on gender-related tasks is traditionally expected to be much lower than the native and the L2 speaker (Bolonyai & Dutkova-Cope, 2001), four more participants from the attrition group who scored less than 50% on one condition were excluded. These participants also happened to have missing data on one other condition. Thus, they were excluded from the analysis.

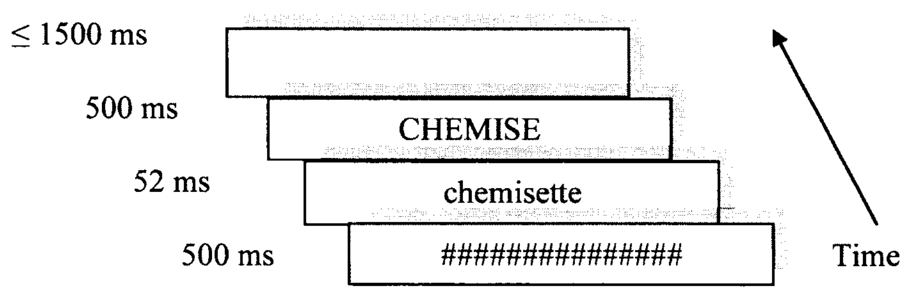
The remaining 70 participants (10 males) had an average age of 23.9 years (*SD* = 4.4). According to their language history and their performance on the language background questionnaire, participants were classified into 4 groups: French native speakers (NS: n = 23, 2 males, mean age = 22.39, *SD* = 3.53); Early French L2 speakers (EL2: n = 19, 3 males, mean age = 23.84, *SD* = 5.39); Late French L2 speakers (LL2: n = 15, 2 males, mean age = 23.73, *SD* = 5.22); and Language Attrition (LA: n = 13, 3 males, mean age = 21.23, *SD* = 2.86). All participants from the first three groups indicated that they still used the French language on a frequent basis, and thus should not be in a state of attrition. The fourth group (LA) indicated experiencing some deterioration in their French language skills as a result of lack of use. This was also reflected in their weak performance on the French proficiency cloze test (*M* = 28%, *SD* = 6%).

Procedure and stimuli

Procedure

After filling out the language questionnaire and the language proficiency test, participants completed the masked visual priming gender decision task in French. Each participant was tested individually. The priming paradigm procedure was the same as that used for Experiment 1 and 2. The following diagram (Figure 10) illustrates the sequence of events for the morphological congruent condition.

Figure 10. A schematic diagram of the visual masked priming paradigm (Experiment 3). The prime was forward masked by a visual noise pattern and backward masked by the target so that the participants were not consciously aware of the prime.



Participants were instructed to decide, as quickly and as accurately as possible, whether the target stimulus was a feminine word in French or a masculine one by pressing one of two specific buttons on the keyboard. The experiment began with a practice session consisting of 10 prime-target pairs, which were not included in the analysis. The experiment took an average of 16 minutes and consisted of three break intervals. The first item after each break was excluded from the analysis. Instructions appeared on the screen before each experiment and if there were no questions the experimental procedure was started. Four types of prime target pairs were generated

(Appendix E): (1) related congruent (e.g., *chaufferie*$_{fem}$-*chauffe*$_{fem}$), (2) related incongruent (e.g., *chauffage*$_{masc}$-*chauffe*$_{fem}$), (3) unrelated congruent (e.g., *tasse*$_{fem}$-*chauffe*$_{fem}$), and (4) unrelated incongruent (e.g., *gâteau*$_{masc}$ - *chauffe*$_{fem}$) (i.e., boiler room-heating, heater-heating, cup-heating, cake-heating, respectively). Each participant from each group saw words from each category, however, the stimuli were designed in such a way that no one participant saw any target word more than once.

Stimuli

The stimuli consisted of a total of 94 French targets per each list from the four experimental categories mentioned above; there was a total of 20 items in each of the two morphologically related conditions and 27 items in each of the morphologically-unrelated conditions. In each condition half of the items (i.e., a minimum of 10) were from the feminine gender, whereas the other half were from the masculine gender. Items were balanced in terms of numbers of letters across conditions and gender type; morphologically related congruent (mean number of letters = 5.80, *SD*= 1), incongruent (mean number of letters 5.65, *SD* = 1), unrelated congruent (mean number of letters = 5.65, *SD* = 1), and the unrelated incongruent (mean number of letters = 5.61, *SD* = 1). Finally, about one third of the items in each condition were categorized as of highest frequency; the congruent condition (N = 6, mean frequency = 100, *SD* = 85), incongruent condition (N = 8, mean frequency = 99, *SD* = 78), unrelated congruent (N = 9, mean frequency = 57, *SD* = 27), unrelated incongruent (N = 9, mean frequency = 90, *SD* = 82). Another third of the items in each condition were categorized as of lowest frequency; the congruent condition (N = 6, mean frequency = 4.5, *SD*= 3.5), incongruent condition (N =

7, mean frequency = 3, $SD = 0.7$), unrelated congruent (N = 9, mean frequency = 3.6, $SD = 2.4$), unrelated incongruent (N = 8, mean frequency = 7, $SD = 3.4$).

As was the case with the two previous experiments, and because both French and English have been influenced by Latin, and thus share a large number of words, various potentially confounding variables were taken into consideration before a final list of items was selected. Among these factors is cognate status; words that have a cognate in English were avoided (for exp. *BOTTE-bottillon-bottine* vs. the English equivalent *boots*). False cognates were also avoided (i.e., words that exist in English albeit with a different meaning: *MARMITE-marmiton (pot- chef)* vs. the English *marmite* which means a type of food spread). Similarly, words that share orthographic form but might exist in less formal English with a different meaning were eliminated (for exp., *CHAT-chaton (cat- kitten)* vs. *chat* as in "online chatting"). Various other factors were considered before a final list of items was selected: 1-some words have only one type of derivatives (feminine or masculine, but not both, for exp., $LAIT_{masc}$- $laitage_{masc}$, milk- dairy), 2- other French words exist in both of their feminine and masculine variety (for exp., MALADE_{masc}- MALADE_{fem}- MALADIE_{fem}, patient_{masc}, patient_{fem}, $\text{illness}_{\text{masc}}$), which sometimes mean two different things (for exp., $MANCHE_{fem}$- sleeve, $MANCHE_{masc}$- handle). These were avoided as both responses concerning their grammatical gender status would have to be considered correct.

Once a final list was selected (after carefully eliminating all items that fell into any category from the above mentioned potential confounds), it was matched for frequency, neighborhood size, and item length.

Results

RTs and accuracy were analyzed in two repeated measures mixed ANOVAs with three factors: 2 (frequency type: high vs. low) x 2 (morphological relatedness: related vs unrelated) x 2 (gender congruency: congruent vs. incongruent) and language group as the between groups variable (4 groups: native French speakers, early French L2 speakers, late French L2 speakers, attrition group). Post hoc pairwise comparisons were also performed between means for each of these variables using the Bonferroni test with .05 alpha correction level.

Prior to the calculation of gender decision times, incorrect responses (i.e., non-word responses to existing words and word responses to non-words) and extreme reaction times that exceeded two standard deviations from a participant's mean per condition were excluded from further analysis. This resulted in the removal of 3.3 % of the native speakers' responses, 2.3% of the early L2 speakers' responses, 2.4 % of the late L2 speakers' responses, and 2.5 % of the attrition group responses.

Response times

As predicted, participants' responses were faster in the morphologically-related condition (803 ms) than in the unrelated condition (823 ms), F (1, 66) = 9.48, p = .003, η_p^2 = .13. There was no difference in response times to congruent and incongruent items however, F (1, 66) = .01, p = .92. Latencies also varied with frequency (804 vs 822 ms), F (1, 66) = 3.90, p = .053, η_p^2 = .06, and language group, F (3, 66) = 4.35, p = .007, η_p^2 = .17. Unexpectedly, the early L2 speakers' responses were slower than those of the language attrition group (950 vs. 677 ms, p = .004). The attrition group had overall the fastest RTs (L1: 835ms; LL2: 950 ms). Correlations between RT and accuracy were used to test for a speed-accuracy trade-off. The correlation was not significant for all participants, $r = .12$, $N = 70$, $p = .331$, or for the attrition group, $r = .04$, $n = 13$, $p = .894$. However, a strong positive correlation was found between overall RTs and proficiency, $r = .31$, $N = 70$, $p = .009$. The highest proficiency group (i.e., the native speakers), were the slowest, followed by the second highest in proficiency (i.e., the early L2), suggesting that the late L2 and the attrition group were perhaps simply guessing on their responses.

Table 8. Significant effects: Experiment 3

RT	*F*	*Df*	*Sig.*	η_p^2
Frequency*	3.9	1	.053	.06
Morphological relatedness*	9.48	1	.003	.13
Language group*	4.35	3	.007	.17
Morphological relatedness* by language group	3.78	3	.015	.15
Frequency by Morphological relatedness by congruency by Language Group*	5.81	3	.001	.21
Accuracy				
Frequency**	30.39	1	< .001	.32
Congruency*	4.92	1	.030	.07
Language Group**	15	3	< .001	.41

Note. * Significant at $p < .05$, ** significant at $p < .001$.

The interaction between frequency and language group was significant, $F(3, 84) = 4.34$, $p = .007$, $\eta_p^2 = .13$. High frequency made a difference (i.e., yielding faster responses) only in the native speakers (806 ms vs. 863 ms) and the early L2 group (937 ms vs. 963 ms). The late L2 speakers (798 ms vs. 785 ms) and the language attrition group (677 ms vs. 678 ms) did not respond faster to the higher frequency items (Figure 11). Similarly, the interaction between morphological relatedness and language group was found to be significant, $F(3, 66) = 3.78, p = .015, \eta_p^2 = .15$. All the groups showed morphological priming except the late L2 group (Figure 12).

Figure 11. RT data showing the interaction between frequency and language group. Experiment 3

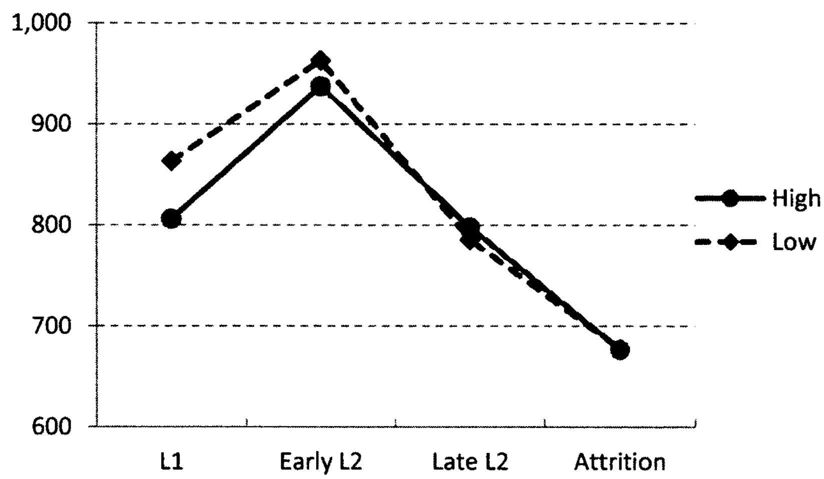
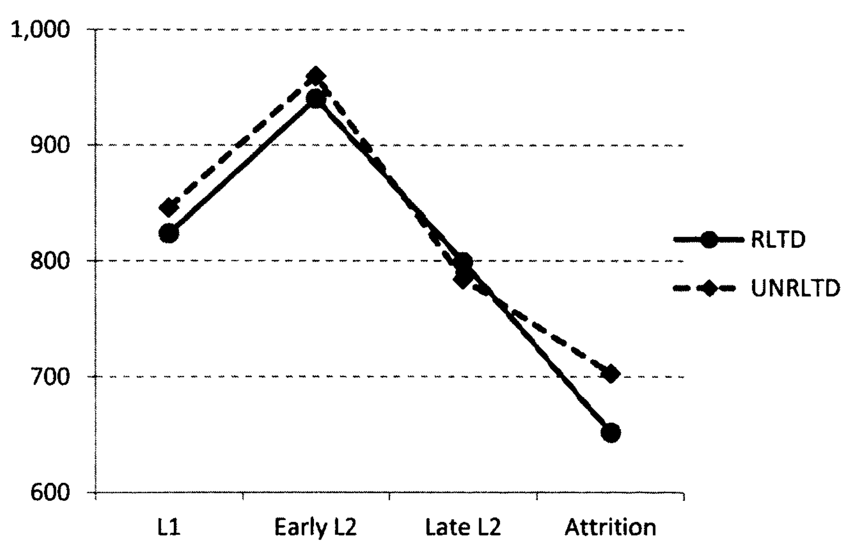


Figure 12. RT data showing the interaction between morphological relatedness and language group. Experiment 3



Furthermore, a significant four-way interaction among frequency, morphological relatedness, congruency, and language group, $F\,(3, 66) = 5.82, p = .001, \eta_p^2 = .21$, revealed that the late L2 group differed from the early L2 and the native speakers but, similar to the attrition group showed faster overall RTs (please see Appendix F for descriptive statistics). The late L2 group also showed a different pattern on each of these variables; no morphological priming effects, faster responses for the incongruent than the congruent condition and faster responses on the low frequency items as well. Taken together these results suggest that perhaps the attrition and the L2 group found the task too difficult and simply guessed on most trials, which also explains their faster RTs compared to the early L2 and the native speakers. This conclusion was further supported with findings from the accuracy data.

Accuracy

Accuracy varied with language group, $F\,(3, 66) = 15, p < .001.\ \eta_p^2 = .41$. Participants from the native speakers group were more accurate (88%) than the three other groups; the early L2 group (76%, $p < .001$), the late L2 group (76%, $p < .001$), and the language attrition group (72%, $p < .001$). As expected, the attrition group had the lowest accuracy score than any other group (72%). However, the three L2 groups did not differ statistically among each other.

Participants were more accurate on the high- than the low-frequency items (80% vs. 75%), $F\,(1, 66) = 30.4, p < .001.\ \eta_p^2 = .32$. There was a small congruency effect, $F\,(1, 66) = 4.92, p = .03.\ \eta_p^2 = .07$, with the incongruent items yielding slightly more accurate responses (79%) than the congruent ones (77%). No other significant effects were found.

Taken together, the findings that the attrition and the L2 group (who also had the lowest proficiencies) had the fastest RTs and the lowest accuracies suggested that their data may not be as reliable as the other two groups for the purposes of Experiment 3. Consequently, it was decided that any conclusions to be made from Experiment 3 would not be based on data from these two groups. Thus, a second ANOVA was run comparing the native speakers and the early L2 groups only.

Processing grammatical gender: L1 versus L2

Response times

As predicted, responses from both groups were faster in the morphologically-related condition (882 ms) than in the unrelated condition (902 ms), $F\ (1, 40) = 6.77, p = .013, \eta_p^2 = .15$ (see Table 9). There was no difference in response times to congruent and incongruent items however, $F\ (1, 40) = .31, p = .584$

Table 9. Significant effects: Experiment 3.

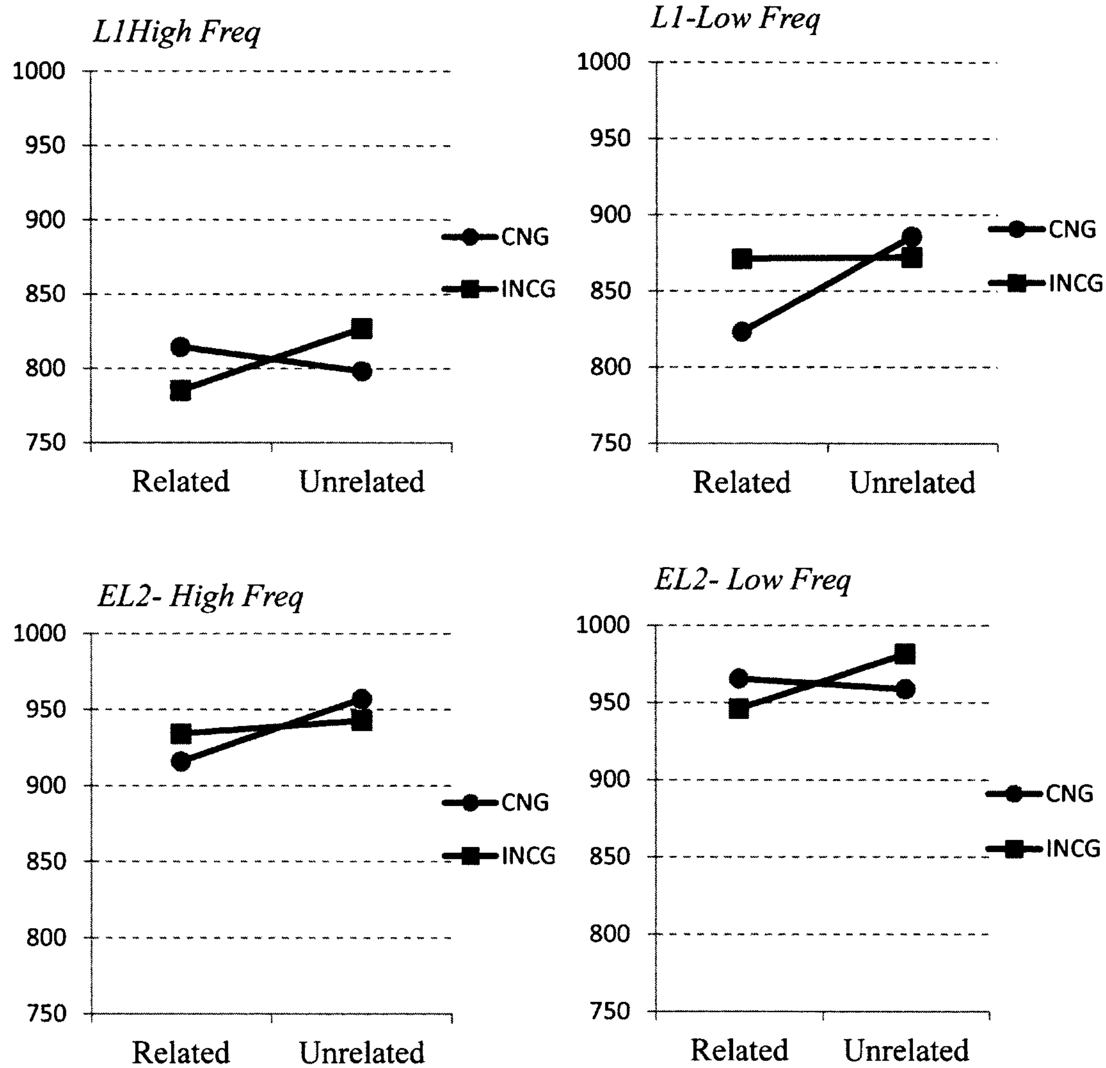
	F	*Df*	*Sig.*	η_p^2
Frequency*	12.67	1	.001	.24
Morphological relatedness*	6.77	1	.013	.15
Frequency by Morphological relatedness by* congruency by Language Group[1]	8.02	1	.007	.17
Accuracy				
Frequency**	31.94	1	< .001	.44
Language Group**	25.99	1	< .001	.39

Note. * Significant at $p < .05$, ** Significant at $p < .001$

Latencies varied with frequency (804 vs. 822 ms), $F\,(1, 40) = 12.67, p = .001, \eta_p^2 = .24$. However, they did not vary with language group, $F\,(1, 40) = 2.61, p = .114$, confirming the prediction that morphologically complex words are processed similarly in L1 and L2 when the latter was acquired at an early age. Consistent with this view, the interaction of morphological relatedness effects and language group was not significant, $F\,(1, 40) = .54$, p = .47.

A significant four way interaction was found among frequency, morphological relatedness, congruency, and language group, $F\,(1, 40) = 8.02, p = .007, \eta_p^2 = .17$. When plotted (Figure 13), the interaction revealed that the congruency factor mattered only at low frequency for the native speakers, whereas the early L2 showed no major variation in sensitivity to congruency across the two frequency levels.

Figure 13. RT data showing the 4-way interaction between frequency, morphological relatedness, congruency, and language group for native speakers and early L2. Experiment 3.



It is not clear, however, whether the congruency factor interfered with processing speed for the native speakers. With low frequency, the native speakers showed comparatively slow RTs to low frequency items in the unrelated conditions from both congruent and incongruent items. The early L2 showed the slowest RTs on the low frequency, incongruent targets that are morphologically unrelated to the prime. Incongruency seems to be problematic more to the early L2 than to the native speaker leading to a delay in processing time.

Accuracy

Accuracy varied with language group, $F(1, 40) = 25.99, p <.001, \eta_p^2 = .39$. Participants from the native speakers group were more accurate (88%) than the early L2 group (76%, $p < .001$). Participants were more accurate on the high than the low frequency items (85 vs. 78%), $F(1, 40) = 31.94, p <.001. \eta_p^2 = .44$. No other significant effects were found.

Discussion

The main issue addressed in this experiment concerned the processing of gender during visual word recognition. This question was examined by looking at how morphological effects, reflected in the gender morpheme in French, affect gender decision speed and accuracy. The term morphological gender priming is used here to reflect the phenomenon where pre-activation of a particular item's gender, through exposition to a derivative of the item that shares the same gender, can facilitate visual recognition of that item when presented shortly before. This phenomenon is known in the literature as the gender recency effect (Jescheniak & Levelt, 1994).

The results from the current experiment revealed a priming effect from the morphologically-related condition relative to a morphologically-unrelated condition both for the native and the L2 speaker. Primes that were derivatives of the target were processed faster than primes that did not relate morphologically to the target. The morphemic unit (in the form of a suffix) thus seems to have an impact on lexical access.

This experiment also revealed a significant effect from primes that are derivatives of the target in question but do not share the target's gender (i.e., they, in fact, carry the opposite gender of the target). This pattern of results suggests that our language processor is sensitive to the morphemic structure of morphologically complex words and thus supports the conclusions from Experiment 2 and the morpheme-based decompositional models. The fact that the morphologically related primes produced larger priming effects (20 ms) than the morphologically unrelated primes establishes the morpheme as a priority of the language processor at an early stage of processing which precedes the orthographic stage.

The importance of the morpheme is confirmed by the fact that the congruency factor on its own did not contribute to faster responses (except with low frequency). This pattern of results is important because it provides an insight into the time course of lexical access processes (i.e., the moment at which gender is taken into account during word recognition).

CHAPTER 9

CONCLUSION AND LIMITATIONS

In contrast to the rich experimental literature on native speakers, there is, to date, little evidence on how adult L2 learners process morphologically complex words. The present study was intended to contribute new evidence on morphological processing in native and non-native language speakers, and broaden our understanding of conditions under which orthographic or morphological transparency (or both) influence the decomposition of morphologically complex words. To this end, I compared lexical decision performance in masked priming experiments of L1 speakers' performance to that of various groups of L2 speakers (early L2 speakers, late L2 speakers, early L2 speakers with attrition effects).

For processing morphologically complex words, two basic processes can be distinguished: (a) storage of an inflected or derived form in lexical memory and (b) morphological computation by which an inflected or derived form is decomposed into its morphological constituents and possible stems and affixes are identified. Morphological effects with masked priming indicate that the segmentation process is fast, automatic, and effortless, because a prime presented briefly is enough to facilitate the processing of its morphological relatives. Prime presentation leads to growth of activation in a given morphemic representation, thus, conferring an advantage in the processing of target stimuli that contain the same morpheme. Morphological effects found in the current study provide evidence that (1) morphological units are exploited in the course of poly-morphemic word processing (Experiments 1, 2, and 3); (2) adult French speakers exploit morphological structure and morphological relationships between words during initial stages of visual exposure to morphologically complex words (Experiments 1, 2, and 3); (3) when participants first learned French does not influence morphological processing (Experiment 2), and further (4) native and second-language speakers showed equivalent morphological priming, suggesting that the organization of the mental lexicon is equivalent for first and second language speakers when L2 has been acquired at an early age (Experiment, 2, and 3). These findings suggest that lexical processing in L1 and L2 occurs within the same architectural environment.

The comparable priming patterns in L1-and L2 are at odds with previous evidence on the existence of fundamental differences between the two (Silva & Clahsen, 2008, 2009, 2003). The only differences found in the present thesis, generally reflected faster responses and higher accuracies for the native speakers. Such effects are unlikely to reflect fundamental processing differences between the native and the non-native speakers but instead can be attributed to the general slower speed of processing, reduced proficiency, and working-memory limitations often associated with L2 processing. In essence, I identified quantitative differences in accuracy and speed of processing but no qualitative or quantitative differences in morphological processing across these groups.

These results are consistent with recent research (i.e., Diependaele et al., 2011) that investigated the processing of suffix derivations in first and second language, and reported similar priming patterns for the native and non-native speakers of English. Moreover, the results show that adult L2 learners who have not used their L2 as frequently, and thus experienced some attrition effects are as sensitive to the morphemic structure of morphologically complex words as fluent L2 speakers and native speakers.

Although the attrition and the late L2 data were not useful for the purposes of Experiment 3 of this research, the results from the L1 and early L2 are in line with the conclusion that no major differences exist between native and non-native language processing. Early L2 speakers were relatively slower than the native speakers and had lower accuracy scores, overall, but the response latencies from all groups of French speakers follow similar patterns.

Of major interest to the field of attrition, is the finding that the masked priming paradigm yields priming effects even in non-practising L2 speakers. The fact that processing in attrition does not seem to be fundamentally different from processing in native speakers and speakers of an L2 with no attrition effects is also in line with findings about processing in speakers with pathological language loss (i.e., aphasia). In some literature on the topic, aphasic patients were found to retain knowledge of a word's morphological status even when they cannot access that word (e.g., Badecker, 2001; Blanken, 2000; Delazer & Semenza, 1998; Friedman, 2001; Jarema & Kehayia, 1992; Kohn & Melvold, 2000; Månsson & Ahlsén, 2001; Menn & Obler, 1990). This finding implies that attrition is more of a production phenomenon that manifests at the level of articulation rather than perception.

Limitations

This research has several limitations. The first involved limited sample sizes and the difficulty in establishing homogeneous groups of L2 speakers. Thus, it is not clear whether lack of group by priming condition effects is a matter of power (i.e., sample size was limited to detect effects across the four groups). By virtue of consisting of L2 learners, the samples were not sufficiently homogeneous in terms of proficiency.

Heterogeneity within the L2 groups could have affected both the nature of the priming effects and accuracy within these groups. Although the issue of variability is generally unavoidable when conducting research on L2, to generalize the results for larger groups, future research has to involve more participants in order to be able to control for variability within the groups, mainly in terms of proficiency.

Another limitation was the limited access to an attrition group in the capital region. People who live in Ottawa are continually exposed to French whether or not they use it themselves. Thus, even though they have not used French for years, participants from the attrition group in the current research were likely still exposed to French. Future research on attrition should consider recruitment from early immersion populations who were educated in Ottawa or similar bilingual regions and then moved to a place where exposure to French is limited (such as Toronto/Vancouver/Edmonton...etc...).

Additionally, failure of the attrition group to accurately perform gender decisions in Experiment 3 of the current study seems to be more of a competence problem (in the sense that production at the level of the articulator did not have to happen). Nevertheless, it remains unclear how the difficulties they encountered while performing the task would compare to those of the late L2 group, who showed the same patterns of results. Part of the problem is that assessing the original proficiency of the attrition group before their L2 enters in inactive mode was not a possible option at the time of testing. It would have been very useful to know whether the participants from this group (as well as the late L2) knew the grammatical gender of the stems used in the task. This limitation is one that applies to attrition research in general. The participants' failure on the task, though, supports previous findings that gender is one of the vulnerable language components in attrition (such as in Bolonyai & Dutkova-Cope, 2001; Cacciari & Cubelli, 2003).

Overall the current research showed sufficient power for accuracy effects, frequency effects, and some priming effects (i.e., identity). Nevertheless, specifying the contribution of morphological structure in lexical processing is complex for various reasons. In particular, the stimulus list is limited because arbitrary attributes of natural language confound many of the stimulus qualities of morphologically complex items. For example, in trying to select items for the orthographic condition in Experiment 2, it was not easy to find the required number of words that would match the particular inflectional and derivational items orthographically without being at the same time morphologically related, hence the use of pseudo-complex words. One of the arguments in this context is that lack of sufficient priming from a made-up orthographic and pseudo-complex item (such as the ones used in this experiment), could be a result of the fact that this item never existed in the first place as an entry in the mental lexicon. However, this potential limitation was carefully investigated in a dedicated review of the literature on the topic prior to the implementation of the final design. Various studies have elicited priming effects from complex pseudo-words (such as "*rapiduit*", i.e., quickify) that could not have their own lexical entry in the mental lexicon (Longtin & Meunier, 2005; Longtin, Segui & Halle, 2003; Meunier & Longtin, 2007).

Finally, although there are several ways this research could be improved, the findings from the attrition group are among the few available on lexical processing in language decay, and as such they lay the groundwork for future research. For example, future investigations could address the issue of gender processing in attrition by implementing a slightly modified version of the task used in Experiment 3. One suggestion is to measure congruency effects by adding the definite or indefinite determiner (le/ la or un/ une) to the prime (perhaps with a neutral one (chaque) to facilitate the task. Such modifications might eliminate the guessing factor. It is well known in the literature (Desrochers & Brabant, 1995; Desrochers & Paivio, 1990; Holmes and Segui 2004; Tucker et al. 1977) that even native speakers rely on these determiners as the primary source of gender information. Typically, however, native speakers are not used to judging words as masculine or feminine which perhaps explains the slow RT patterns found in Experiment 3 relative to the lexical decision tasks in Experiment 1 and 2.

CHAPTER 10

MODELLING MORPHOLOGICAL PROCESSING IN ATTRITION: TOWARDS A NEURO-COGNITIVE MODEL

Although the finding from the current research that morphologically related primes facilitated processing relative to unrelated primes supports a decompositional account of morphologically complex word representations, it also supports a sub-lexical architecture. The architecture of a sub-lexical model (such as proposed by Taft (1994) within the interactive-activation framework) consists of shared morpheme units located below the level of whole-word form. Morphemic representations are activated directly, before whole word representations, because the processing hierarchy moves from lower level form analysis of the stimulus to higher level semantics (Giraudo & Grainger, 2000; Grainger et al., 1991). In other words, at initial exposure to a morphologically complex word (as reflected in masked priming with short SOAs), morphemic representations seem to be extracted from the stimulus without reference to whole-word representations. Taft's (1994) model proposes that excitatory connections facilitate processing of a target word that shares a morpheme with its prime leading to activation of the root representation. The inhibitory effects of orthographic priming, on the other hand, reflect competitive processes acting across whole word representations (Giraudo & Grainger, 2000).

Based on L1 and L2 data from the first two experiments in the current thesis, it follows that at an early stage of processing, the language processor is sensitive to the morphemic structure regardless of whether the language in question is an L1 or an L2, and even when a particular language is used infrequently. However, results from the attrition literature (Hansen, 2001; Hansen & Chen, 2001; Filiaci, 2004; Tsimpli, Sorace, Heycock, & Filiaci 2004; Sorace, 2004) as well as from literature on pathological language loss (i.e, aphasia, e.g. Badecker, 2001; Blanken, 2000; Delazer & Semenza, 1998; Friedman, 2001; Jarema & Kehayia, 1992; Kohn & Melvold, 2000; Månsson & Ahlsén, 2001; Menn & Obler, 1990) suggest that what can be detected at the perception level is not always reflected in performance during production. Delazer and Semenza (1998) claimed that patients may retain knowledge of a word's morphological status even when they cannot access that word. In other words, production related difficulties with morphologically complex words exist even when perception remains intact. Similarly, Nasti and Marangolo (2005) found that more errors were produced with multimorphemic words than with monomorphemic words. These conclusions bring us to the question of what particular architecture for lexical processing in attrition would predict the dissociation between a native like language processor that is sensitive to the morphemic structure of words during perception, and yet fails to retrieve the same type of information (i.e., complex words) during production.

Findings from case studies from the attrition literature (De Bot & Stoessel, 2000) show that participants who perform above average in recognition tasks, did not perform as well in production. Such findings lead to the conclusion that attrition is more of a problem of production rather than perception. De Bot and Stoessel (2000) addressed the question of whether attrition involves total loss of linguistic representations or difficulty with access to such representations. Through re-learning/reactivations paradigms, they detected traces of residual knowledge at a sub-threshold level that was not accessible in production and that was maintained in memory despite lack of use. They argued that although retrieval slowdown and failure are among the first and strongest indicators of language attrition, total loss of information is unlikely once the information was stored in long-term memory.

Although the results from De Bot and Stoessel (2000) support the idea that attrition involves difficulties in retrieving information, and that residual knowledge of the language in question often remains, many questions are unanswered. For example, it is not clear yet whether there is a critical age or a cut-off point before which one should have had some exposure to a particular language component (grammatical gender, for example) for it to be retrieved or relearned with ease later, and whether certain structures (other than cognates) are less vulnerable than others regardless of the age factor.

Other studies have found evidence that performance-related processes (i.e., phonological mapping, orthographic form retrieval) deteriorate in attrition. For example, Levy et al. (2007) proposed that first language attrition was a case of phonological retrieval-induced forgetting. In picture naming tasks, they showed that regardless of the naming language (i.e., including the attrition language), accessibility to the concepts of previously seen pictures was facilitated by primes that were related to the target semantically. The results also showed that the more often participants repeated a word in their L2 the worse their performance became in producing the corresponding word in L1, suggesting the possibility of inhibition of the word in L1.

Levy et al. (2007) argued that inhibitory control mechanisms are responsible for the resolution of interference from one's L1 during L2 production, and as a result of this inhibition, retrieving an L2 word for a specific concept might induce forgetting the phonology of that word in L1. In one of the picture naming experiments they ran, 32 native English speakers were asked to repeat object names for pictures they saw either in

English or in their second language (i.e., Spanish). Then they were asked to provide the corresponding name for each object in the other language. The results showed that the more often participants repeated a word in their L2 the worse their performance became in producing the corresponding word in L1, suggesting that the production of the word in L2 inhibited activation of the same word in L1.

In Levy et al.'s (2007) second experiment, 64 participants were asked to produce words relating to those previously seen pictures after being presented with another word that rhymed with the picture name (e. g., *break* as a probe for *snake)*. The rhyming word served as a probe to measure accessibility of the English phonology. To measure the accessibility of the concept, participants were presented with a word that was related to the target word semantically (e.g., *venom* as a probe for *snake*). Results from Experiment 2 showed that retrieval-induced forgetting has its effect mostly on phonology. Regardless of the naming language, accessibility to the concepts of previously seen pictures was facilitated with semantic probes.

Thus, any model of attrition that includes hypotheses about the state of the lexicon must define and dissociate the contribution of orthographic, phonologic, morphologic, and semantic information in language production as compared to language perception.

Support for production-related deterioration in attrition can also be drawn from studies that argued for a reductionist approach to lexical processing (Andersen 1982; Cohen, 1975; Olshtain, 1989; Seliger, 1991, Seliger & Vago, 1991). Research shows that stored forms for irregular words are vulnerable to loss. For example, Olshtain (1989) found that Hebrew-English bilinguals (with Hebrew as L1) overused past tense morphemes of irregular verbs producing the Hebrew equivalents of the forms *gived*, *eated* and *waked up*. Similarly, Seliger and Vago (1991) found that German language attriters (with German as L1) produced the forms *er wisst*, *er schleichte*, and *er nimmte* instead of the forms *weiss*, *schlich*, and *nahm* (*knew*, *slunk*, and *took*, respectively). These findings highlight the tendency of the language processor to resort to rule based processes, and therefore, they bring forward the contribution of the morphemic structure to lexical processing in attrition.

Although these findings are in line with a symbolic account characterized by morphological decomposition, they do not completely exclude a connectionist explanation. In some research that supports a connectionist view (Plaut & Gonnerman, 2000; Seidenberg & Gonnerman, 2000) morphological decomposition is viewed as the learned sensitivity to systematic relationships between the surface forms of lexical units and their meanings. Morphology, in this connectionist view, emerges as a graded, inter-level activation pattern that reflects frequency-based correlations among orthography, phonology and semantics.

One of the implications arising from connectionist models in the context of attrition is the effect of how frequently language is used. For instance, when a speaker has not used a language for years, the lexical representations of that language might not compete as strongly as they did when that language was spoken more frequently. Van Hell and Dijkstra (2002) suggest that the resting activation levels of representational units when the language is dormant (i.e., has not been used for a while) are assumed to decrease. As a consequence, such representations will be subjected to more lateral inhibition exerted by their lexical competitors during recognition. Thus, the time required for a response to be made will be affected by accompanying changes in the pattern of activation of the various competitors.

To address the previously raised question of what particular architecture for lexical processing in attrition would predict the dissociation between a native like language processor that is sensitive to the morphemic structure of words during perception, and yet fails to retrieve the same type of information (i.e., complex words) during production, I start with a prominent model of lexical retrieval, designed by Levelt and colleagues (1989, 1995. I first outline the architecture of word retrieval phases in the normal speaker, and with reference to De Bot's (1992) adaptation of this model to the bilingual speaker, I discuss the proposed theory for the dynamics of lexical retrieval in attrition.

Conceiving speech production as a staged process, Levelt (1989) proposed a model consisting of a number of autonomous components which are responsible for different aspects of word production (Figure 14). These components include three strata of lexical access: conceptual (semantic) activation, lemma (syntactic) selection, and finally form (phonological) encoding, which entails morphological and phonological encoding at the lexeme[17] level.

Thus to produce a word such as "sheep", for example, the process starts at the lexical or conceptual level, where the image activates the lexical module, or node, for *sheep*, carrying all the information the brain has stored about sheep: an animal with

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[17] In Levelt (1989) model of speech production a distinction is made between "lemma" retrieval where a word's syntactic properties and meaning are retrieved from memory and "lexeme" retrieval where information about the word's phonological form is recovered.

hooves, wool, etc. Each node is believed to be a widely distributed network of connected neurons in the brain. Adjacent lexical nodes for related words, like lamb, goat, animal, etc., are also activated. The information is then passed on to the next module for processing (i.e., the lemma module). At this level, proper syntax is assigned such as word order, gender, case marking, and any other grammatical features[18].

Meanwhile, the various activated concepts compete. Activation then spreads through the network in a forward fashion, and nodes are selected following simple rules. When a lemma is retrieved because it matches part of the preverbal message, its syntactic properties become available and they trigger syntactic building procedures. The morphological encoder selects segments and metrical structures. It accesses the morphemes (roots and affixes) which are linked to the selected lemma, while the phonological encoder operates on the segments and metrical structures that are linked to these morphemes and selects the nodes whose links correspond to the phonological syllable positions assigned to the segments. The most highly activated concept wins, but the more interference and similarity there is among competing concepts, the longer it takes to generate the desired word.

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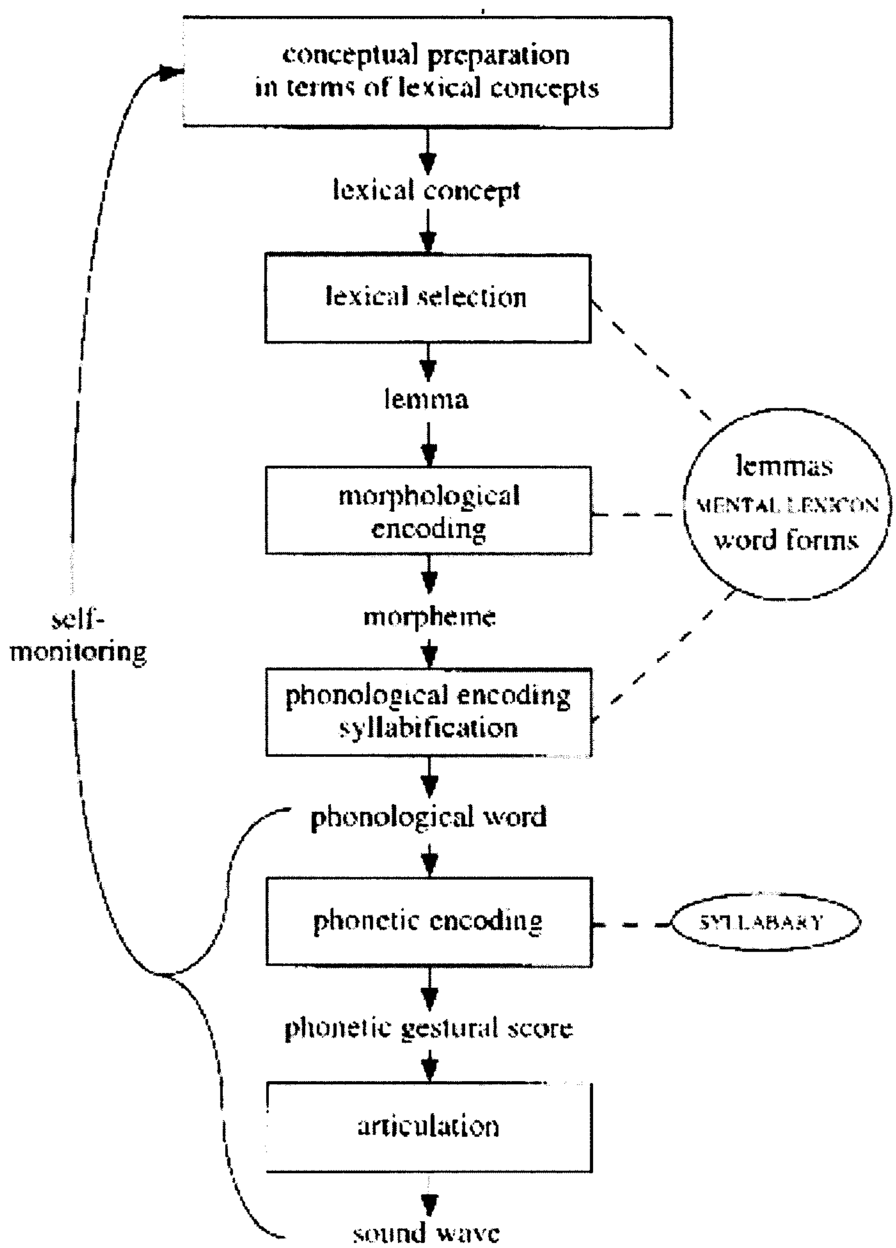
[18] Thus, in the context of language attrition, one might suggest that at this stage of the process if the input data in the L2 contains a comparable grammatical feature that is more universal and less marked than the competing grammar in the primary language, that form in the L2 will be favored. As discussed earlier, some findings from L2 attrition reflect this tendency to switch to unmarked forms (Olshtain & Barzilay, 1989; Seliger & Vago, 1991).

Figure 14. Levelt's model of speech production. Preparing a word proceeds through stages of conceptual preparation, lexical selection, morphological and phonological encoding, and phonetic encoding before articulation can be initiated. Adapted from Levelt, Roelofs, and Meyer (1999).



Levelt's monolingual model of word production was first adapted for bilingual word production by de Bot (1992). Arguing that the languages of a bilingual can be activated simultaneously to varying degrees depending on how frequently they are used, De Bot proposes that a language can be active, selected, or dormant.

Accordingly, it follows that, depending on individual competence factors and on how frequently a language is used, items from an attriting language may be activated simultaneously to items in the language the speaker uses more frequently[19]. This assumption implies that the choice of lemmas, the production of surface structures, and the forming of phonetic plans may happen in parallel in the attriting language and in the dominant language. However, planned utterances from the attriting language will not be passed on to the articulator because the attriting language is never as activated as the dominant language.

Turning the desired concept into a spoken word requires matching the syntactical elements from the lemma level to the sounds that make up a language including, but not limited to syllable, stress, rhythm, and intonation. At this level of word form encoding, Levelt argues that only selected Lemmas will become phonologically activated. The lexical pointer specified in the lemma, then, triggers the phonological encoding process which results in the selection of specific morphological and phonological forms (Figure 14) before it is finally executed by the articulator. Retrieval difficulties associated with attrition may occur at this stage, perhaps because a given lexical node was not activated to make it to the lexeme level (Figure 14).

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[19] This phenomenon leads to switching to the more accessible item from the dominant language, and is often referred to as *Code Switching* in second language research.

CONCLUSION AND FUTURE DIRECTIONS

The current research contributes to the literature on lexical processing in native and non-native speakers. There is at present only a small body of research on lexical processing in attrition. The present research highlights the existence of quantitative differences between native and L2 speakers of French. In contrast to some predictions from the literature, no qualitative differences among these groups were identified in morphological word processing. The comparable priming patterns found in this study in L1 and L2 (especially in an L2 that has been acquired at an early age) are unlikely to reflect fundamental processing differences between the native and the non-native speakers but instead can be attributed to the general slower speed of processing, reduced proficiency, and working-memory limitations often associated with L2 processing.

Of major interest to the field of attrition is the finding that the masked priming paradigm yields priming effects even in non-practising L2 speakers. Additionally, the finding that the attrition group showed priming effects for the orthographic condition in the derivational type and in the low frequency inflectional type lays the groundwork for future research and leaves interesting and important factors for further investigation. The fact that processing in attrition does not seem to be fundamentally different from processing in native speakers and speakers of an L2 with no attrition effects, suggests new directions for future research. Although the current research focused on processing in attrition, future research might benefit more from an indepth investigation of what happens at the lexeme stage of the word production process.

One area that is of particular interest to the study of attrition, is sign language. Sign language is well known to share all the characteristics of a natural language (de Bot, 1992). With respect to the suggestion made earlier about the locus of lexical difficulties' effects, the study of morphological processing in sign language could be useful for investigation of lexical processes in attrition. An important question in this context is how would gestures such as hand movements reflect signs of attrition that would otherwise pertain to difficulties at the level of phonological retrieval, as compared to difficulties associated with concept retrieval. Equally important is the question of how would hand movements reflect decomposition or lack of it.

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APPENDIX A: LINGUISTIC BACKGROUND QUESTIONNAIRE

Participant number: ___________ Age: _________Gender: □ Male □ Female

Thank you for agreeing to fill out this questionnaire, which is part of a graduate research project being conducted by Sarra Ghazel under the supervision of Dr. Jo-Anne LeFevre at Carleton University and Dr. Laura Sabourin at the Linguistics Department at the University of Ottawa. There are two phases to the project. The first phase consists of a questionnaire designed to obtain some basic information about you and about your relative amount of exposure to French and English. Your completion of this questionnaire is **voluntary.** You will not be compensated in any way for filling it out. All of the information you provide will be held in strict confidence and will not be shared with anyone else or used for any other purpose. Please be advised that your answers are not limited to the options provided. If at any point you would like to add information, please feel free to do so.

1 Background Information

Date of birth:...

Place of birth: Region........................ ....Country...

Preferred language of communication	French □	English □	both □
I normally **write** with my...	right hand □	left hand □	both □
I have a known hearing impairment in my...	right ear □	left ear □	neither □
Nationality(ies)			

1) What is the highest level of education you have completed?

   ❑ primary school ❑ secondary school, level ❑ higher education, namely:

   ❑ no vocational training. ❑ apprenticeship ❑university

2) What is your current profession?

   ....

   ....

3) Do you feel more comfortable speaking French or English?

   ❑ English, ❑ French, ❑ no difference

4) Could you elaborate on your answer: why do you feel more comfortable speaking either French or English or why don't you have any preference?

   ....

   ....

2.1 Context of Language Acquisition:

Please indicate which language(s) you have learned in the following context by writing the number of months, semesters or years you have been learning them in the appropriate squares. Also indicate the dates (e.g. from: 1990 to 2000). Please let the researcher know if you need additional columns.

Language Context		English	French	Other (specify)	Other (specify)
Home					
Nursery/ kindergarten	language of instruction				
	Classes				
Elementary school	language of instruction				
	Classes				
High school	language of instruction				
	Classes				

2 Language Use

5) Could you, in the following table, please indicate to what extent you use French and English? Place a tick mark in the box that indicates how much of the time you use each of the languages in each situation. If a certain domain is not applicable to you (for example, if you don't have any pets), you may leave the box empty.

Amount of **language** used.....	PERCENTAGES											
		0	10	20	30	40	50	60	70	80	90	100	Notes
by maternal grandparents with you	Fr												
	Eng												
	Other												
by paternal grandparents with you	Fr												
	Eng												
	Other												
by mother with you	Fr												
	Eng												
	Other												
by father with you	Fr												
	Eng												
	Other												
generally in home from birth to pre-school	Fr												
	Eng												
	Other												

		0	10	20	30	40	50	60	70	80	90	100	Notes
generally in home from pre-school to 14 years old	Fr												
	Eng												
	Other												
generally in home from 14 years old to departure	Fr												
	Eng												
	Other												
generally in home from 14 years old to departure	Fr												
	Eng												
	Other												
generally in home in last 5 years and currently	Fr												
	Eng												
	Other												

		0	10	20	30	40	50	60	70	80	90	100	Notes
as language of communication with friends in pre-school	Fr												
	Eng												
	Other												
as language of communication with friends in primary school	Fr												
	Eng												
	Other												
as language of communication with friends in middle school	Fr												
	Eng												
	Other												
as language of communication with friends & community in childhood	Fr												
	Eng												
	Other												

		0	10	20	30	40	50	60	70	80	90	100	Notes
in current workplace	Fr												
	Eng												
	Other												
in present daily use overall	Fr												
	Eng												
	Other												
with your partner	Fr												
	Eng												
	Other												
with your children	Fr												
	Eng												
	Other												
with your pets	Fr												
	Eng												
	Other												
To watch TV / listen to music/radio	Fr												
	Eng												
	Other												
To read newspapers/magazines/books	Fr												
	Eng												
	Other												

Language proficiency:

Listed below are a number of "can-do" scales. They consist of statements about your language proficiency in both French and English. Please read each description carefully and circle the appropriate number to indicate whether, at the present time, you would be able to carry out each task in each language. Thus, you can only circle one number per language and per statement. Please use the following scale:

1 = I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at all

	Listening comprehension	**French**	**English**
1.	I can understand most TV news and current affairs programmes.	1 2 3 4 5	1 2 3 4 5
2.	I can understand the main points of many radio or TV programmes on current affairs or topics of personal or professional interest when the delivery is relatively slow and clear.	1 2 3 4 5	1 2 3 4 5
3.	I have no difficulty in understanding any kind of spoken language, whether live or broadcast, even when delivered at fast native speed, provided that I have some time to get familiar with the accent.	1 2 3 4 5	1 2 3 4 5

1 = I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at all

		French	**English**
4.	I can understand extended speech even when it is not clearly structured and when relationships are only implied and not signalled explicitly.	1 2 3 4 5	1 2 3 4 5
5.	I can understand the main points of clear standard speech on familiar matters regularly encountered in work, school, leisure, etc.	1 2 3 4 5	1 2 3 4 5
6.	I can understand extended speech and lectures and follow even complex lines of argument provided the topic is reasonably familiar.	1 2 3 4 5	1 2 3 4 5
7.	I can understand the majority of films in standard dialects.	1 2 3 4 5	1 2 3 4 5
8.	I can understand television programmes and films without too much effort.	1 2 3 4 5	1 2 3 4 5
Comments:			

1 = I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at all

		French	**English**
9.	I can understand long and complex factual and literary texts, appreciating distinctions of style.	1 2 3 4 5	1 2 3 4 5
10.	I can read articles and reports concerned with contemporary problems in which the writers adopt particular attitudes or viewpoints.	1 2 3 4 5	1 2 3 4 5
11.	I can read with ease virtually all forms of the written language, including abstract, structurally or linguistically complex texts such as manuals, specialised articles and literary works.	1 2 3 4 5	1 2 3 4 5
12.	I can understand the description of events, feelings and wishes in personal letters.	1 2 3 4 5	1 2 3 4 5
13.	I can understand texts that consist mainly of high frequency everyday or job-related language.	1 2 3 4 5	1 2 3 4 5
Comments:			

1 = I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at all

	Reading proficiency	**French**	**English**
14.	I can understand specialised articles and longer technical instructions, even when they do not relate to my field.	1 2 3 4 5	1 2 3 4 5
15.	I can understand contemporary literary prose.	1 2 3 4 5	1 2 3 4 5
16.	I can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible.	1 2 3 4 5	1 2 3 4 5
17.	I can present a clear, smoothly flowing description or argument in a style appropriate to the context and with an effective logical structure which helps the recipient to notice and remember significant points.	1 2 3 4 5	1 2 3 4 5
18.	I can use language flexibly and effectively for social and professional purposes.	1 2 3 4 5	1 2 3 4 5
Comments:			

1 = I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at al

	Speaking ability	**French**	**English**
19.	I can enter unprepared into conversation on topics that are familiar, of personal interest or pertinent to everyday life (e.g. family, hobbies, work, travel, current events).	1 2 3 4 5	1 2 3 4 5
20.	I can take part effortlessly in any conversation or discussion and have a good familiarity with idiomatic expressions and colloquialisms.	1 2 3 4 5	1 2 3 4 5
21.	I can narrate a story or relate the plot of a book or film and describe my reactions.	1 2 3 4 5	1 2 3 4 5
22.	I can deal with most situations likely to arise whilst travelling in an area where the language is spoken.	1 2 3 4 5	1 2 3 4 5
23.	I can take an active part in discussion in familiar contexts, accounting for and sustaining my views.	1 2 3 4 5	1 2 3 4 5
Comments:			

1= I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at all

		French	**English**
24.	I can present clear, detailed descriptions of complex subjects integrating sub-themes, developing particular points and rounding off with an appropriate conclusion.	1 2 3 4 5	1 2 3 4 5
25.	If I do have a problem I can backtrack and restructure around the difficulty so smoothly that other people are hardly aware of it.	1 2 3 4 5	1 2 3 4 5
26.	I can connect phrases in a simple way in order to describe experiences and events, my dreams, hopes and ambitions.	1 2 3 4 5	1 2 3 4 5
27.	I can present clear, detailed descriptions on a wide range of subjects related to my field of interest.	1 2 3 4 5	1 2 3 4 5
28.	I can express myself fluently and convey finer shades of meaning precisely.	1 2 3 4 5	1 2 3 4 5
Comments:			

1= I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at all

		French	English
29.	I can explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.	1 2 3 4 5	1 2 3 4 5
30.	I can briefly give reasons and explanations for opinions and plans.	1 2 3 4 5	1 2 3 4 5
31.	I can express myself fluently and spontaneously without much obvious searching for expressions.	1 2 3 4 5	1 2 3 4 5
32.	I can formulate ideas and opinions with precision and relate my contribution skillfully to those of other speakers.	1 2 3 4 5	1 2 3 4 5
33.	I can select style appropriate to the reader in mind.	1 2 3 4 5	1 2 3 4 5
34.	I can write simple connected text on topics which are familiar or of personal interest.	1 2 3 4 5	1 2 3 4 5
Comments:			

1= I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at all

	Writing proficiency	**French**	**English**
35.	I can write simple connected text on topics which are familiar or of personal interest.	1 2 3 4 5	1 2 3 4 5
36.	I can write complex letters, reports or articles which present a case with an effective logical structure which helps the recipient to notice and remember significant points.	1 2 3 4 5	1 2 3 4 5
37.	I can write an essay or report, passing on information or giving reasons in support of or against a particular point of view.	1 2 3 4 5	1 2 3 4 5
38.	I can write personal letters describing experiences and impressions.	1 2 3 4 5	1 2 3 4 5
39.	I can express myself in clear, well-structured text, expressing points of view at some length.	1 2 3 4 5	1 2 3 4 5
Comments:			

1= I cannot do this at all

2 = I can do this, but with much difficulty

3 = I can do this, although with some difficulty

4 = I can do this fairly easily

5 = I can do this without any difficulty at all

		French	**English**
40.	I can write summaries and reviews of professional or literary works.	1 2 3 4 5	1 2 3 4 5
41.	I can write clear, detailed text on a wide range of subjects related to my interests.	1 2 3 4 5	1 2 3 4 5
42.	I can write clear, smoothly flowing text in an appropriate style.	1 2 3 4 5	1 2 3 4 5
43.	I can write letters highlighting the personal significance of events and experiences.	1 2 3 4 5	1 2 3 4 5
44.	I can write about complex subjects in a letter, an essay or a report, underlying what I consider to be the salient issues.	1 2 3 4 5	1 2 3 4 5
Comments			

7) You have come to the end of this questionnaire. Is there anything you would like to add? This can be anything from language-related comments to remarks about the questionnaire or research itself.

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APPENDIX B: LINGUISTIC PROFICIENCY CLOZE TEST

"Le taux de CO2 dans l'atmosphère augmente plus vite que prévu"

La croissance économique mondiale (1) ______________ provoqué un accroissement de (2) ______________ teneur en dioxyde de (3) ______________ (CO2) dans l'atmosphère beaucoup (4) ______________ rapidement que prévu, selon une étude (5) ______________ lundi dans les comptes rendus de l'Académie (6) ______________ des sciences des États-Unis.

Cette étude (7)______________ que la concentration des émissions (8)______________ gaz carbonique dans l'atmosphère a (9)______________ de 35 % en 2006, entre le début (10)______________ années 1990 et les (11)______________ 2000-2006, passant de 7 à 10 milliards de tonnes (12)______________ an, alors que le protocole de Kyoto prévoyait (13)______________ en 2012, ces émissions responsables (14)______________ réchauffement climatique devaient (15)______________ baissé de 5 % par (16)______________ à 1990. « Les améliorations dans l'intensité carbonique de l'économie (17)______________ stagnent depuis 2000, après trente (18)______________ de progrès, ce qui a provoqué cette (19)______________ inattendue de la concentration de CO2 (20)______________ l'atmosphère », indique dans (21)______________ communiqué le British Antarctic Survey, (22)______________ a participé à cette étude.

(23)_______________ les chercheurs, les carburants polluants (24)_______________ responsables de 17 % de cette augmentation, (25)_______________ que les 18 % restant sont (26)_______________ à un déclin de la capacité des « puits » naturels comme (27)_______________ forêts ou les océans (28)_______________ absorber le gaz carbonique. « (29)_______________ y a cinquante ans, pour chaque tonne de CO_2 émise, 600 kg (30)_______________ absorbés par les puits naturels. (31)_______________ 2006, seulement 550 kg par tonne ont été (32)_______________, et cette quantité continue à baisser », explique (33)_______________ auteur principal de l'étude, Pep Canadell, du Global Carbon Project. « La baisse de l'efficacité (34)_______________ puits mondiaux laisse (35)_______________ que la stabilisation de cette (36)_______________ sera encore plus (37)_______________ à obtenir que ce que l'on pensait jusqu'à (38)_______________ », indique pour sa (39)_______________ le British Antarctic Survey.

Ces (40)_______________ obligent à une révision à la hausse (41)_______________ prévisions du Groupe intergouvernemental d'experts (42)_______________ l'évolution du climat qui, dans son (43)_______________ de février, tablait sur l'augmentation de la température (44)_______________ de la terre de 1,8 °C à 4 °C (45)_______________ l'horizon 2100.

LINGUISTIC PROFICIENCY CLOZE TEST: ANSWER KEY

	Exact Answer	Lexically Acceptable Answers
1	a	
2	la	
3	carbone	
4	plus	
5	publiée	ce, parue, présentée, scientifique, sortie
6	nationale	officielle
7	souligne	affirme, conclut, constate, démontre, dit, explique, indique, montre, rapporte, révèle, suggère
8	de	
9	augmenté	progressé
10	des	
11	années	
12	par	
13	qu’	
14	du	
15	avoir	
16	rapport	comparaison
17	mondiale	globale, internationale

18	ans	années
19	croissance	augmentation, crise, hausse, montée, teneur
20	dans	
21	un	son
22	qui	
23	Selon	Pour
24	sont	seraient
25	tandis	alors
26	dus	accordés, attribuables, attribués, liés
27	les	
28	à	d’
29	Il	
30	étaient	
31	En	
32	absorbés	
33	l’	
34	des	
35	penser	croire, entendre, entrevoir, présumer, prévoir, supposer
36	concentration	augmentation, croissance, hausse, quantité
37	difficile	dure, importante, longue, nécessaire
38	présent	aujourd’hui, maintenant
39	part	

40	résultats	analyses, chiffres, conclusions, constats, découvertes, données, faits, figures, informations, mesures, nombres, nouvelles, observations, renseignements
41	des	
42	sur	concernant, de
43	rapport	analyse, annonce, article, bilan, bulletin, communiqué, discours, dossier, étude, exposé
44	moyenne	atmosphérique, climatique, globale, thermique
45	à	avant, pour

FROM:

Tremblay, A. (2011). Proficiency assessment standards in second language acquisition research: "Clozing" the gap. *Studies in Second Language Acquisition*. 33, 339-372

APPENDIX C: EXP 1 STIMULI

INFLECTIONAL: ITEMS PER CONDITION

IDENTITY PRIME	MORPHOLOGICAL PRIME	UNRELATED PRIME	TARGET
aller	allais	savoir	ALLER
croire	croyais	décrire	CROIRE
dire	disais	parler	DIRE
ouvrir	ouvrais	naître	OUVRIR
donner	donnais	guérir	DONNER
boire	buvais	laver	BOIRE
faire	faisais	dormir	FAIRE
lire	lisais	éteindre	LIRE
courir	courais	partager	COURIR
connaître	connaissais	nager	CONNAITRE
devoir	devais	appeler	DEVOIR
pouvoir	pouvais	démentir	POUVOIR
prendre	prenais	decouper	PRENDRE
mettre	mettais	suivre	METTRE
mourir	mourais	prévoir	MOURIR
plaire	plaisais	suffire	PLAIRE
rire	riais	offrir	RIRE
savoir	savais	mentir	SAVOIR

sortir	sortais	coudre	SORTIR
suivre	suivais	asseoir	SUIVRE
valoir	valais	essuyer	VALOIR
voir	voyais	rencontrer	VOIR
vouloir	voulais	marquer	VOULOIR
venir	venais	déchirer	VENIR
écrire	écrivais	monter	ÉCRIRE

DERIVATIONAL: ITEMS PER CONDITION

IDENTITY PRIME	MORPHOLOGICAL PRIME	UNRELATED PRIME	TARGET
triste	tristement	doux	TRISTE
affreux	affreusement	pauvre	AFFREUX
aveugle	aveuglement	proche	AVEUGLE
facile	facilement	honnête	FACILE
étonnant	étonnamment	fatigué	ÉTONNANT
éperdu	éperdument	tiède	ÉPERDU
provisoire	provisoirement	endormi	PROVISOIRE
étroit	étroitement	surchauffé	ÉTROIT
ouvert	ouvertement	argenté	OUVERT
chaleureux	chaleureusement	chanceux	CHALEUREUX
furtif	furtivement	brûlant	FURTIF
libre	librement	éveillé	LIBRE
pleine	pleinement	inconnu	PLEINE
paisible	paisiblement	fou	PAISIBLE
haut	hautement	grippé	HAUT
digne	dignement	foncé	DIGNE
bête	bêtement	sourd	BETE
fol	follement	vide	FOL
fière	fièrement	gros	FIÉR

inutile	inutilement	inquiet	INUTIL
chaud	chaudement	faux	CHAUD
dernier	dernièrement	bon	DERNIER
drole	drolement	sucré	DROLE
pareil	pareillement	jeune	PAREIL
parfait	parfaitement	tondu	PARFAIT
lourd	lourdement	nouveau	LOURD
courant	couramment	tardif	COURANT
douce	doucement	bas	DOUCE
aucune	aucunement	surgelé	AUCUNE
cher	chèrement	sacré	CHER
méchant	méchamment	têtu	MÉCHANT
poli	poliment	beau	POLI
étrange	étrangement	souriant	ÉTRANGE
subit	subitement	sablé	SUBIT
autre	autrement	tendu	AUTRE
pénible	péniblement	bref	PÉNIBLE

PSEUDO-WORDS (EXP 1 & 2)

PSEUDO-WORDS			
LOUAGESSE	LOINTUDE	BLESSAGE	COMPORTESSE
BATAILLEMENT	HEUREMENT	AUTRESSE	APAISIBLE
DECROYER	DROITMENT	LOUCHEUR	FOISSEUR
BAVARDESSE	FLEUVEUR	TROMPAGE	SOIGNEMENT
TIRESSE	NOISETUDE	"PARAÎTREMENT"	CHEVALEUR
RAMENETUDE	AGIREMENT	DEBOUTAGE	SUSCITABLE
FAIBLETUDE	TEINDRESSE	TROUVAGE	INFIRMETUDE
RACINEMENT	TRICOTIQUE	DOUANAGE	FROTTUME
CLAQUOGNE	CHERCHAGE	SECOURSAGE	LESSIVEMENT
INQUIETION	"BRÛLATION"	NAGATION	DESSINEUR
NOYEUSE	VITESSEUR	"PRÊTEMENT"	POUSSEMENT
BRISAGE	TRAVAILMENT	LUTTEMENT	NOMMATION
BAIGNAGE	TROUPAGE	HURLATION	POURSUIVEUR
ENROBATION	QUADRAGE	PLUMESSE	HILAREMENT
ESCLAVEUR	PENSETUDE	VENTRESSE	ARROSEMENT
MENTESSE	JOUETEUSE		

PRACTICE ITEMS	DUMMIES
SOURIRE	RÉFLECHIR
COMPRENDRE	COMPTER
MALADE	PESANT
ENTRÉE	PRÉVENIR
FEUILLE	
QUAI	
NAVIRE	
BLESSER	
DOULEUR	
DIRIGER	

APEENDIX D: EXP 2 STIMULI

INFLECTIONAL: ITEMS PER CONDITION

Morphological Prime	Identity Prime	Unrelated Prime	Orthographic Prime	Target
allais	Aller	saisir	Allecte	ALLER
croyais	Croire	ramasser	Croigne	CROIRE
ouvrais	Ouvrir	naître	Ouvrade	OUVRIR
donnais	Donner	guérir	Donnecte	DONNER
buvais	Boire	laver	Boivour	BOIRE
faisais	Faire	dormir	Faiche	FAIRE
lisais	Lire	éteindre	Lisare	LIRE
courais	Courir	partager	Courigne	COURIR
connaissais	connaître	nager	conneille	CONNAÎTRE
devais	Devoir	appeler	devecte	DEVOIR
pouvais	pouvoir	démentir	pouvigne	POUVOIR
prenais	Prendre	decouper	prenape	PRENDRE
mettais	Mettre	sauter	mettuit	METTRE
mourais	Mourir	prévoir	moureche	MOURIR
plaisais	Plaire	souffire	plaiseille	PLAIRE
riais	Rire	offrir	rigne	RIRE
savais	Savoir	mentir	savade	SAVOIR

sortais	Sortir	coudre	sorterge	SORTIR
suivais	Suivre	asseoir	suiverne	SUIVRE
valais	Valoir	essuyer	valume	VALOIR
voyais	Voir	rencontrer	voyare	VOIR
voulais	Vouloir	marquer	voulupe	VOULOIR
venais	Venir	déchirer	venerne	VENIR
écrivais	Écrire	manger	écrivogne	ÉCRIRE
expliquais	expliquer	ressusciter	expliquit	EXPLIQUER
jouais	Jouer	coller	jouerne	JOUER
terminais	terminer	cadrer	terminecte	TERMINER
assiégeais	assiéger	motiver	assiégeille	ASSIÉGER
broyais	Broyer	répliquer	broyume	BROYER
souhaitais	souhaiter	moudre	souhaiterne	SOUHAITER
fondais	Fondre	apitoyer	fonduche	FONDRE
saluais	Saluer	pondre	saluape	SALUER
cédais	Céder	grogner	cédogne	CÉDER
effectuais	effectuer	pieger	effecterge	EFFECTUER
envoyais	envoyer	mâcher	envoyade	ENVOYER
étudiais	Étudier	parier	étuderne	ÉTUDIER
écoutais	écouter	démolir	écouteille	ÉCOUTER
racontais	raconter	amortir	racontigne	RACONTER
jetais	Jeter	luire	jetoupe	JETER

finissais	Finir	bercer	finissour	FINIR
créais	Créer	fleurir	créape	CRÉER
gagnais	Gagner	ruiner	gagnume	GAGNER
apprenais	apprendre	trier	apprenoupe	APPRENDRE
oubliais	Oublier	attendrir	oublime	OUBLIER
montais	monter	tousser	montecte	MONTER
laissais	Laisser	remercier	laisseille	LAISSER
fatiguais	fatiguer	acquérir	fatiguerne	FATIGUER
vivais	Vivre	chercher	vivape	VIVRE

DERIVATIONAL: ITEMS PER CONDITION

Morphological Prime	Identity Prime	Unrelated Prime	Orthographic Prime	Target
Subitement	Subit	sablé	subiteche	SUBIT
Tristement	Triste	doux	tristogne	TRISTE
Affreusement	Affreux	pauvre	affreusuit	AFFREUX
Aveuglement	Aveugle	proche	aveuglour	AVEUGLE
Facilement	Facile	honnête	facilogne	FACILE
Étonnamment	étonnant	fatigué	étonuche	ÉTONNANT
Éperdument	éperdu	tiède	éperdupe	ÉPERDU
Provisoirement	provisoire	endormi	proviserne	PROVISOIRE
Étroitement	étroit	surchauffé	étroitape	ÉTROIT
Ouvertement	Ouvert	argenté	ouverteps	OUVERT
Chaleuresement	chaleureux	chanceux	chaleurogne	CHALEUREUX
Furtivement	Furtif	brûlant	furtivuit	FURTIF
Librement	Libre	éveillé	librode	LIBRE
Pleinement	Pleine	inconnu	pleinerne	PLEINE
Paisiblement	Paisible	fou	paisiblude	PAISIBLE
Hautement	Haut	grippé	hautuche	HAUT
Dignement	Digne	foncé	dignape	DIGNE
Bêtement	Bête	sourd	bêtegne	BÊTE
Follement	Fol	vide	folloirne	FOL
Fièrement	Fière	gros	fièreteps	FIÉR

Inutilement	Inutil	inquiet	inutilape	INUTIL
Chaudement	Chaud	faux	chaudigne	CHAUD
Dernièrement	Dernier	bon	dernièroir	DERNIER
Drolement	Drole	sucré	drollour	DROLE
Pareillement	Pareil	jeune	pareillume	PAREIL
Parfaitement	Parfait	tondu	parfaitogne	PARFAIT
Lourdement	Lourd	nouveau	lourdeps	LOURD
Doucement	Douce	bas	doucecte	DOUCE
Aucunement	Aucune	surgelé	aucunoupe	AUCUNE
Chèrement	Cher	sacré	chèremour	CHER
Méchamment	méchant	Têtu	méchamuit	MÉCHANT
Poliment	Poli	Beau	polignon	POLI
Étrangement	Étrange	souriant	étrangude	ÉTRANGE
Autrement	Autre	Tendu	autrare	AUTRE
Péniblement	Pénible	Bref	péniblecte	PÉNIBLE
Fiabilité	Fiable	grognon	fiabilour	FIABLE
Onctuosité	onctueux	croquant	onctuosude	ONCTUEUX
Fébrilité	Febrile	Hâtif	fébrileche	FEBRILE
Irréalité	Irréel	Bénin	irréalerne	IRRÉEL
Somptuosité	somptueux	Coquet	somptuosape	SOMPTUEUX
Immuniabilité	immuable	Enragé	immunieille	IMMUABLE
Disponibilité	disponible	Hautain	disponibleps	DISPONIBLE
Ivresse	ivre	ravissant	ivrogne	IVRE

Vieilesse	vieil	Douée	vieillude	VIEIL
Égalité	égal	Bavard	égalerne	ÉGAL
Légèreté	leger	troublant	légèreche	LEGER
Tristesse	triste	Malin	tristogne	TRISTE
Faiblesse	faible	Éloigné	faiblure	FAIBLE
Pauvresse	pauvre	Grêle	pauvraille	PAUVRE
Vitesse	vite	honteux	vitage	VITE
Heureusement	heureux	Petit	heureude	HEUREUX
Vivacité	vivace	Maigre	vivogne	VIVACE

PSEUDO-WORDS			
LOUAGESSE	LOINTUDE	BLESSAGE	COMPORTESSE
BATAILLEMENT	HEUREMENT	AUTRESSE	APAISIBLE
DECROYER	DROITMENT	LOUCHEUR	FOISSEUR
BAVARDESSE	FLEUVEUR	TROMPAGE	SOIGNEMENT
TIRESSE	NOISETUDE	"PARAÎTREMENT"	CHEVALEUR
RAMENETUDE	AGIREMENT	DEBOUTAGE	SUSCITABLE
FAIBLETUDE	TEINDRESSE	TROUVAGE	INFIRMETUDE
RACINEMENT	TRICOTIQUE	DOUANAGE	FROTTUME
CLAQUOGNE	CHERCHAGE	SECOURSAGE	LESSIVEMENT
INQUIETION	"BRÛLATION"	NAGATION	DESSINEUR
NOYEUSE	VITESSEUR	"PRÊTEMENT"	POUSSEMENT
BRISAGE	TRAVAILMENT	LUTTEMENT	NOMMATION
BAIGNAGE	TROUPAGE	HURLATION	POURSUIVEUR
ENROBATION	QUADRAGE	PLUMESSE	HILAREMENT
ESCLAVEUR	PENSETUDE	VENTRESSE	ARROSEMENT
MENTESSE	JOUETEUSE		

PRACTICE ITEMS	**DUMMIES**
SOURIRE	RÉFLECHIR
COMPRENDRE	COMPTER
MALADE	PESANT
ENTRÉE	PRÉVENIR
FEUILLE	
QUAI	
NAVIRE	
BLESSER	
DOULEUR	
DIRIGER	

APEENDIX E: EXP 3 STIMULI

Morphological Congruent Prime	Morphological Incongruent Prime	Non-Morphological Congruent Prime	Non-Morphlogical Incongruent Prime	TARGET
amoureux	amourette	coeur	crainte	AMOUR
Ø	annuaire	nage	caillou	ANNÉE
arbrisseau	Ø	poussin	ventouse	ARBRE
argentier	argenterie	champ	feinte	ARGENT
"assiettée"	Ø	croute	sable	ASSIETTE
baigneur	baignade	voisin	gifle	BAIN
bannette	banneton	bougie	meuble	BANNE
"bâtonnet"	Ø	jour	langue	BÂTON
boisage	boiserie	cachot	"poupée"	BOIS
Ø	boulonnnerie	cadre	"poussière"	BOULON
brouillerie	brouillage	broche	destin	BROUILLE
Ø	cachot	proie	matou	CACHE
cacheton	Ø	miroir	heure	CACHET
camionnage	camionnette	rappel	taille	CAMION
Ø	ceinturon	valence	"siècle"	CEINTURE
"cendrée"	cendrier	nappe	voisin	CENDRE
Ø	cerceau	soie	timbre	CERCE
cerisaie	cerisier	veilleuse	genou	CERISE

chaudron	"chaudière"	poupon	crainte	CHAUD
chaufferie	chauffage	craie	"mélange"	CHAUFFE
chaussure	chausson	croute	stylo	CHAUSSÉE
chemineau	Ø	pentalon	proie	CHEMIN
chemisette	chemisier	tasse	"gâteau"	CHEMISE
chiffrage	Ø	cadre	"clé"	CHIFFRE
cochonnet	cochonnerie	doigt	matrice	COCHON
Ø	collant	boite	moelle	COLLE
Ø	comploteuse	avion	cadeau	COMPLOT
coffret	Ø	"gâteau"	"nausée"	COFFRE
copinage	copinerie	morse	brioche	COPAIN
coquillette	coquillage	cadence	festin	COQUILLE
"cuillerée"		boite	doigt	CUILLÈRE
Ø	cuisseau	cabane	"étage"	CUISSE
Ø	"délirante"	grattoir	"fête"	DÉLIRE
droiture	Ø	taille	colis	DROITE
"écalure"	Ø	"poignée"	champ	ÉCALE
"écartement"	Ø	doigt	"nausée"	ÉCART
feuillure	"échapement"	viande	morse	ÉCHAPPÉE
Ø	"échelon"	foule	vide	ÉCHELLE
Ø	encrier	"tête"	navire	ENCRE
Ø	"fenêtrage"	douille	pentalon	FENÊTRE
Ø	feuillet	moelle	jeu	FEUILLE

Ø	fichet	tige	volant	FICHE
Ø	fossette	gilet	cadence	FOSSÉ
fouettement	"fouettée"	poumon	"fête"	FOUET
fourchette	fourchon	bougie	rappel	FOURCHE
"fourmilière"	fourmilier	viande	rayon	FOURMI
fournaise	fourneau	boucle	impot	FOURNÉE
frissonnement	Ø	sable	tige	FRISSON
friterie	Ø	nuit	hiver	FRITE
Ø	froidure	poids	"poussière"	FROID
fromageon	fromagerie	rappel	gitane	FROMAGE
"fugacité"	fugueur	valeur	poussin	FUGUE
Ø	fusillade	feu	gitane	FUSIL
goudronneur	Ø	sabot	bordure	GOUDRON
Ø	goulette	"mélange"	fuite	GOULET
gouttelette	Ø	"tête"	poumon	GOUTTE
grimpette	grimpeur	foule	doute	GRIMPÉE
grisard	grisaille	doigt	porte	GRISÉ
horlogerie	horloger	matrice	"géant"	HORLOGE
jardinage	"jardinière"	volant	douille	JARDIN
jupette	jupon	broche	landeau	JUPE
laitage	louchet	linge	Ville	LAIT
Ø	lutteur	heure	cadre	LUTTE
loupiote	Ø	garderie	cachot	LOUPE

lunetterie	Ø	proie	"éveil"	LUNETTE
Ø	lutteur	"poussière"	avion	LUTTE
maisonnette	Ø	ventouse	colis	MAISON
matineux	"matinée"	poussin	plage	MATIN
Ø	"mentonnière"	sable	pluie	MENTON
muret	muraille	landeau	foule	MUR
ondine	ondoiement	soie	fumeur	ONDE
onglet	"onglée"	sabot	croute	ONGLE
oreillette	oreillard	gomme	crible	OREILLE
parquetage	parqueterie	tympan	larve	PARQUET
patinage	patinoire	crible	proie	PATIN
"pêcherie"	"pêcheur"	griffe	"étage"	PÊCHE
peignoir	peignerie	feu	voix	PEIGNE
plafonnier	Ø	rayon	houette	PLAFOND
planchette	plancher	gifle	sang	PLANCHE
Ø	pliage	"poignée"	avion	PLIE
plissage	plissure	boucaut	nage	PLISSÉ
plombage	plomberie	morse	croute	PLOMB
"plongée"	Ø	"poupée"	timbre	PLONGE
plumule	plumeau	montre	rappel	PLUME
pochette	poissonière	cadence	couteau	POCHE
poissonier	Ø	"mélange"	champ	POISSON
poivron	"poivrière"	monde	soie	POIVRE

pommeraie	pommier	"poussière"	louage	POMME
pontage	Ø	limbe	nuit	PONT
poulette	poulailler	nappe	sabot	POULE
"rêvasseur"	"rêverie"	jour	langue	RÊVE
Ø	robinetterie	sabot	poussette	ROBINET
"rotondité"	Ø	"ruchée"	pantin	ROTONDE
rouillure	roulette	jument	impot	ROUILLE
rouleau	Ø	"mélange"	feinte	ROULÉ
Ø	rouvraie	fleuve	voix	ROUVRE
ruelle	Ø	valence	poil	RUE
savonnier	savonnette	stylo	jument	SAVON
Ø	sondage	"poupée"	doute	SONDE
Ø	sottise	poumon	nappe	SOT
Ø	talonnette	gilet	fuite	TALON
tamisage	tamiserie	meuble	bougie	TAMIS
tapissier	tapisserie	cadeau	viande	TAPIS
toilerie	Ø	fuite	coeur	TOILE
tuilerie	tuilier	tresse	fumeur	TUILE
Ø	vendeur	tige	colis	VENTE
verrier	Ø	poids	"clé"	VERRE
vitrerie	Ø	poussette	tiroir	VITRE

PRACTICE ITEMS	DUMMIES
SAUT	FOULARD
CLOCHE	GORGE
MAILLE	FOURRURE
POUTRE	
SONNERIE	
GAUFRE	
COUSSIN	
BUIS	
DOUANE	
ROND	

APEENDIX F: DESCRIPTIVE STATISTICS TABLES

Experiment 1: Mean Response Latencies on Correct Trials (ms), Standard Deviations (ms), and Percentage (derivational morpheme).

	Type of Prime					
Groups	Identity		Morphological		Unrelated	
	RT	% Correct	RT	% Correct	RT	% Correct
	High Frequency					
L1	567(118)	100(0)	578(132)	100(0)	628(103)	97(8)
L2	534(133)	90(17)	599(102)	97(8)	611(71)	89(22)
LA	649(136)	94(12)	665(127)	86(15)	647(127)	82(22)
	Low Frequency					
L1	613(130)	72(31)	681(154)	78(28)	749(183)	87(13)
L2	643(129)	83(15)	714(179)	72(29)	720(171)	58(27)
LA	772(149)	70(25)	810(156)	65(32)	844(215)	61(28)

Experiment 1: Mean Response Latencies on Correct Trials (ms), Standard Deviations (ms), and Percentage (inflectional morpheme).

	Type of Prime					
	Identity		Morphological		Unrelated	
Group	RT	%Correct	RT	%Correct	RT	%Correct
			High Frequency			
L1	558(104)	97(9)	578(130)	97(8)	575(88)	100(0)
L2	531(81)	96(9)	562(77)	100(0)	587(101)	98(7)
LA	670(113)	95(14)	663(142)	93(12)	669(106)	98(7)
			Low Frequency			
L1	569(101)	97(7)	604(175)	94(10)	593(129)	100(0)
L2	541(110)	96(9)	594(118)	98(7)	694(93)	95(9)
LA	697(173)	100(0)	697(114)	91(18)	705(102)	97(7)

Experiment 2: Mean Response Latencies on Correct Trials (ms), Standard Deviations (ms), and Percentage-(inflectional morpheme).

	Type of Prime							
	Identity		Morphological		Unrelated		Orthographic	
	High Frequency							
	RT	% correct	RT	% correct	RT	% correct	RT	% correct
L1	557(107)	99(.03)	562(128)	99(.03)	620(166)	99(.07)	581(81)	100(.0)
EL2	590(93)	97(.07)	609(103)	95(.12)	651(107)	98(.05)	619(117)	98(.05)
LL2	622(135)	97(.08)	664(139)	96(.08)	678(177)	89(.15)	692(133)	95(.11)
LA	595(116)	94(.10)	603(147)	93(.10)	647(145)	85(.12)	624(194)	88(.17)
	Low Frequency							
L1	571(127)	98(.06)	614(115)	99(.05)	642(130)	96(.07)	611(106)	97(.06)
EL2	597(117)	89(.14)	635(113)	95(.09)	660(129)	89(.13)	654(114)	82(.19)
LL2	642(140)	88(.15)	671(122)	85(.20)	735(199)	83(.16)	710(149)	81(.22)
LA	609(169)	72(.19)	643(150)	78(.17)	670(132)	78(.21)	627(197)	78(.19)

Experiment 2: Mean Response Latencies on Correct Trials (ms), Standard Deviations (ms), and Percentage-(derivational morpheme)

	Type of Prime							
	Identity		Morphological		Unrelated		Orthographic	
	High Frequency							
	RT	% correct	RT	% correct	RT	% correct	RT	% correct
L1	573(122)	99(.03)	651(152)	97(.06)	661(104)	96(.07)	638(185)	98(.06)
EL2	643(132)	96(.09)	641(118)	89(.11)	671(158)	89(.17)	681(144)	90(.12)
LL2	738(156)	80(.21)	707(152)	83(.20)	738(145)	86(.19)	717(175)	77(.29)
LA	637(141)	70(.18)	653(166)	74(.21)	699(253)	72(.22)	612(163)	65(.19)
	Low Frequency							
L1	695(207)	91(.11)	671(192)	82(.21)	746(146)	79(.16)	688(168)	85(.20)
EL2	689(191)	64(.24)	743(187)	68(.23)	767(219)	63(.28)	728(168)	62(.26)
LL2	747(181)	52(.17)	775(222)	67(.27)	836(229)	65(.26)	806(268)	58(.29)
LA	702(283)	54(.25)	689(242)	56(.25)	699(212)	48(.23)	657(163)	46(.30)

Experiment 3: Mean Response Latencies on Correct Trials (ms), Standard Deviations (ms), and Percentage.

	Type of Prime							
	Congruent		Incongruent		UnrelatedCong		UnrelatedInc	
	High Frequency							
	RT	% Corrrect	RT	% Correct	RT	% Correct	RT	% Correct
L1	814(184)	89(.14)	785(166)	94(.08)	798(179)	91(.12)	827(178)	88(.09)
EL2	916(284)	81(.16)	934(305)	79(.12)	957(308)	76(.11)	943(300)	83(.11)
LL2	794(294)	77(.14)	812(271)	85(.11)	814(226)	74(.14)	771(204)	75(.10)
LA	633(139)	73(.11)	664(122)	80(.09)	696(157)	68(.15)	713(145)	75(.13)
	Low Frequency							
L1	823(238)	90(10)	871(215)	82(16)	886(198)	84(12)	872(177)	84(12)
EL2	965(298)	72(20)	946(303)	73(18)	959(281)	71(15)	981(297)	72(15)
LL2	823(261)	69(19)	767(187)	75(17)	775(217)	79(13)	777(183)	75(14)
LA	638(147)	64(18)	671(174)	72(14)	717(174)	71(17)	685(173)	75(12)

APEENDIX G: T-TEST RESULTS FOR EXPERIMENT 2

Experiment 2: T-test Results for Lexical Decision (RTs) on Morphological and Orthographic Effects

	Type of Priming Effect			
	Morphological Effect- INFL	Morphological Effect- DERV	Orthographic Effect- INFL	Orthographic Effect- DERV
L1 vs. EL2	$t(47) = .54$, $p = .59$	$t(47) = .49$, $p = .62$	$t(47) = .74$, $p = .46$	$t(47) = .86, p = .39$
L1 vs. L2	$t(82) = .46$, $p = .65$	$t(82) = .38$, $p = .71$	$t(82) = .82$, $p = .42$	$t(82) = .37$, $p = .71$
EL2 vs. LA	$t(40) = .07$, $p = .95$	$t(40) = .03$, $p = .97$	$t(40) = .39$, $p = .70$	$t(40) = .99, p = .33$
L1 vs. LL2	$t(40) = .17$, $p = .87$	$t(40) = .06, p = .95$	$t(40) = 1.16$, $p = .25$	$t(40) = .39, p = .70$

APEENDIX H: ON-SCREEN INSTRUCTIONS FOR EXP 1 & 2

1-Dans cette expérience, vous allez voir plusieurs mots. Les mots seront montrés un à la fois. Appuyez sur la touche Z, si vous pensez que le mot est un mot du Français correct. Appuyez sur la touche / si vous pensez que le mot n'est pas un mot correct de la langue française. Veuillez répondre aussi rapidement et précisément que vous le pouvez. Appuyez sur la barre espace pour commencer les essais de la pratique.

2-C'est assez de pratique pour le moment. Si vous avez des questions, veuillez demander à votre expérimentateur. Lorsque vous êtes prêt, appuyez sur la barre espace pour commencer.

3- Il est temps de faire la première pause. S'il vous plaît se détendre. Lorsque vous êtes prêt, appuyez sur la barre espace pour commencer la section suivante.

4-Il s'agit de votre deuxième pause. S'il vous plaît se détendre à nouveau. Lorsque vous êtes prêt, appuyez sur la barre espace pour commencer la section suivante.

5-Félicitations! Vous avez fini! Merci d'avoir pris part à cette expérience. S'il vous plaît appelez votre expérimentateur.

APEENDIX I: ON-SCREEN INSTRUCTIONS FOR EXP 3

1-Dans cette expérience, vous allez voir plusieurs mots. Les mots seront montrés un à la fois. Appuyez sur la touche Z, si vous pensez que le mot est un mot du genre feminin. Appuyez sur la touche / si vous pensez que le mot est du genre masculin. Veuillez répondre aussi rapidement et précisément que vous le pouvez. Appuyez sur la barre espace pour commencer les essais de la pratique.

2-C'est assez de pratique pour le moment. Si vous avez des questions, veuillez demander à votre expérimentateur. Lorsque vous êtes prêt, appuyez sur la barre espace pour commencer.

3- Il est temps de faire la première pause. S'il vous plaît se détendre. Lorsque vous êtes prêt, appuyez sur la barre espace pour commencer la section suivante.

4-Il s'agit de votre deuxième pause. S'il vous plaît se détendre à nouveau. Lorsque vous êtes prêt, appuyez sur la barre espace pour commencer la section suivante.

5-Félicitations! Vous avez fini! Merci d'avoir pris part à cette expérience. S'il vous plaît appelez votre expérimentateur.