Episodic Memory Use in L2 Vocabulary Processing

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Acknowledgments

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Abstract

The experiment discussed in this paper is a direct replication of Finkbeiner (2005) and an indirect replication of Jiang and Forster (2001) and Witzel and Forster (2012). The paper explores the use of episodic memory in L2 vocabulary processing. By administering an L1 episodic recognition task with L2 masked translation primes, reduced reaction times would suggest L2 vocabulary storage in episodic memory. The methodology follows Finkbeiner (2005) who argued that a blank screen introduced after the prime in Jiang Forster (2001) led to a ghosting effect, compromising the imperceptibility of the prime. The results here mostly corroborate Finkbeiner (2005) with no significant priming effects. While Finkbeiner discusses his findings in terms of the dissociability of episodic and semantic memory, and discounts Jiang and Forster's (2001) results to participants' strategic responding, I add a layer of analysis based on declarative and procedural constituents. From this perspective, Jiang and Forster (2001) and Witzel and Forster's (2012) results can be seen as possible episodic memory activation, and Finkbeiner's (2005) and my lack of priming effects might be due to the sole activation of procedural neural networks. Priming effects are found in concrete and abstract words but require verification through further experimentation.

1 Introduction

1.1 Aim

This paper explores the use of episodic memory in adult L2 vocabulary processing. By administering a primed episodic recognition task, it can be determined if parts of the L2 vocabulary are stored in that memory system.

The experiment conducted here is a direct replication of Finkbeiner (2005) and indirectly based on Jiang and Forster (2001) and Witzel and Forster (2012). In all three pieces, the researchers execute an episodic recognition task in which a masked (imperceptible) L2 prime precedes L1 targets. Because the L1 vocabulary items were processed in episodic memory, the presence of priming effects would suggest that the L2 words are at least partially stored in episodic memory as well. Both Jiang and Forster (2001) and Witzel and Forster (2012) found priming effects in their studies. However, as will be discussed in the literature review, Finkbeiner (2005) questions the masked nature of the prime in Jiang and Forster (2001), thereby tweaking the procedure in his experiment, which resulted in the disappearance of the priming effects. Because Witzel and Forster (2012) replicate Jiang and Forster (2001) without heeding Finkbeiner's critique, a verification of Finkbeiner's results is in order.

This paper does not only serve to replicate Finkbeiner (2005); it also contributes to the literature in additional ways. For one, all three sets of authors approached their analyses from a psychology perspective with the intent of proving/disproving the separate memory systems account. By assuming a Second Language Acquisition (SLA) stance, the L2 becomes less of a means to an end and more the object of study. Likewise, while their discussions understandably revolve around research on memory, mine will also incorporate more SLA-slanted theory, namely declarative and procedural constituents of L2 processing.

Moreover, the current experiment has included a word familiarity questionnaire in order to verify that a lack of priming effects cannot be attributed to gaps in participants' vocabulary knowledge. Finally, a post-hoc analysis was conducted on the additional variable of word concreteness. I will elaborate on these developments in the literature review and procedure sections.

1.2 General background and implications

A longstanding question in the SLA literature has dealt with whether the L1 and L2 are represented and processed similarly in bilinguals (Dussias & Piñar, 2009; Pienemman, 1998; VanPatten & Jegerski, 2010). While studying such a question fosters a deeper understanding from the perspective of the philosophy of language, it also holds significant benefits for language pedagogy. Various approaches to language teaching have operated along the premise that replicating the L1 learning environment most effectively spurs L2 acquisition (Andrews, 2007; Cook, 2009; Ellis, 1994; Ferris & Hedgcock, 2005; Leki, 1992; Matsuda, 2003). Consequently, investigating both the particularities of non-native language acquisition and the cognitive relationship between the L1 and L2 can inform language pedagogy practices. In this case, some theorists have argued that long-term memory use differs between native and non-native language processing which forms a foundation for this study (N. Ellis, 2005; Paradis, 1994, 2004, 2009; Rastelli, 2014; Ullman, 2001). As a facet of the SLA literature, declarative and procedural memory use will be reviewed and incorporated into the analysis of the results. While the authors cited above do not agree in every aspect, they all grapple with how these memory systems process the L1 and L2 and stress that further research in this area would benefit language teaching practices. A much less studied distinction to be addressed in this paper is that of episodic and semantic memory, the two subcomponents of the declarative system. While this distinction has been neglected in SLA, I argue that a greater understanding here would also hold implications for the language classroom. In one sense, studies in this area might point to yet another difference between L1 and L2 long-term storage and processing. In another sense, as characteristics of particular stimuli aid in encoding memories in one but not the other, such advances could directly translate into activity and syllabus planning.

To these ends, this paper will not answer all the pertinent questions with regard to episodic memory use and L2 acquisition. Nevertheless, one of its goals lies in exploiting a chasm in the field with the hopes of stimulating more research in this direction. In order to fill this space, more nuanced research is needed on long-term memory in L2 and L3 acquisition.

Short-term memory has currently received its fair share of attention, but in reality all three memory types associate within human physiology and cannot be separated (Gass & Lee, 2011; Mackey et al., 2002; Service et al., 2002; Williams, 2012). In Robinson's (2007) model of language processing through the memory systems, long-term memory is reduced to a single component with no mention of the intricacies of declarative, procedural, episodic, or semantic subdivisions. In essence, I am first acknowledging the existence of memory systems as schematized within the cognitive sciences and second, building upon that foundation with the application of developments in SLA.

From another angle, and as will be expanded upon in later sections, this paper both problematizes how vocabulary/lexicon is understood from a memory perspective and that rule computation in areas like phonology and morphosyntax cannot be taken for granted as exclusively procedural processes. The goal here is not to develop theory or even substantiate the claims made by other authors, but rather to implement their ideas in the analysis of data. By considering multiple views on cognitive processing, I hope to avoid a one-track explanation and open up discussions on what the results might entail for the psychology and SLA literature.

1.3 Outline

The paper will be organized as follows. After this introduction, the literature review will briefly cover four elements integral to the development of the argument. First, a discussion of human memory will preface the reviewed studies and introduce most relevant terminology. The next section will explore theoretical interpretations of how L2 acquisition depends on declarative and procedural memory systems. As mentioned previously, results will be analyzed from a declarative/procedural perspective. Moreover, because long-term memory, particularly episodic and semantic systems, receives so little attention in SLA, the most prevalent theorizing in this area must be covered to assess its trajectory. The third literature review section will delve into those studies that have in fact considered episodic and semantic memory and language. While they set the stage for the three replicated studies, they only focus on mother tongue processing. Finally, I will specifically review the three studies to be replicated so as to point out those elements carried over to this study or critiqued.

The literature review will be followed by the research questions, hypotheses, and predictions. This section will directly relate to the three replicated articles.

The procedure section will then emphasize those methodological decisions that set this study apart from its predecessors as well as the general means of investigation. Participants, testing specifics and conditions, and variables controlled for will fill out this section.

Relevant results will be presented next, followed by a discussion of those results and conclusions. Limitations and further avenues of research will precede the conclusion section.

2 Literature review

2.1 Human memory

This first part of the literature review will explore contemporary views on human memory systems. I will highlight that information that must be considered when designing an experiment and analyzing results. In addition, I will mention what questions remain with regard to memory operations and design, for this study has a role to play in addressing those questions.

At the broadest level, memory consists of three distinct types, sensory, short-term, and long-term memories. The first, sensory memory, associates with perceptive functioning. The brain temporarily stores visual, auditory, olfactory, gustatory, and tactile stimuli that do not transfer into short-term memory (Galotti et al., 2010). While researchers have studied each of these independently, I will only visit visual perception here as it pertains to Finkbeiner's (2005) critique of Jiang and Forster's (2001) masked prime. Neisser (1967) termed the visual stimulus stored in sensory memory the icon (see Irwin & Thomas, 2008; Massaro & Loftus, 1996, for critical overviews). Starting with Sperling (1960), many studies have revealed that humans can recall random letter combinations if prompted immediately, but only one second later, that capacity substantially declines. Another piece of evidence in favor of the existence of the icon is the visual system's perception of a brief stimulus even after it has disappeared, such as a lightning strike in a dark sky or a letter combination on a bright screen. In the case of a letter string, as Sperling (1960) showed, if no association can be formed to existing memories, the brain will quickly discard the information. Whereas if a known word is displayed followed by a blank screen, as Jiang and Forster (2001) did, it is possible that the participant can associate the perceived form with the meaning stored in long-term memory (Thompson & Madigan, 2005).

Also with a temporary capacity, short-term memory allows individuals to recall information without needing to encode it with a more durable trace. In remembering a few digits, for instance, those numbers will either decay with time or be replaced by new incoming information (Cowan, 2008). In the brain, although multiple zones facilitate the various processes of the system, the cortex is considered to be a significant source of short-term processing (Plotnik & Kouyoumdjian, 2014). While researchers cannot agree on how to measure its capacity (Surprenant & Neath, 2009), short-term memory lasts approximately twenty seconds or holds about seven items (Sprenger, 1999). For the purposes of this paper, the most important point of consideration here is the dissociation between short- and long-term systems (Lustig et al., 2009). Multiple studies of brain-injured patients have revealed that each system appears to function normally independent of the other (Baddeley & Warrington, 1970; Olson et al., 2006; Scoville & Milner, 1957; Shallice & Warrington, 1970; Vallar & Papagano, 2002). Therefore, with this study's focus on long-term memory, results will be analyzed based on the information covered in the next paragraphs.

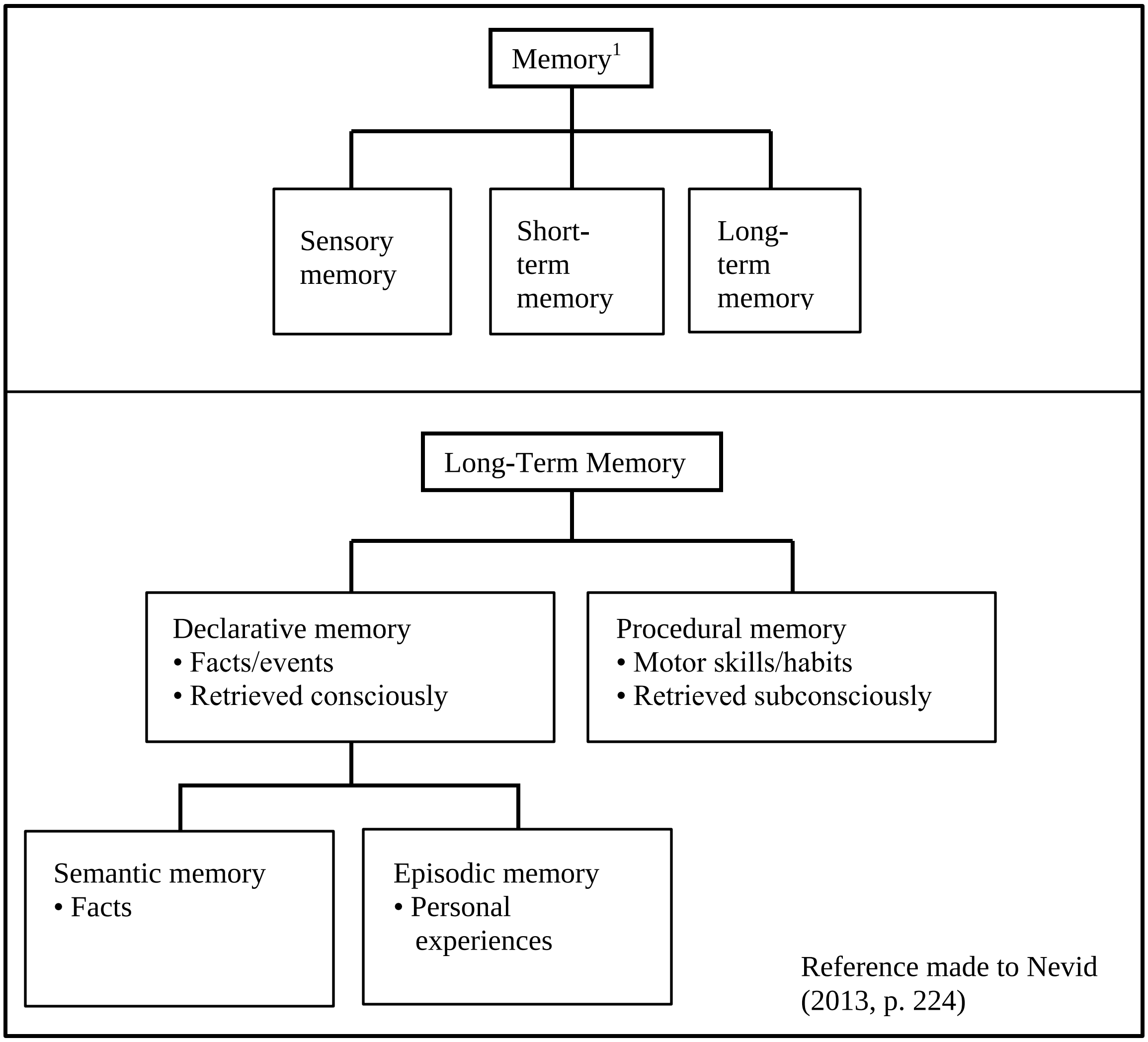
Long-term memory refers to the encoding, storage, and retrieval of knowledge or experience that remains accessible beyond the threshold of short-term memory. While experts continue to debate the interaction between short- and long-term memory (Thorn & Page, 2009), the process of consolidation refers to the transformation of fleeting traces into durable neural pathways (Schacter, 1996). Long-term memory consists of two possibly independent systems, known as declarative and procedural memory. That which is stored in the declarative system is consciously accessible. Facts, personal experiences, and linguistic forms therefore reside in this system (Squire et al., 2004). The hippocampus and parahippocampal region provide the anatomical foundation for the processing of this knowledge (Eichenbaum, 2003). Conversely, the procedural system underlies the formation of habits, conditioning, subconscious priming, and certain rule computations (Eichenbaum & Cohen, 2001; Johnson, 2003; Squire & Knowlton, 2000). Therefore, so-called muscle memory and learning to play a sport are two examples of practices rooted in procedural memory. In most cases, the striatum and cerebellum store and process the neural bundles at the core of these subconscious memories.

As for the relationship between language and conscious and subconscious access to knowledge stores, I will integrate that discussion into the following literature review section. Before moving on, one more distinction must be made in this schema of long-term memory.

Although experts do not agree as to their level of dissociation, episodic and semantic memory together form the declarative system (see Figure 1). The subdivision of conscious long-term memory is credited to Tulving with his discovery in 1972. He proposed the existence of an additional declarative memory store that functions separately from Collins and Quillian's (1969) purported semantic memory (Hasselmo, 2012). The psychology community internalized the concept of episodic memory about two decades after Tulving's breakthrough with the publication of Squire's (1987) taxonomy of human memory. In essence, semantic memory stores general knowledge about the world, such as remembering that the capital of China is Beijing. Crucially, however, the brain does not associate with the memory spatiotemporal attributes from when the knowledge was learned (Moscovitch et al., 2005; St. Jacques & Cabeza, 2012). On the other hand, episodic memories are characterized by the intact nature of the learning context as part of the memory trace (Peacocke, 2001). As a result, episodic memory is used for reliving events, also known as autobiographical memories (Emilien et al., 2004; Wheeler et al., 1997), mental time travel (Emilien et al., 2004), and spatial, temporal, or sensory associations linked to an incident of learning (Yee et al., 2013).

Tulving's work prompted an intellectual debate over the separate memory systems

Figure 1. Schema of memory detailing the subcomponents of long-term memory



account. The question at play dealt with the extent to which, if at all, semantic and episodic memory operate independent of each other. Yee et al. (2013) provide a sensible overview of where the psychology literature currently stands. First of all, brain scans reveal that the type of

[1] This three-pronged schema does not capture the complexity of the general structure of human memory that some authors call for. For one, some experts have proposed that each sense processes stimuli along independent memory tracks (Galotti et al., 2010). And second, short-term and working memory, while often used interchangeably, are not always understood as physiologically equivalent (Tehan & Mills, 2007).

memory in use affects which parts of the brain are activated, demonstrating that one can in fact speak of two declarative systems. While not understood fully, the hippocampus appears to facilitate access to all episodic memories with support from the neocortex (Gilboa et al., 2004; Maguire et al., 2001; Rekkas & Constable, 2005; Ryan et al., 2001, 2008). In contrast, semantic memory also relies on the temporal lobes (Chertkow et al., 2008). Many authors have concluded through neuroimaging studies that episodic and semantic memory are distinct but overlapping (Buckner, 2000; Cabeza & Nyberg, 2000; Groome, 2006; Hays, 2006; Levine et al., 2004; Nyberg, 1998; Nyberg, 2002; Weiten, 2013). At the same time, brain scans employed during lexical and semantic tasks reveal particular reliance on the temporal lobes (Barrett & Rugg, 1989; Martin et al., 1996; Nobre et al., 1994; Simos et al., 1997). Studies of patients have explored what memory types are affected when specific brain areas have been damaged. Researchers have studied patients with semantic dementia (Bozeat et al., 2000, 2002a, 2002b, 2004; Funnell, 1995, 2001; Graham et al., 1997, 1999; Hodges et al., 1992; Patterson et al., 2006; Rogers & Patterson, 2007; Snowden et al., 1989, 1994, 1996, 1999, 2001), posterior aphasia (Alexander, 1997; Farah & Grossman, 1997; Goodglass, 1993), and medial temporal lobe amnesia (Zola, 1997), as well as children with amnesia (Bindschaedller et al., 2011; Gabrieli et al., 1988; Gardiner, 2008; O'Kane et al., 2004; Vargha-Khadem et al., 1997). A case study of K.C., who had suffered damage to the hippocampus, could remember general knowledge, but not spatiotemporal associations to the learning experiences themselves (Rosenbaum et al., 2005). Another case study of a patient whose hippocampus remained unaffected showed opposite results, with at times the inability to recall the meanings of words (DeRenzi et al., 1987).

In their synthesis of the literature, Yee et al. (2013) remain fairly conservative. They recognize that the evidence points to the existence of two declarative subsystems, episodic and semantic memory. However, due to their partial reliance on similar brain structures, it is a challenge to cleanly separate them. Yee et al. present the issue of whether episodic and semantic memory share an interface in the form of a debate. They first mention the need to draw conclusions carefully. When studies focus on brain-damaged patients, just because a system can function independently of another does not mean that brain-intact individuals do not use them together. With this caveat in mind, plenty of authors have strongly argued either for or against the presence of an interface (Emilien et al., 2004; Graham et al., 2000; Nadel & Moscovitch, 1997; O'Keefe & Nadel, 1978; Ryan, Hoscheidt, & Nadel, 2008; Simmons et al., 2001; Squire & Zola, 1998). Another debate in this area concerns whether the association of general knowledge to an episodic memory can act as an enhancement tool (Baars & Gage, 2010; Graham et al., 1999; Goldstein, 2011; Snowden et al., 1996; Westmacott & Moscovitch, 2003; Westmacott et al., 2004). In yet another view, Eichenbaum (2002) posits that in some cases, the brain uses an episodic memory first which can then develop into a semantic memory. Because, as an individual is exposed to the same general knowledge on multiple occasions, the spatiotemporal associations from any one instance may collapse into a single semantic memory, these arguments appear quite rational.

We are therefore left with a few relevant points. Those who argue against an interface between semantic and episodic memory base their claim on the capabilities of brain-damaged individuals, therefore overlooking the possibility of compensation for the impaired zone. On the other hand, while an interface between the two systems appears to be a rational proposition, the strength of that connection remains unknown.

This section on the workings of human memory provides a framework for both what remains of the literature review and the presentation of the study itself. Some of the points highlighted in this discussion will also form a basis for the analysis of results. First, the characteristics of sensory memory might underlie the difference between a successful and unsuccessful masked prime. The icon, or extended perception of a visual stimulus, coupled with a real-word, meaningful, prime, can result in the activation of declarative memory (Neisser, 1967). Second, because the access to or verbalization of long-term memory does not rely on its short-term counterpart, I can explain participants' performance solely based on long-term memory determinants and neural networks (Lustig et al., 2009). In the case of long-term memory, the dissociation between the procedural and declarative systems will motivate a significant portion of the analyses in this paper (see *section 6.2*). While the complexity of cognitive processes currently inhibits authors from treating most findings as fact, it is fair to say that declarative and procedural memory occupy their own niche and can thus be separated in most analyses (Anderson, 1993; Feeney & Roberts, 2012; Sherry & Schacter, 1987). The subdivision of declarative memory into semantic and episodic components, however, is much less agreed upon. In their synthesis of the literature, Yee et al. (2013) point out that while certain brain structures underlie both systems, the discipline of psychology has internalized their responsibility for storing distinct memories. In the discussion section of this paper, I will at one point incorporate the rational argument that spatiotemporal associations can enhance preexisting semantic memories or lay the groundwork for their development (Eichenbaum, 2002; Goldstein, 2011).

2.2 Declarative and procedural constituents of L2 processing

This section of the literature review will explore those SLA pieces that consider the distinction between declarative and procedural memory. This review is necessary as results from the experiment can be understood through this lens. However, these chapters and articles neglect the further subdivision of the declarative system which I argue holds valuable insights into the L2 development process. In addition, the highly theoretical nature of the authors' conjectures, except when referencing studies of brain-damaged individuals, illustrates the need for L2 experimentation that respects the categorization of long-term memory.

I will outline the most relevant perspectives from a variety of authors in the field. In some, declarative and procedural memory are the center of attention, while in another, views on language development appear to reflect the distinction, but the author employs other terms. In this case, a reference to progress in the psycholinguistic literature might have served the theorizing well.

I begin with one of the earlier views on L2 development in which the author forms two distinctions that in some ways resemble the declarative/procedural division. Krashen (1982) argued that one could classify episodes of L2 development as either learning or acquisition. In a similar vein, he put forward the additional distinction between a student's implicit development and that learning which occurs explicitly.

Starting with the learning/acquisition divide, Krashen likens acquisition in adults to the way children acquire their L1, in which "language acquirers are not usually aware of the fact that they are acquiring language" (p. 10). Here he points to the subconscious nature of acquisition, where "errors feel wrong, even if we do not consciously know what rule was violated" (p. 10). This explanation could have been pulled directly from a description of procedural memory. On the other hand, Krashen links learning to the conscious awareness of rules, and "being able to talk about them," the determining factor of declarative memory (p. 10).

The second distinction, that of implicit and explicit learning, draws on very similar reasoning. While implicit development occurs subconsciously, explicit learning is noticed and can thus be explained. Krashen's clear endorsement for the implicit type demonstrates his preference for treating adult L2 acquisition as if it did not differ from the L1 acquisition process.

What is lacking from these claims is a more sophisticated understanding of language within long-term memory, pointing to the importance of that element in L2 acquisition. First of all, Krashen treats procedural memory ("acquisition") as the only system worth cultivating. We will see later that both the L1 and adult-learned L2's rely on declarative and procedural memory stores (Ullman, 2008). Second, he develops his entire argument around the premise that infants and adults learn languages in an identical manner. However, the literature on long-term memory and language use indicates that level of cognitive maturity impacts how much the individual calls upon each of the two systems (Rastelli, 2014). Therefore, the fact that children cannot express the underlying rules of their mother tongue should not be taken as a suggestion that adult L2 learners necessarily avoid opportunities for explicit instruction. A survey of the literature on the phenomenon of fossilization will reveal that adult learners differ from mother tongue speakers in their level of ultimate attainment, particularly in the realms of morphosyntax and phonetics (Franceschina, 2005; Han, 2012; Lardiere, 2006). Curiously, even though his arguments would benefit from a reflection on the workings of memory, the word itself, memory, only appears twice in the entire book.

Moreover, Krashen's overt concentration on grammatical rule processing needs to be addressed. When one views language acquisition from a long-term memory perspective, the complexity of other components of language, such as vocabulary and phonetics, becomes clearer. While a word's form must exist as a declarative memory trace, do rule-based operations (allophonic/argumentative information) not accompany vocabulary knowledge (Paradis, 2009)?

Krashen also downplays the value of output in the L2 learning process. If the memory literature were consulted here, the concept of consolidation would emerge as a support piece for the pursuit of opportunities for output (Dehn, 2010). From the declarative/procedural perspective, Paradis (2004, 2009) argues for a dissociation between the two in which neural networks rarely, if ever, traverse the divide. From this approach, declarative memory-generated output could be viewed as additional input in the learner's attempt to proceduralize L2 processing.

This critique of Krashen (1982) has attempted to illustrate the value of a long-term memory perspective to L2 acquisition theory. In fact, most critical works on Krashen themselves ignore long-term memory as a point of evaluation (Gass & Selinker, 2001). The lack of attention paid to such a crucial component of language development exposes one of the gaps in the literature this paper aims to investigate. The remainder of this section will explore those contemporary pieces that do in fact draw a link between the intricacies of long-term memory and psycholinguistics.

One of the first models of language storage and processing to incorporate the declarative/procedural distinction comes from Ullman (2001, 2005, 2008). He is also unique in the respect that he has supported the model with experimentation on brain-intact individuals. However, as we will see, experimentation in this area presents a formidable challenge. We will also see that some of Ullman's points are well accepted while others clash with the authors to be reviewed later.

The foundation for this model lies in the contention that both declarative and procedural systems underlie language processing. The least controversial assertion, that of form-meaning relationships, posits that a word form must exist in declarative memory in order to be verbalized by the speaker. Other arguments require more experimental backing. For example, Ullman draws a clear line between the mental grammar/rule processing and the mental lexicon. I have written previously that the commonsense view of the lexicon as a one-dimensional, rule-independent structure, must be challenged in the literature. As Broccias (2008) highlights, if the motivations for extended senses of meanings are unknown to linguists, how could the knowledge of meanings be subsumed exclusively by the declarative system in a native speaker? The final argument worth mentioning here stems from Ullman's distinction between productive and unproductive morphology. In essence, one can consider regular morphology (*walk*, *walk-ed*) as productive because the speaker's rule system can subsequently produce the correct derivational form from the root. On the other hand, because speakers must memorize irregular forms (*go*, *went*), the mental grammar cannot apply a rule to the base form. In this model, particularly in native speakers, productive rules are stored in the procedural system to be applied to an existing form while unproductive irregulars are memorized in declarative memory.

Ullman, as well as other authors, asserts that the declarative system can compensate for procedural deficiencies and memorize any regular finite forms. Moreover, if that system has stored the rule itself, speakers might be capable of performing computations there. This schema would most often pertain to adult L2 learners. What Ullman does not consider, and Paradis (1994, 2005, 2009) does, is the possibility for irregular/unproductive forms to eventually automatize. Why a rule that concerns hundreds of forms differs from a rule that concerns only one in terms of storage and processing is not addressed. In the same vein, even if word forms must be consciously accessible, why must all related lexical information also be stored in declarative memory?

Ullman's concentration on long-term memory in his approach to psycholinguistics has provided a valuable springboard in the literature. It has become clear, however, that the distinction between episodic and semantic memory is noticeably absent. In addition, Ullman's supporting experimentation focuses solely on single words that can undergo morphological transformations. In this way, he separates vocabulary and grammar while controlling for other factors. Unfortunately, this approach leaves not only additional components of language unattended, but also removes the contextuality of authentic language use.

Nick Ellis (2005) attempts to develop a comprehensive model of L2 acquisition and, in doing so, grapples with issues like consciousness, explicit and implicit learning, and long-term memory. His view on proceduralization directly relates to our treatment of the underlying systems responsible for L2 processing. Ellis writes that proceduralization is the "tally[ing of] the likelihoods of occurrence of constructions and the relative probabilities of their mappings between aspects of form and interpretations" (p. 306). Therefore, the more the learner perceives a given construction, whether native-like or target-deviant from a non-native speaker, the more proceduralized it becomes. Crucial to this account is that the tallying mechanism resides in procedural memory and that an interface, consciousness, links it to the verbalization mechanism. Ellis himself calls for more research in this avenue of SLA, implying that psycholinguistic perspectives on L2 processing are not trivial.

Three of Paradis's works (1994, 2005, 2009) focus solely on the development of a declarative/procedural model of SLA. Once again, the source of evidence stems almost exclusively from brain-damaged patients, opening up for debate his contention that declarative and procedural memory operate independently with no interface. Here I will touch on his account of form-meaning pairings and rule processing.

While Paradis concedes that word forms must be consciously accessible, he argues that subconscious knowledge accompanies word-level productions. His distinction relies directly on the unique roles of the two long-term memory systems. He classifies one's vocabulary as word-level knowledge stored in declarative memory and one's lexicon as the accompanying subconscious knowledge computed in procedural memory. Examples Paradis provides of underlying lexical information include the transitive status of a verb and collocations. Even though these attributes only "feel" right or wrong on the speaker's tongue, the SLA literature usually excludes them as instances of syntactic computation.

In addition, Paradis's work problematizes SLA experimentation that attempts to determine when a learner has automatized a rule. Various authors allude to the debate in their publications, making it clear that systems of evaluation are predicated on arbitrary notions, while some have even teased apart conscious and unconscious contributions to processing (Jacoby, 1991; Jacoby et al., 1999; Segalowitz, 2008). Paradis takes the argument one step further by saying that automatization should only refer to processing that occurs within the procedural system, and, due to the imperfect nature of the system (or the input, for that matter), automatized processing does not necessarily signify native-like output. Moreover, Paradis asserts that not only can any computation take place in declarative memory, but with sufficient practice, it can resemble procedural-based reactions/output in speed, accuracy, and effort.

The authors presented so far do not exhaust the work published that reports on declarative/procedural determinants of language phenomena. For example, Bardel and Falk (2007), Falk and Bardel (2011) and Falk, Lindqvist, and Bardel (2015) argue that the L2 status factor in L3 acquisition can be understood in terms of the organization of long-term memory. Because adult-learned languages rely more heavily on declarative memory than a native language does, the L3 can draw more directly on L2 resources. In the most recent of these publications, they explain this phenomenon with regard to the amount of metalinguistic knowledge possessed by the learner. In this case, an individual with an advanced awareness of the underlying rules of his/her L1 can even employ such knowledge in the L3 acquisition process.

Rastelli (2014) and Kotz (2009) apply a long-term memory perspective to the age debate in SLA. They contend that encoding and storage in declarative memory require age-dependent development and that, as a consequence, young learners employ procedural memory to a greater extent.

These authors were not the first to play around with ideas like long-term memory, subconscious learning, and rule processing in language acquisition (Anderson, 1983; Faerch & Kasper, 1984, 1987; O'Malley & Chamot, 1990; Towell & Hawkins, 1994). At the same time, I have not reviewed all contemporary pieces on the matter, although the ideas do not stray far from those outlined here (DeKeyser, 1997; de Jong, 2005; R. Ellis, 2005, 2007). Moreover, I argue that a variety of notions from the SLA literature would benefit from a treatment of the workings of long-term memory: performance versus competence (Brown et al., 1996), noticing and awareness (Robinson et al., 2012), inductive versus deductive teaching (Martínez-Flor, 2008), and the tip-of-the-tongue phenomenon (Ecke, 2008), to name a few.

In this section of the literature review, I have highlighted declarative and procedural constituents of L2 processing. Various conclusions can be drawn that support the trajectory of this paper. First of all, because episodic memory is a subset of the declarative system, it is valuable to recognize that conscious knowledge appears to play a larger role in adult-learned L2's than in one's native tongue. This knowledge store extends beyond the utilization of metalinguistic knowledge as a prime to develop automatized rule processing in procedural memory. Rather, the literature points to the ability for rule processing itself to take place (and speed up) within the declarative system. This notion stresses the need to determine the dynamics of L2 development as a function of semantic and episodic memory. As we have seen, none of these works addresses this distinction, leaving the only experimentation in this avenue to psychologists (see *section 2.3*). In addition, the critique of Krashen (1982) aimed to demonstrate that SLA constructs, not only his, might profit from a cognitive science perspective on long-term memory. And finally, I have argued that a one-dimensional, form-meaning view of vocabulary may not suffice when conducting experiments. If procedural knowledge does in fact accompany word-level stimuli, conclusions must take this position into consideration.

2.3 Episodic and semantic memory and language

This section reviews those experiments that employ language as a mechanism to dissect episodic and semantic memory. These studies emerged in response to Tulving's proposal in 1972 of a subdivided declarative memory system. For this reason, their main focus consisted of gaining a more accurate view of how the brain operates, not necessarily of language dynamics. In addition, the use of the L1 in their methodology leaves a considerable gap in the literature for L2-based studies.

Following Tulving's (1972) pioneering work, a fifteen-year debate raged in the psychology literature. Because L1 vocabulary forms, without any study session, constitute semantic knowledge, language became a popular means to research the separate memory systems account. In all the studies, priming effects for episodic recognition tasks were compared to lexical decision tasks. By manipulating the prime, the researchers were able to measure the amount of interference between semantic and episodic memory and in what direction. However, the results from one study to the next did not sketch a neat picture, either substantiating

Tulving’s distinction or disproving it. As a result, contemporary views maintain that the two harbor distinct functions but cannot be entirely dissociated (Yee et al, 2013).

Essentially, in the ’70s and ’80s, experimental results clustered together into two main camps, one that argued against dissociation and one that found evidence in favor, which will be covered first. Atkinson et al. (1974), Carroll and Kirsner (1982), Kintsch (1975), Lockhart et al. (1976), Neely and Durgunoğlu (1985), Tulving (1976), and Watkins and Tulving (1975) are examples of studies that obtained priming effects pointing toward a dissociable model of declarative memory.

For instance, Carroll and Kirsner (1982) devised an experiment in which three separate priming variables were analyzed in an episodic recognition task as well as a lexical decision task. In this way, the researchers could compare reaction times between the two tasks as a direct function of the nature of the prime. Their results revealed that semantic relatedness of the prime to the test item only facilitated retrieval in the lexical decision task (semantic memory-based). Because semantic links did not carry over to episodic memory, the authors claimed that neural associations between the two declarative systems were limited at most.

To give another example, Neely and Durgunoğlu (1985) provided their participants with a study list of semantically unrelated word pairings. When asked whether the test items had appeared on the study list (episodic recognition task), one of four prime types preceded each token. In one case, another word from the study list acted as the prime (episodic memory trace) which resulted in a significant reduction in reaction times. However, when a semantically related word preceded the target, reaction times were significantly slower than the neutral prime condition. While Neely and Durgunoğlu considered these results evidence of a dissociation between the subsystems of declarative memory, I would caution this interpretation. The interference of semantic networks on episodic memory recall suggests that neural connections link the two systems.

In contrast to these studies, multiple authors argued that separating episodic and semantic memory was not substantiated by their results (Anderson, 1976; Baddeley, 1976, Lindsay & Norman, 1977; Mckoon & Ratcliff, 1979, 1986; Wikelgren, 1977). In general, the researchers found priming effects that put into question the strict divide between the two subsystems maintained by other authors.

To expand on one of these articles, Mckoon and Ratcliff (1979) provide evidence that illustrates how cross-system priming operates. Participants were asked to respond as quickly as possible to whether or not the flashed letter string constituted a real word. A variety of conditions was used in order to compare reaction times for episodic primes (from the study list, but unassociated semantically), semantic primes (not from the study list, but associated semantically), semantically associated pairs from the study list, and controls (neutral words). In this case, Mckoon and Ratcliff found very similar priming effects in all three test conditions. The most significant result here is that a newly associated pairing from the study list, thus stored in episodic memory, could foster priming effects in a lexical decision task which the participants carry out in semantic memory. For this reason, the authors argue that the brain develops associations between semantic and episodic memory. One limitation here lies in their choice of the semantically unassociated pairings for the episodic condition. In order to facilitate memorization, they chose easy associations that were not collocations (e.g., *city* + *grass*). However, even after only one instance of studying this pairing, a native speaker could encode it into long-term memory via semantic neural networks, possibly undermining the authors' conclusions.

This section has reviewed some of the literature that deals with language and the distinction between episodic and semantic memory. A few pertinent points can be gleaned from this discussion. First, similar to the studies to be replicated in this paper (Finkbeiner, 2005; Jiang & Forster, 2001; Witzel & Forster, 2012), the authors approached their data from a psychology perspective. They interpreted their results not in terms of the cognition of language, but as a weighing in on the debate on memory started by Tulving (1972, 1973) and continued by Posner and Snyder (1975) and Jacoby and Dallas (1981). Moreover, as alluded to in the introduction, if memory use distinguishes L1 from L2 processing, their focus on the mother tongue leaves yet another gap in the literature.

As Yee et al. (2013) explain, the past few decades of experimentation on the makeup of declarative memory have revealed that semantic and episodic memory, while interrelated, perform different functions. The clear division in opinion between the two groups of authors reviewed here most likely stands testament to Yee et al.'s compromising stance.

2.4 L2 and episodic memory – Replicated studies

The literature on the intricacies of L2 storage within declarative memory is sparse. However, three studies will form the basis for a replication in which an episodic recognition task was conducted using L2 primes and L1 targets. These three papers, Jiang and Forster (2001), Finkbeiner (2005), and Witzel and Forster (2012), will be reviewed here so as to preface the procedure of the current study. After those reviews, theories of semantic networks will briefly be touched upon as they are relevant to both these studies and the current paper.

Jiang and Forster (2001) performed multiple experiments, comparing priming direction (L1-L2 vs. L2-L1) and task type (lexical decision vs. episodic recognition). As mentioned above, in the L1, lexical decision tasks stimulate semantic memory while episodic recognition tasks require processing in episodic memory. The authors were surprised to find limited priming effects from the L2 to the L1 in a lexical decision task as it contradicts Kroll and Stewart's (1994) revised hierarchical model. However, other authors have also attested to the lack of priming in these circumstances (Gollan et al., 1997; Grainger & Frenck-Mestre, 1998; Jiang, 1999; Sanchez-Casas et al., 1992). This result made them question if the L2 lexicon is in fact stored alongside the L1 in semantic memory. It therefore prompted them to run an episodic recognition task in the L1 with L2 translations acting as primes.

In their episodic recognition task, Jiang and Forster (2001) had Chinese L1 advanced learners of English study 32 words in their native language (Chinese). In the testing phase, the target stimuli were preceded by a masked prime of an English word (L2). The prime consisted of hash marks (#) for 500 milliseconds (ms), the English word for 50 ms, a blank screen for 50 ms, and a backward mask of hash marks for 150 ms.

The experimental items consisted of four conditions. Of 64 total items, one-quarter (16) had appeared on the study list and were preceded by their English translations. The remaining words from the study list constituted the second condition and were preceded by an unrelated English word. The third and fourth conditions displayed Chinese words not before seen during the experiment. Half of those words were preceded by their English translation while the other half were preceded by an unrelated English word. Conditions three and four acted as fillers, and the comparison of reaction times between the first two conditions was the sought-after statistic in the study.

The results revealed a masked priming effect from an L2 translation in the participants' attempt to recall whether the L1 target had appeared on the study list or not. When the L1 has been studied, the spatiotemporal characteristics of the study session are associated with the word in the participant's episodic memory store. Therefore, when the L2 translation facilitates the retrieval of the memory trace, "the lexical associations between words in L2 and words in L1 must have been represented episodically" (Jiang & Forster, 2001, p. 37). From these findings, Jiang and Forster propose a model in which semantic memory stores form-meaning relationships in the L1 and episodic memory stores L2 forms in addition to spatiotemporal associations.

Due to the implications of these findings for the separate memory systems account and lexical networks in the brain, Finkbeiner (2005) set out to replicate Jiang and Forster's (2001) results. Finkbeiner took issue with one methodological component in their work, rectifying it for his own experiment. As outlined above, Jiang and Forster followed their 50-ms prime with a 50-ms blank screen. Previously in the literature review, I delved into the interaction between sensory and long-term memory. While a prime of only 50 ms is undetectable, a trailing blank screen will most likely foster what Neisser (1967) termed the icon. In his chapter, Finkbeiner refers to this phenomenon as a ghosting effect. The main issue at play lies in the extended exposure to the prime, due to the perceived ghost, of an additional 50 ms. Because Jiang and Forster compiled no qualitative data from their participants regarding the perceptibility of the prime, Finkbeiner argues that it must not be assumed that no conscious processing occurred. If this alternative evaluation of the study is indeed the case, Finkbeiner asserts that the conclusions must consider the possibility of strategic responding on the part of the participants, not necessarily that the L2 lexicon is stored in episodic memory.

Finkbeiner's modified prime presentation ensured the imperceptibility (masked prime) of the English word. Specifically, he employed a forward mask of hash marks for 500 ms, the prime for 50 ms, and a backward mask for 150 ms. Therefore, the only difference between this prime presentation and Jiang and Forster's is the removal of the 50-ms blank screen following the

English word. The results revealed that from the studied word list (episodic memory), no significant differences surfaced between those test items primed by a direct L2 translation and those primed by an unrelated word. Finkbeiner contends that these findings “[serve] to weaken the separate memory systems account” (2005, p. 749).

In response to Finkbeiner (2005), Witzel and Forster (2012) replicated the study once again. However, they neither heeded Finkbeiner’s critique nor addressed his proposition that strategic responding could explain the results due to the perceptibility of the prime. Not surprisingly, after preserving the 50-ms blank screen, Witzel and Forster’s results matched those of Jiang and Forster (2001). After acknowledging Finkbeiner, Witzel and Forster write that “settling this issue of masking of L2 primes would take us far beyond the scope of this present article” (2012, p. 1617). Needless to say, I am not so convinced. In fact, if one’s study depends on a priming mechanism, devoting a paragraph to its composition and interaction with the participants might be well warranted. My concern with Witzel and Forster (2012) lies not with the replication of the methodology itself, but with the avoidance of recognizing the implications of their methodology in their discussion.

Before concluding the literature review, a brief outline on theories of semantic networks in the brain is in order. In explaining this study’s results, these theories can be used as a point of reference. Priming effects (or lack thereof) can serve to illuminate how semantic networks in bilinguals operate.

The first of two models, Keatley et al. (1994) posit that any given word in the L1 exists within a bundle of extended senses, synonyms, and semantically related concepts. As a result, priming for within-L1 tasks or L2-target tasks would show significant effects. On the other hand, L2 representations not only link to fewer L2 nodes, but those neural pathways that do exist have received less “traffic.” Therefore, L2 priming to the L1 would be negligible at best.

Kroll and Tokowitz (2001) argue for the same priming effects but for different reasons. In this case, a particular real-world meaning is accessed directly via the L1 form. However, an L2 form linked to the same meaning only retains indirect access. Whether because the L2 is processed through a translation to the L1 or because it was learned after the establishment of the L1 form-meaning association, L2 words in this model would also reveal insignificant priming effects in an L1 task.

2.5 Concluding the literature review

The elements of language and memory covered in the literature review serve as both the identification of a gap in SLA and the foundation for analyzing results later in the paper.

In the section on studies that incorporate language and episodic and semantic memory, we saw that the bulk of experiments have dealt with the mother tongue. At the same time, a psychology perspective has coursed through that literature. Then in the review of the works to be replicated, I highlighted that Witzel and Forster (2012) neglected Finkbeiner’s (2005) critique, meaning that a replication of his methodology has yet to be carried out.

I have also demonstrated that the dynamics of sensory and long-term memory hold implications for the analysis of results. Because of the icon perceived after the presence of brief stimuli, masked priming must be carefully designed. And due to the dissociability of procedural and declarative memory and their roles in language processing, authors must be careful not to confound them as a single system (e.g., literature regarding automatization).

Finally, both in the literature review and in the discussion section, I make the case for a need to problematize views on rule processing and vocabulary in the L2. It is possible that any rule processing that might be maintained by procedural memory in the L1 be sustained and/or compensated for in declarative stores for adult-learned L2's, including in episodic memory. Conversely, vocabulary should not be stripped of its underlying computational requirements by conceiving of it only as a form-meaning relationship in semantic memory.

3 Research questions and hypotheses

The remainder of the paper will deal with the current study. It aims to replicate Finkbeiner's (2005) methodology in order to determine whether or not the L2 can successfully act as a masked prime in an L1 episodic recognition task. Part of the purpose also lies in the analysis of the results. Unlike the replicated authors, who focused mainly on the implications for memory systems, I will incorporate a critical, SLA-based view of vocabulary as it pertains to the procedure. Two more changes will be implemented here. First, a word familiarity questionnaire was administered to the participants to ensure adequate knowledge of the L2 primes. By not discarding unknown words, Finkbeiner's means might have collapsed relevant priming effects. Similarly, if Finkbeiner selected all very high frequency words to guarantee participant knowledge, those L2 memory traces might be more developed in semantic memory than episodic memory, once again eliminating priming effects. And second, a post-hoc analysis based on the variable of word concreteness will be carried out.

The research questions are as follows:

1) Will a masked L2 translation prime produce a reduction in reaction times in an L1 episodic recognition task?
2) *Post-hoc* – Will priming effects emerge as a function of word concreteness?

Results for the first research question could take multiple forms. Priming effects might be found, contradicting Finkbeiner's (2005) results, for two reasons. First, because Finkbeiner does not specify the word frequency of the test items, that variable could have played a role in priming dynamics. Second, if his experiment is simply a random result, this study can put it into question.

On the other hand, if the masked prime does not show any effects on reaction times, such a result will constitute a confirmation of Finkbeiner's (2005) findings. In this case, Jiang and Forster (2001) and Witzel and Forster's (2012) results can be attributed to the 50-ms blank screen in their priming presentation.

Finally, slower reaction times for the primed test condition would indicate either poor test items or an interference effect from the L2 during an L1 task.

It is predicted that no priming effects will be observed following Finkbeiner's (2005) results.

Research question two takes the same hypotheses as research question one. In this case, word concreteness will be split into two separate variables to be tested for, abstract and concrete. Jiang and Forster (2001) and Witzel and Forster (2012) specifically included abstract test items for word choice reasons. Therefore, it was not possible to compare reaction times against concrete exemplars. Finkbeiner (2005) controlled for word concreteness, but once again did not reveal any further information.

It is predicted that the variable word concreteness will not be responsible for priming effects because masking the prime would influence access equally across the L2 lexicon (given that they are not very high frequency words or cognates).

4 Procedure

4.1 Participants

In total, sixty English learners took part in the study. They were all Spanish speakers as the test was conducted in Spanish. All were selected from a university English Studies program in which all courses (except foreign language courses) are taught in English. The goal was to include advanced foreign language learners of English. A language background questionnaire was administered to determine whether they met the requirements for participation. No individuals were rejected for not having grown up in a Spanish-speaking society or for not possessing an appropriate command of English. Advanced L2 speakers were sought after in order to accurately replicate the participant characteristics of Jiang and Forster (2001), Finkbeiner (2005), and Witzel and Forster (2012). The reliance on episodic memory in L2 acquisition may very well depend on proficiency level, so studies are needed that work with beginning and intermediate learners. The use of advanced students does offer one methodological advantage. As mentioned before, the word list should not include many very high frequency words as their mapping may resemble L1 associations more so than L2 associations. By using advanced learners, lower frequency words could be incorporated into the word list with individual knowledge gaps compensated for through the administering of a word familiarity questionnaire. Participants' first exposure to English was after starting school. At least fourteen years of English classes and acceptance into an English-based university program stood as evidence for advanced English ability. The university program requires students to earn a given score on the Oxford Placement Test in order to participate.

Ages of all sixty participants ranged from 20 to 31 with an average age of 21. Forty-seven were female with an average age of 20.8 years and a range from 20 to 29. Thirteen participants were male with an average age of 21.8 years and a range from 20 to 31.

Due to particular participant characteristics, various trimmed datasets will be presented in the results section in addition to the full dataset. The number of participants included in each analysis and the criteria for rejection will be explained in the respective results sections. Of the original sixty participants, 55 were included in the full dataset for analysis. Of those 55, thirteen are Euskara (Basque) native speakers who do not speak Spanish at home. While it has been argued that language ability is sociolinguistically determined (Bialystok, 2001; Hinton, 2008), it is possible that proceduralization is highly age-sensitive. For this reason, 39 native Spanish speakers (after outliers removed) formed an additional cohort. With the number of data points collected per participant, statistical analyses are reliable with 39 individuals. For the full dataset, the Euskara native speakers were included.

Left-handed participants were included in the experiment. The keyboard and instructions were adjusted accordingly.

As remuneration for their participation, all individuals received five Euros and five percent of their final grade in one class.

4.2 Method

4.2.1 Materials

The DMDX (from http://www.u.arizona.edu/~kforster/dmdx/dmdx.htm) software package was used. It can present instructions, a study list, and the primed test items, randomize test items as desired, capture reaction times, and reject participants or individual responses as programmed.

Data were exported to the SPSS (from http://www-01.ibm.com/software/analytics/spss/products/statistics) software package for statistical analyses.

All participants took the test in the same computer lab as location must be controlled for when working with episodic memory. The word familiarity questionnaire was administered after the participant had completed the test so that all words were seen for the first time during the test itself.

The test was piloted on two Spanish-English bilinguals to ensure that it functioned properly and that the prime was undetectable. In response to piloting suggestions, stickers were added to the shift keys and a brief pause was added between test items.

4.2.2 Procedure

After filling out a language background questionnaire, participants were asked to study a list of Spanish words. Participants had no time limit during the study phase but, in the instructions, were told to spend “a few minutes” studying. Controlling for study time would not have addressed the issue of individual memory differences or attention paid, so this approach allowed participants to take the time they felt they needed. Time spent should have only affected error rates and average reaction times, not priming effects. In other aspects, the study phase was controlled as all participants saw the words in the same order. They were first shown a screen with the 32 Spanish words. Then they saw each word individually but in a new order. Finally, they were shown the entire list again in a third order. Orders were changed because when shown a list of more than seven items, the brain attends to the items at the beginning and end of the list (Pastorino & Doyle-Portillo, 2013).

After the study phase, participants moved onto the test component. Due to the need for the facilitator to change programs and for the participant to read instructions, a gap of at least a minute separated the study and test phases. Because short-term memory only lasts between a few seconds and half a minute, test responses were processed in long-term memory.

A single test item followed a set form as established by Finkbeiner (2005). A row of hash marks (#) was first shown for 500 ms. These hash marks serve two purposes, guidance of eye placement and the forward mask. Due to the location of the hash marks, the participant is guaranteed to have his/her gaze fixed on the correct mark for both the prime and the target. Also, the forward mask, coupled with the backward mask, ensure the prime’s imperceptibility.

The masked prime, an English word, immediately followed the hash marks. It lasted for 50 ms and was not detected by those who piloted the experiment. A backward mask of hash marks was the final priming element and lasted 200 ms. It also serves as a processing period (50-ms prime + 200-ms mask = 250 ms). Because the processing demand is condensed into a masked prime, English words were kept to either one or two syllables.

The target, a Spanish word, was displayed immediately after the backward mask and lasted 500 ms. Half of the targets (32) were the words on the study list while the other half had not been seen before. The participants needed to decide whether the word had appeared on the study list or not. In order to respond "yes," right-handed participants clicked the right shift key while left-handed participants clicked the left shift key. In order to respond "no," right-handed participants clicked the left shift key while left-handed participants clicked the right shift key. The keys were marked accordingly with different colors and said "yes" or "no" in Spanish. Participants were asked to respond as quickly as possible without negatively affecting performance.

The test items were randomized by group and within group. The 64 items were divided into eight groups of eight. Because there were four conditions, each group contained two words from each condition. Participants were shown groups one through eight in random order. Within every group, the eight words were also randomized.

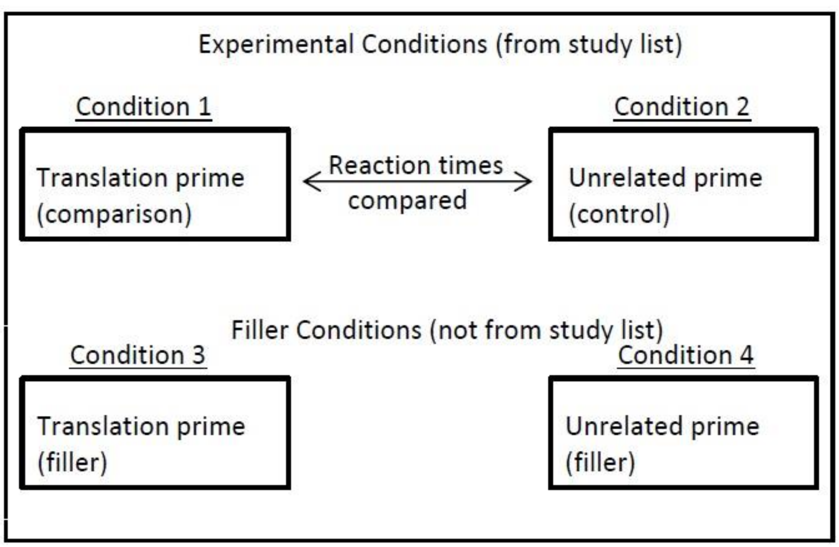
After the test, participants filled out a word familiarity questionnaire for the English primes in the experimental condition. Four levels of familiarity were provided, and responses of ones or twos were discarded from analyses (see *Appendix A*). An even number of responses was selected in order to force participants to one side of the scale. Options three and four intended to evoke recognition of active knowledge of a word's meaning. The options' focus on meaning was meant to directly challenge the assumption that meaning (even in the L2) is stored in semantic memory.

The entire process took less than thirty minutes; the test itself required about ten. All instructions were provided in Spanish (see *Appendices B-F*).

4.2.3 Item conditions

The prime-target pairings were grouped into four conditions (see Figure 2). The first two conditions constituted the experimental groups as these Spanish words had appeared on the study list. The reaction times from condition 1, the comparison group, will be compared with reaction times from condition 2, the control group. The primes in condition 1 are therefore English translations of the Spanish targets and act as the independent variable. The primes in the control group are English words, but not translations of the targets. They are matched roughly to their respective targets and other primes for part of speech, concreteness, and word frequency. The dependent variable is the mean of the reaction times from condition 1. In order to determine

Figure 2. Allotment of prime-target pairings by condition



whether the translation prime has facilitated participants' decision making, the reaction times from condition 1 will be compared with those from the control group (condition 2).

Conditions 3 and 4 act as fillers. Because the participants must decide whether or not the flashed target belonged to the study group, half of the total targets (32) are previously unstudied words. Those fillers are preceded by either a translation (condition 3) or an unrelated English word (condition 4).

4.2.4 Prime-target pairings

The Spanish targets and English primes were controlled across conditions for word length, part of speech, concreteness, and word frequency. Concreteness measurements were taken from the MRC Psycholinguistic Database (from http://websites.psychology.uwa.edu.au). Unlike Jiang and Forster (2001) and Witzel and Forster (2012), who chose only abstract words, each condition in this word set included a range of concreteness values. For the concreteness test (RQ #2), values below 350 were classified as abstract, values above 500 as concrete, and values between 350 and 500 as fillers. Word frequencies were taken from the British National Corpus (http://www.natcorp.ox.ac.uk). While syllable length in the targets could be longer, the masked primes never exceeded two syllables due to the demands placed on the perceptual system. No translation pairings included cognates as multiple studies have demonstrated that where L2 priming is not found, cognates do facilitate faster reaction times (de Groot, 1992, 1993; de Groot et al., 1994; de Groot & Nas, 1991; Sanchez-Casas, 1992). This phenomenon occurs presumably because the L2 form is received and processed along the L1 form-meaning memory trace (for the word lists sorted by condition, see *Appendices G-J*).

5 Results

Multiple analyses were conducted on the dataset in order to rule out the effect of particular confounding variables. In all cases, the mean of the reaction times from condition 1 was compared to the mean from condition 2. Alpha (α) was preset at 0.05 following Jiang and Forster (2001) and Witzel and Forster (2012). Moreover, the criteria for the rejection of individual reaction times consisted of abnormally fast or slow responses and inadequate word familiarity. Fast responses were defined as the 25th percentile minus two times the interquartile range. Abnormally fast responses are most likely inadvertently signaled or carryover from a previous target. Slow responses were defined as the 75th percentile plus two times the interquartile range. Abnormally slow responses disproportionately drag up the mean and are thus rejected.

Five participants were discarded from all analyses. Participant rejections were established at an overall error rate of greater than twenty percent. This threshold ensures that participants who guessed on a substantial proportion of targets have not affected results. The rejected participants most likely paid little attention during the study session.

In each analyzed subset, participant outliers were removed so as not to disproportionately affect the mean. These outliers were set at 1.5 times the interquartile range.

Additionally, descriptive statistics have been based on a normal distribution of data points and symmetry. Asymmetry has been operationalized as a skewness value of greater than 1 or less than -1.

5.1 Full dataset

The full dataset includes native Spanish speakers (with varying degrees of knowledge of other languages) as well as Euskara-Spanish bilinguals whose mother tongue is Euskara. The latter were included in the study because, as Spanish is the lingua franca in this social context, Spanish knowledge should be proceduralized. In case age of first exposure to Spanish is a confounding variable, a subset of only native Spanish speakers was analyzed (see *section 5.2*).

5.1.1 Descriptive statistics

Five outliers were removed from analyses, leaving a total of fifty participants (n = 50). Data from condition 1 were normally distributed (μ = 873.9 ms; σ = 148.8 ms) and sufficiently symmetrical (S = .59; SE = .34) to run parametric tests. Data from condition 2 were also normally distributed (μ = 876.8 ms; σ = 111.4 ms) and sufficiently symmetrical to run parametric tests (S = -.28; SE = .34).

Figure 3. Summary of the results from the full dataset

Full Dataset

	Reaction times (ms)
Control (unrelated prime) —	876.8
Comparison (translation prime) —	873.9
Priming effect —	2.9*

*Insignificant at α = 0.05	p = .44	n = 50	df = 49	t = -.155

5.1.2 Priming effects

Results from analyses of the full dataset show that the difference in reaction times between condition 1 (μ = 873.9 ms) and condition 2 (μ = 876.8 ms), or the priming effect, was 2.9 ms. Thus, Spanish words primed by an English translation were responded to 2.9 ms faster than those test items with an unrelated prime (control). The null hypothesis held that reaction times between the two conditions would be equal. The null hypothesis is accepted because differences did not reach significant levels (at $\alpha = 0.05$). Therefore, the priming effect is insignificant ($p = .44$). The results for this subset are summarized in Figure 3.

5.2 Spanish native speakers

This subset excludes the Euskara native speakers. If their Spanish vocabulary is not proceduralized in the same way as mother tongue speakers', the L2-L3 associations may differ qualitatively from L1-L2 associations. If priming is thus nonexistent in that population, the inclusion of that subset could drag the mean priming effect toward zero. The results in this section explore that possibility. Note that reaction times between the Spanish and Euskara groups cannot be compared as too few Euskara native speakers took part in the study ($n = 13$).

5.2.1 Descriptive statistics

Three outliers were removed from analyses, leaving a total of 39 participants ($n = 39$). Data from condition 1 were normally distributed ($\mu = 885.9$ ms; $\sigma = 147.9$ ms) and sufficiently symmetrical ($S = .71$; $SE = .38$) to run parametric tests. Data from condition 2 were also normally distributed ($\mu = 887.5$ ms; $\sigma = 109.3$ ms) and sufficiently symmetrical ($S = -.22$; $SE = .38$) to run parametric tests.

5.2.2 Priming effects

Results from analyses of the Spanish native speakers subset show that the difference in reaction times between condition 1 ($\mu = 885.9$ ms) and condition 2 ($\mu = 887.5$ ms), or the priming effect, was 1.6 ms. Thus, Spanish words primed by an English translation were responded to 1.6 ms faster than those test items with an unrelated prime (control). The null hypothesis held that reaction times between the two conditions would be equal. The null hypothesis is accepted because differences did not reach significant levels (at $\alpha = 0.05$).

Figure 4. Summary of the results from the Spanish native speakers subset

Spanish Native Speakers Subset

	Reaction times (ms)
Control (unrelated prime) —	887.5
Comparison (translation prime) —	885.9
Priming effect —	1.6*

*Insignificant at $\alpha = 0.05$	$p = .47$	$n = 39$	$df = 38$	$t = -0.073$

Therefore, the priming effect is insignificant (p = .47). It appears that priming effects in the full dataset were not diminished by the Euskara mother tongue speakers as no significant priming was observed in the Spanish native speakers. The remaining two tests will thus draw on all participants who did not fail the exam (n = 55). The results for the Spanish native speakers subset are summarized in Figure 4.

5.3 Low error rates

This subset only includes those participants whose error rate on the exam was at or below seven percent. If long-term memory dynamics are at play in the materialization of priming effects, there may be no observed influence of the translation prime on those with higher error rates. This subset was compiled with individual differences in memory, time spent studying, and test performance in mind.

5.3.1 Descriptive statistics

Thirty-one participants obtained scores of 93% or higher with an average error rate of 3.6%. Four participants earned a perfect score. This subset included both Spanish and Euskara native speakers. Data from condition 1 were mostly normally distributed (μ = 919.9 ms;

σ = 212.0 ms) with a slight right-tailing tendency (*S* = 1.6; *SE* = .42). Any statistically significant differences must therefore be evaluated cautiously. Data from condition 2 were normally distributed (μ = 923.6 ms; σ = 149.0 ms) and sufficiently symmetrical to run parametric tests (*S* = .81; *SE* = .42).

Figure 5. Summary of the results from the low error rates subset

Low Error Rates Subset

	Reaction times (ms)
Control (unrelated prime) —	923.6
Comparison (translation prime) —	919.9
Priming effect —	3.7*

*Insignificant at $\alpha = 0.05$	$p = .46$	$n = 31$	$df = 30$	$t = -.112$

5.3.2 Priming effects

Results from analyses of the low error rates subset show that the difference in reaction times between condition 1 (μ = 919.9 ms) and condition 2 (μ = 923.6 ms), or the priming effect, was 3.7 ms. Thus, Spanish words primed by an English translation were responded to 3.7 ms faster than those test items with an unrelated prime (control). The null hypothesis held that reaction times between the two conditions would be equal. The null hypothesis is accepted because differences did not reach significant levels (at $\alpha = 0.05$). Therefore, the priming effect is insignificant ($p = .46$). The results for the low error rates subset are summarized in Figure 5.

5.4 Concreteness

Research question 2 asked if priming effects would emerge as a function of word concreteness. In order to test this variable, each condition contained a range of concreteness values. Those words with a value of below 350 were categorized as abstract, and those with a value of above 500 were considered concrete. Priming effects between conditions 1 and 2 could thus be calculated with those word groupings. As a post-hoc analysis, conclusions must be drawn carefully. While there are sufficient participants to run the tests, the number of total data points has decreased due to the word selection process.

5.4.1 Descriptive statistics

In the concrete analysis, seven outliers were removed, leaving a total of 48 participants (n = 48). As the previous results revealed that priming effects were not affected by age of first Spanish exposure, both Spanish and Euskara native speakers were included. Data from condition 1 were normally distributed (μ = 742.2 ms; σ = 106.4 ms) and sufficiently symmetrical (S = .81; SE = .34) to run parametric tests. Data from condition 2 were also normally distributed (μ = 783.8 ms; σ = 91.7 ms) and sufficiently symmetrical (S = .32; SE = .34) to run parametric tests.

In the abstract analysis, ten outliers were removed, leaving a total of 45 participants (n = 45). Data from condition 1 were normally distributed (μ = 814.0 ms; σ = 124.8 ms) and sufficiently symmetrical (S = .18; SE = .35) to run parametric tests. Data from condition 2 were also normally distributed (μ = 847.7 ms; σ = 105.2 ms) and sufficiently symmetrical (S = .17; SE = .35) to run parametric tests.

Reaction times for concrete (μ = 763.9 ms) targets were significantly faster than abstract (μ = 834.7 ms) targets ($p < 0.001$; t = -5.6). This most likely demonstrates that participants found long-term encoding and/or retrieval easier for concrete words than their abstract counterparts.

5.4.2 Priming effects

Results from analyses of the concrete words subset show that the difference in reaction times between condition 1 (μ = 742.2 ms) and condition 2 (μ = 783.8 ms), or the priming effect, was 41.6 ms. Thus, concrete Spanish words primed by an English translation were responded to 41.6 ms faster than those test items with an unrelated prime (control). The null hypothesis, that the reaction times were equal, is rejected because differences surpassed significant levels (at $\alpha = 0.05$; $p < 0.001$).

Figure 6. Summary of the results for the concrete and abstract subsets

Concrete and Abstract Subsets

	Concrete reaction times (ms)	Abstract (ms)
Control (unrelated prime) —	783.8	847.7
Comparison (translation prime) —	742.2	814.0
Priming effect —	41.6*	33.7**

*Significant at $\alpha = 0.05$	$p < 0.001$	$n = 48$	$df = 47$	$t = -3.58$
**Significant at $\alpha = 0.05$	$p = 0.04$	$n = 45$	$df = 44$	$t = -1.79$

Results from analyses of the abstract words subset show that the difference in reaction times between condition 1 (814.0 ms) and condition 2 (847.7 ms), or the priming effect, was 33.7 ms. Thus, abstract Spanish words primed by an English translation were responded to 33.7 ms faster than those test items with an unrelated prime (control). The null hypothesis, that the reaction times were equal, is rejected because differences surpassed significant levels (at $\alpha = 0.05$; $p = 0.04$). Results for both concrete and abstract subsets are summarized in Figure 6.

6 Discussion

The discussion will be divided into three sections. As mentioned above, in addition to the inclusion of a word familiarity questionnaire and concreteness variable, one of the gaps this study fills is purely analytical. I have argued that an incorporation of a declarative/procedural perspective and a problematized view of vocabulary into analyses would add a layer of sophistication to the current argument. However, the three sets of authors replicated here assume a psychology/cognitive science stance. They essentially set out to explain their results in terms of the debate over the separate memory systems account. The first discussion subsection (*6.1*) will consider this perspective and whether or not the results corroborate Finkbeiner's (2005). The second subsection (*6.2*) will take a more critical approach, viewing priming effects as a function of the dissociation between declarative and procedural memory systems. Moreover, the decontextualized nature of the presentation of vocabulary may not be trivial and therefore should not be overlooked. The third and final subsection (*6.3*) will take stock of current knowledge of the interplay between declarative memory and adult foreign language learning and highlight possible implications of this study.

6.1 Replication of Finkbeiner (2005)

Setting aside for a moment the results from the concreteness subset, the current study appears to have produced similar results to those of Finkbeiner (2005). One could interpret the lack of L2 priming effects in an episodic recognition task as evidence against storage of the L2 vocabulary in episodic memory. Because the studied L1 targets were stored in episodic memory during the task, one would expect the L2 translations to facilitate the retrieval of the appropriate memory if those vocabulary traces also existed in that system. Some might argue that if equal forms in different languages possess their own trace to separate conceptual nodes, translations would not suffice as a priming mechanism. In addition to Jiang and Forster (2001) and Witzel and Forster (2012), the literature on bilingual processing does not assume this position (Gollan et al., 1997; Keatley et al., 1994). Others may justifiably ask if L2 words can even be processed in strictly masked conditions. Finkbeiner (2005) explored this issue with a primed repetition experiment before running the replication. He removed the backward mask (150 ms), leaving only 50 ms of processing time, yet still found significant priming effects in the experimental condition. Therefore, the lack of priming effects in the current study's full dataset results cannot be attributed to insufficient processing time.

Therefore, without considering the concreteness variable, the current results could be understood in Finkbeiner's (2005) terms. He argues not necessarily against the use of episodic memory in L2 development, but against the separate memory systems account. Because Jiang and Forster (2001) and Witzel and Forster's (2005) proposal defies most accepted views on declarative memory, which I have outlined above (Yee et al., 2013), any caveat in their conclusions might undermine that proposition. Finkbeiner (2005) believes this limitation to lie in the perceptibility of their prime. He argues that once the prime becomes perceptible, participants can employ strategies in their decisions, rendering inadequate the evidence in favor of dissociable episodic and semantic memory systems.

What is missing in Finkbeiner's (2005) piece is any attempt to go beyond the purely anatomical discussion and address the role those systems play in L2 vocabulary development. At the same time, in Witzel and Forster's (2012) rebuttal, they offer no explanation for why the blank screen was necessary or how Finkbeiner's critique could be reconciled with their results.

The following section will provide an alternative explanation for the results found in this experiment as well as the other three articles. Before moving on, however, the results from the concreteness subset must be considered.

It is entirely conceivable that the variable of word concreteness could interact with episodic memory use in L2 development. While particular word characteristics may enhance spatiotemporal associations in the moment of memory encoding, others may promote an association to the L1 form-meaning representation. In the results here, both concrete and abstract words produced significant L2-L1 priming effects. Such a finding could point to an influence of word concreteness on episodic memory reliance in L2 vocabulary storage. Reflecting on Jiang and Forster (2001) and Witzel and Forster (2012), who only employed abstract words and observed priming effects, the abstract subset here corroborates their finding. As for concrete words, the current study is the first to propose this interaction of variables. It is also possible that the lack of priming effects in Finkbreiner (2005) could be due in part to the words' concreteness attributes which he did not disclose in his paper.

I emphasize caution in the analysis of these subsets' results for two reasons. First, as a post-hoc test among four subset analyses of the full dataset, reliability decreases. Each time a new sample is drawn out of all data points, the chance of a random result showing significant effects increases. Second, because concrete and abstract words each constitute one-third of the experimental items, each condition's value as a representative sample of its population also decreases. These limitations do not diminish all the value of this post-hoc analysis. It has instead revealed a need to explore in future studies the implications of word concreteness on the long-term memory dynamics of L2 vocabulary development.

6.2 Declarative/procedural constituents

As mentioned in the introduction, a long-standing question in SLA deals with how the L1 and L2 differ from representational and processing perspectives. I later argued in the critique of Krashen (1982) that incorporating a declarative/procedural approach when analyzing results could help in answering this question. If long-term memory use constitutes a difference between subsequently learned languages, this theoretical foundation could illuminate the question at hand.

Finkbeiner (2005) asserts that Jiang and Forster (2001) and Witzel and Forster's (2012) results were due to strategic responding in the task. I would like to propose an alternative account based on declarative/procedural constituents. As discussed in the literature review, procedural memory is responsible for subconscious knowledge stores as well as classical conditioning and possibly other priming examples. Finkbeiner (2005) and I, who undoubtedly used an imperceptible prime, may not have observed reduced reaction times due to subconscious processing of the prime. From this perspective, the separate memory systems account becomes less the point of analysis because declarative memory plays less of a prominent role. Therefore, the L2 translations, having not been activated in the procedural memory-based task, might very well exist principally as declarative traces (either semantic or episodic). This account fits with those SLA authors' arguments that highlight the role of declarative memory in adult L2 development (de Jong, 2005; DeKeyser, 1997; N. Ellis, 2005; Paradis, 1994, 2005, 2009; Rastelli, 2014; Ullman, 2001, 2005, 2008).

Jiang and Forster (2001) and Witzel and Forster (2012), whose primes may not have been entirely imperceptible, could have observed reduced reaction times as a result of declarative memory activation. However, I would hesitate to argue in favor of a strict dissociation between semantic and episodic memory. As the literature from the last two decades indicates, episodic and semantic memory have evolved to work together in encoding and storing declarative knowledge (Baars & Gage, 2010; Goldstein, 2011; Eichenbaum, 2002; Westmacott et al., 2004; Westmacott & Moscovitch, 2003; Yee et al., 2013). However, I would also not go as far as Finkbeiner (2005) who implies that Jiang and Forster's (2001) results do not constitute evidence of episodic memory use in L2 vocabulary development. While strategic responding is a possible explanation, alternatives also exist. It is conceivable that foreign language learners rely on spatiotemporal associations in L2 development. Acquisition of the mother tongue and in second language environments, on the other hand, may behave differently because of more plentiful input and/or age-related cognitive dissimilarities (Kotz, 2009; Rastelli, 2014).

The question then remains as to why masked priming is successful in the L1 during lexical decision tasks. If masked priming does in fact rely to some degree on procedural constituents, why would a reduction in reaction times surface with an L1 prime? My intention here is not to refute the conclusion that L1 form-meaning relationships exist within semantic memory. However, an added proposition of procedural neural activation during the task might point to a difference between native and non-native vocabulary storage. The masked prime's effectiveness might be due to semantic and/or rule processing networks within both semantic and procedural memory (Paradis, 2005; 2009). Whereas with an L2 prime in an episodic recognition task, the activation of declarative knowledge stores, such as with Jiang and Forster's (2001) 50-ms blank screen, may have been necessary to foster significant priming effects. The lack of priming in Finkbeiner (2005) and this study's full dataset may owe to the fully subconscious nature of the prime.

This argument is not meant to rule out the possibility for L2 vocabulary development within procedural memory. However, differences in the quantity and/or quality of networks in procedural knowledge and their subsequent activation might explain the discrepancy in effectiveness between L1 and L2 masked priming in these tasks. As mentioned in the literature review, questioning vocabulary as a form-based, declarative language component is a necessary practice when researching language processing. As will be pointed out in the limitations section, the decontextualized nature of the task (single words lacking discursive significance) might affect the L1 and L2 in different ways. Rule computations in the L1 might be activated even when a single word appears; conversely, procedural L2 knowledge might require more context because of the quality of the rules themselves and how they were acquired.

Finally, if the results from the concreteness subsets were not random, the priming effects can also be explained from a declarative/procedural perspective. The L2 words from those conditions might have developed stronger procedural traces, as semantic and/or rule processing knowledge, triggering stronger reactions when identifying the target as part of the study list. If this reasoning holds, word concreteness and memory system could interact in the L2 vocabulary development process.

What is certain to assemble the pieces is the need for more SLA research that focuses on the distinctions between episodic/semantic memory and declarative/procedural memory. I also argue that many studies would benefit from a theoretical treatment of long-term memory, even if it is not the work's core purpose.

6.3 Implications

Taking into account this study, those the paper has reviewed, and contemporary literature on memory, one can conceptualize a plausible schema of declarative memory use in foreign language learning. As episodic representations might be capable of enhancing particular semantic memories (Baars & Gage 2010; Eichenbaum, 2002), it is conceivable that the brain encodes initial L2 concepts or clear stages of noticed development episodically. As more exemplars of the same concept (e.g., form, extended sense, accompanying object pronoun, etc.) are noticed by the learner, the spatiotemporal associations blur, leaving a greater reliance on the semantic trace. This and any other hypothesis requires experimental evidence to substantiate or disprove it. I offer the notion as a starting point for a future discussion on the implications of declarative memory for foreign language teaching. It is much less difficult to find pieces in the SLA literature that deal with seemingly in-vogue working memory (Gass & Lee, 2011; Mackey et al, 2002; Service et al., 2002; Williams, 2012). Not only that, Robinson's (2007) model of processing through the memory systems reduces long-term memory to a single component with no mention of the intricacies of procedural, declarative, episodic, or semantic determinants. However, as Paradis, N. Ellis, Ullman, and Rastelli have revealed in their work, long-term memory appears to constitute a point of distinction between L1 and L2 processing, meaning that it cannot be taken for granted as is.

Classroom planning decisions will inevitably interact in specific ways with students' memory encoding faculties. What teaching approaches/activities activate one memory system over the other? To provide an example from this paradigm, communicative language teaching, with a focus on meaning conveyance, expects rules to progress naturally in the student's system with limited explicit focus. In such an environment, most rule development will occur in procedural memory, but there exists no evidence in the literature that L2 procedural rule assimilation operates beneath the same mechanism as in the L1. However, when coupled with explicit interventions, a conversational environment offers the spatiotemporal variation and stimulation necessary to encode new, unique declarative memories. At the same time, those explicit interventions and future exemplars of a target form can bind to previous neural networks, a precursor to consolidation (Baars & Gage, 2010; Dehn, 2010). The goal of this example, as well as the critique of Krashen (1982), was to demonstrate that a long-term memory approach to theories of SLA or language pedagogy only serve to strengthen the foundations and interpretations of those notions.

In addition to retaining value for language teaching, another hoped-for implication of this study is to open doors for SLA research that acknowledges and/or focuses on the intricacies of long-term memory. Jiang and Forster (2001), Finkbeiner (2005), and Witzel and Forster (2012) provide a psychology-based view of L2 vocabulary storage. However, research and innovation in this area remain wide open from an SLA perspective. On top of the example of research within language pedagogy given above, I will highlight possible future directions in the following section.

7 Future directions

This avenue of research within SLA remains fairly underdeveloped. Future studies could continue to build off the trajectory advanced in this paper or associate long-term memory with many other subareas of the field.

The current experiment has left a need to verify the results from the concreteness subset. Finding that the variable of concreteness does in fact interact with episodic memory when using an L2 masked prime would hold implications for Finkbeiner's (2005) conclusions. Moreover, as rule or vocabulary development occurs over a period of time, and episodic and semantic memory most likely play different roles as the process progresses, level of development of a certain form might be a relevant variable. For example, when confronted with words that contain many extended senses, the learner may utilize a memory system to assimilate a new meaning to his/her interlanguage. But as meanings previously exposed to are heard again and again, the automatizing of the form-meaning relationship may take place in another system. A very similar paradigm for L2 learners may operate in their attempt at assimilating syntactic rules.

In addition, the development of novel methods for researching the dynamics of L2 memory use could fulfil particular needs that this study leaves undetermined. For example, the decontextualized nature of the study list and presentation might affect L1 and L2 cognitive processes differently. Finding a way to contextualize the test material while still controlling for the appropriate variables would shed light on which memory systems support processing in both languages. Moreover, following Ullman, Paradis, and others, the procedural/declarative distinction might very well be a relevant consideration in rule processing as well as vocabulary/lexicon. In the same vein, I have also argued that the semantic/episodic distinction might constitute a disparity between L1 and adult L2 acquisition. Therefore, studies that focus on vocabulary disregard the valuable exploration into how syntactic rule processing operates from a long-term memory perspective.

Many approaches that already exist within SLA would mesh well with and benefit from a treatment of long-term memory. For instance, language teaching methodologies are often derived from theories projecting views on typical or optimal learning practices. I would contend that these discussions on language acquisition in the classroom would profit from a memory-based evaluation that moves beyond only working memory. To give just one example, inductive/deductive language teaching grapples with what arrangement and presentation of material is most advantageous for students (Martínez-Flor, 2008). Determining to what extent the information is successfully assimilated episodically, semantically, and procedurally would inform how to organize inductive and deductive components of a lesson. Similarly, but from an experimental perspective, when studying a teaching methodology, analyzing results from the angle of long-term memory would provide an added layer of explanation as to the efficacy of the treatment.

This approach to SLA would also hold implications for theories of adult L3 acquisition. As mentioned previously, Falk and Bardel (2011) and Bardel and Falk (2012) have justified evidence in favor of the L2 status factor through a declarative/procedural model. Competing views on L3 acquisition, such as the Cumulative-Enhancement Model (Flynn et al., 2004) or the Typological Primacy Model (Rothman, 2011), by incorporating long-term memory into their accounts, might bring the pieces of the puzzle together. In many cases, differences in results are owed to inconsistent variables between studies, such as language pairings. By developing explanations on the same terms, differences stand out, thus illuminating the interaction between L3 acquisition and particular cognitive processes.

Just as long-term memory can support work in various areas, existing research methodologies can also be used to glean a more exacting understanding of L2 storage and processing. For instance, studies within the noticing/awareness paradigm are highly linked to the distinctions between episodic and semantic memory and declarative and procedural systems. Once noticing has been identified in a given task, declarative memory must be at play. Whereas those areas that develop without awareness, an avenue of research lacking conclusive evidence (Gass et al., 2013), rely on procedural knowledge to a greater extent. Moreover, when a student remains conscious of particular spatiotemporal characteristics from the learning experience at a later time, an episodic memory must have been encoded during the task.

These examples have shown that a consideration of long-term memory and its underlying components can play a significant role in future SLA studies. For one, existing methodologies can help us pick apart the realities of L2 memory use. The theories presented in this paper can also be applied to a wide variety of subfields. And finally, this discussion is not trivial as developments in these areas often translate into more effective classroom practices.

8 Limitations

In this section I will highlight a few limitations that affect most studies that take place in a foreign language setting and incorporate some type of vocabulary test. First and foremost, and as mentioned previously, the decontextualized nature of the study list and target and priming mechanisms may not activate memory traces in the same way as when the words are used to convey discursive functions. It is not known whether decontextualized words stimulate more neural networks in the L1 than in adult-learned L2's. This issue could act as a confounding variable, and future studies that introduce contextualized vocabulary will shed more light on the interaction between language processing and contextualization of target words.

Another issue that affects similar experiments lies in the process of controlling for word frequency. In second language settings, input from the speech community should more or less parallel word frequency counts. However, in a foreign language setting, it is difficult to control for learners' actual exposure to any given word. For this very reason an analysis of reaction times based on the variable of word frequency was not carried out.

Finally, a comment must be made regarding age of first exposure. As mentioned throughout the paper, age of acquisition might play a role in the cognitive processes involved in assimilation and how words and rules are stored. In this case, and certainly in Jiang and Forster (2001), Finkbeiner (2005), and Witzel and Forster (2012), the participants' first exposure to the L2 occurred before puberty. However, this exposure did not come from the home sphere, and the lack of input from the community certainly mediates the context of acquisition in some way.

9 Conclusion

This paper has aimed to directly replicate Finkbeiner (2005) in order to determine if a masked translation prime in the L2 can reduce reaction times in an L1 episodic recognition task. Because of Finkbeiner's critique of Jiang and Forster (2001) that a 50-ms blank screen following the prime could result in a ghosting effect, a discussion of human memory made up the first section of the literature review.

There we saw that what Neisser (1968) termed the icon does in fact trail brief visual stimuli on a contrasting backdrop, allowing for what is otherwise imperceptible to be encoded into short- and/or long-term memory. In general, Neisser's theory continues to be accepted in contemporary psychology (Irwin & Thomas, 2008). This issue justified the need for a replication of Finkbeiner (2005) who removed the blank screen in his methodology.

Following sensory memory, an analysis of short- and long-term memory provided the necessary background to set up the study. First, short-term memory, while crucial to the memory chain, has little effect on already stored long-term memories (Olson et al., 2006), meaning that results could be explained solely in terms of the latter.

Then, the overview of long-term memory left us with two crucial distinctions: declarative versus procedural and, within the declarative system, episodic versus semantic memory. Because of the lack of research dealing with the episodic/semantic distinction in SLA, a hefty portion of the literature considered the work of Ullman, Paradis, and others, who have highlighted declarative/procedural constituents as a point of dissimilarity between L1 and L2 processing. Here I problematized two notions relevant to the current study. First, masked priming, due to its subconscious operation, may be a reflection of underlying procedural knowledge, a point neglected by Jiang and Forster (2001), Finkbeiner (2005), and Witzel and Forster (2012).

Moreover, Paradis's (2004, 2009) proposition that rule computations accompany vocabulary holds additional implications for studies that utilize vocabulary as a means of testing.

The results of the experiment appeared to corroborate Finkbeiner's (2005) findings. However, a post-hoc analysis of the variable word concreteness revealed significantly faster reaction times for both concrete and abstract words. This result suggests that these types of words might exist as episodic memory traces and/or develop rule-based associations in procedural memory. Because this statistical test was conducted post-hoc and therefore fewer words constituted the subset, the implications are presented tentatively and must be verified.

On the other hand, the other three subsets, including the full dataset, showed equal reaction times between those words primed by a translation those primed by an unrelated word. While Finkbeiner (2005) argued that Jiang and Forster's (2001) results were due to strategic responding by the participants, I do not rule out the possibility of episodic memory use as an explanation for Jiang and Forster (2001) and Witzel and Forster's (2012) findings. Moreover, I added an additional layer of analysis beyond the separate memory systems account (episodic/semantic) by considering the distinction between declarative and procedural memory. The priming that is found with the inclusion of the blank screen may be due to the activation of declarative memory stores. In contrast, Finkbeiner's (2005) and my priming presentation, operating subconsciously, may have only activated procedural knowledge. This suggestion has a couple possible implications. It may mean that the L1 vocabulary possesses greater and stronger neural networks within procedural memory. Or, the decontextualized nature of the vocabulary study session and test is less successful in activating those L2 networks that do exist in subconscious knowledge stores. In either case, this experiment's results raise questions for how the L1 and L2 might differ in terms of cognitive representation and processing.

In general, it is difficult to draw definite conclusions regarding episodic memory use in L2 development. However, with the analysis presented in this paper and the current view that episodic memories can precede and strengthen semantic knowledge, it is plausible that the episodic system plays an important role in various stages of development. What is needed is further research to delve deeper into this issue, with SLA studies paying closer attention to long-term memory. A greater understanding of the dynamics of the interaction between language growth and declarative and procedural memory will shed light on L2 acquisition and processing while informing current and future approaches to language pedagogy.

Appendix A
Word familiarity questionnaire

Below is an example and English translation of the word familiarity questionnaire that the participants filled out after taking the test.

Marque su nivel de familiaridad con las siguientes palabras inglesas.

1 = Nunca he visto/oído la palabra

2 = Reconozco la palabra, pero no sé su significado

3 = Sé el significado de la palabra, pero no me siento completamente cómodo/a con ella

4 = Me siento completamente cómodo/a con la palabra

Pride

1 ☐ 2 ☐ 3 ☐ 4 ☐

Indicate your level of familiarity with the following English words.

1 = I have never seen/heard this word

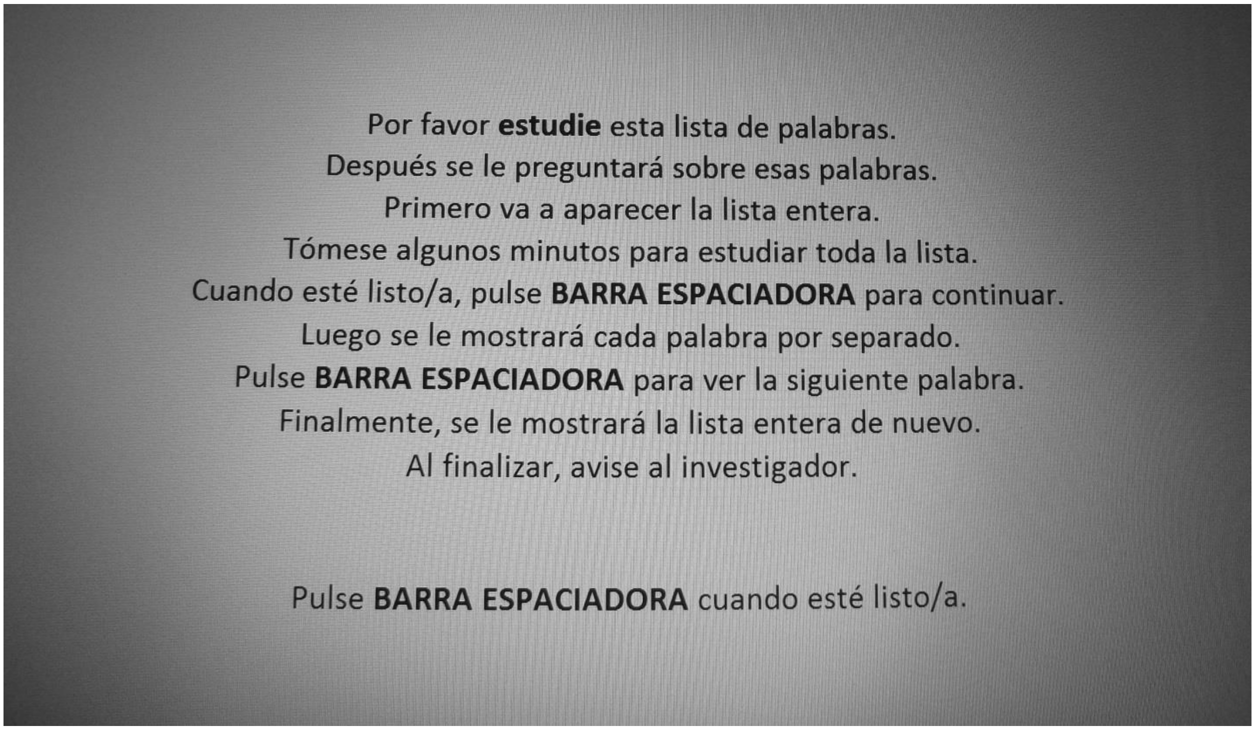
2 = I recognize the word but don't know its meaning

3 = I know the meaning of the word, but I don't feel completely comfortable with it

4 = I feel completely comfortable with the word

Appendix B
Instructions for study session

Displayed is a screenshot of what participants saw as instructions prior to the study session. Below is a translation to English.



Please **study** the following list of words.

You will later be asked about these words.

First you will see the entire list.

Take a few minutes to study the whole list.

When you are ready, press **SPACEBAR** to proceed.

Then you will be shown the words one at a time.

Press **SPACEBAR** to go from word to word.

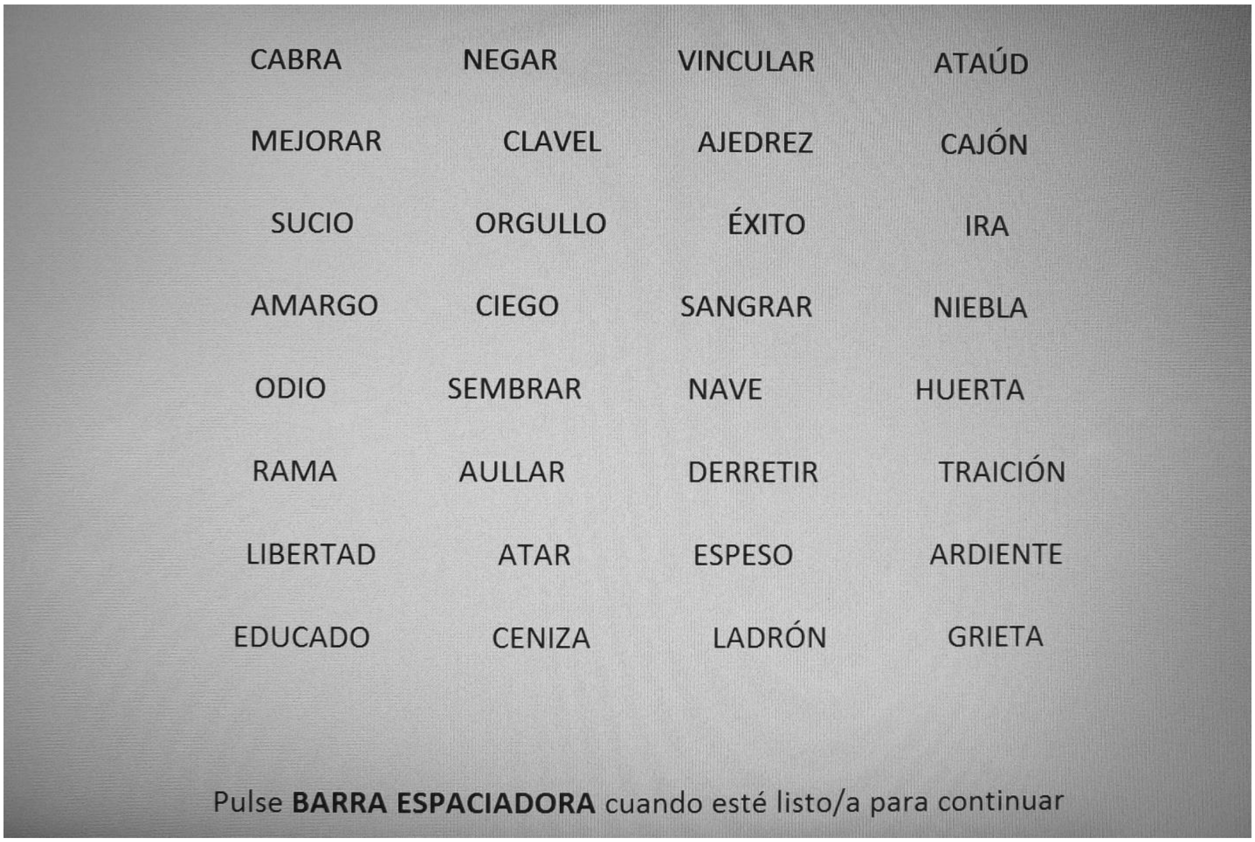
Finally, you will be shown the entire list again.

When you are done, notify the researcher.

Press **SPACEBAR** when you are ready.

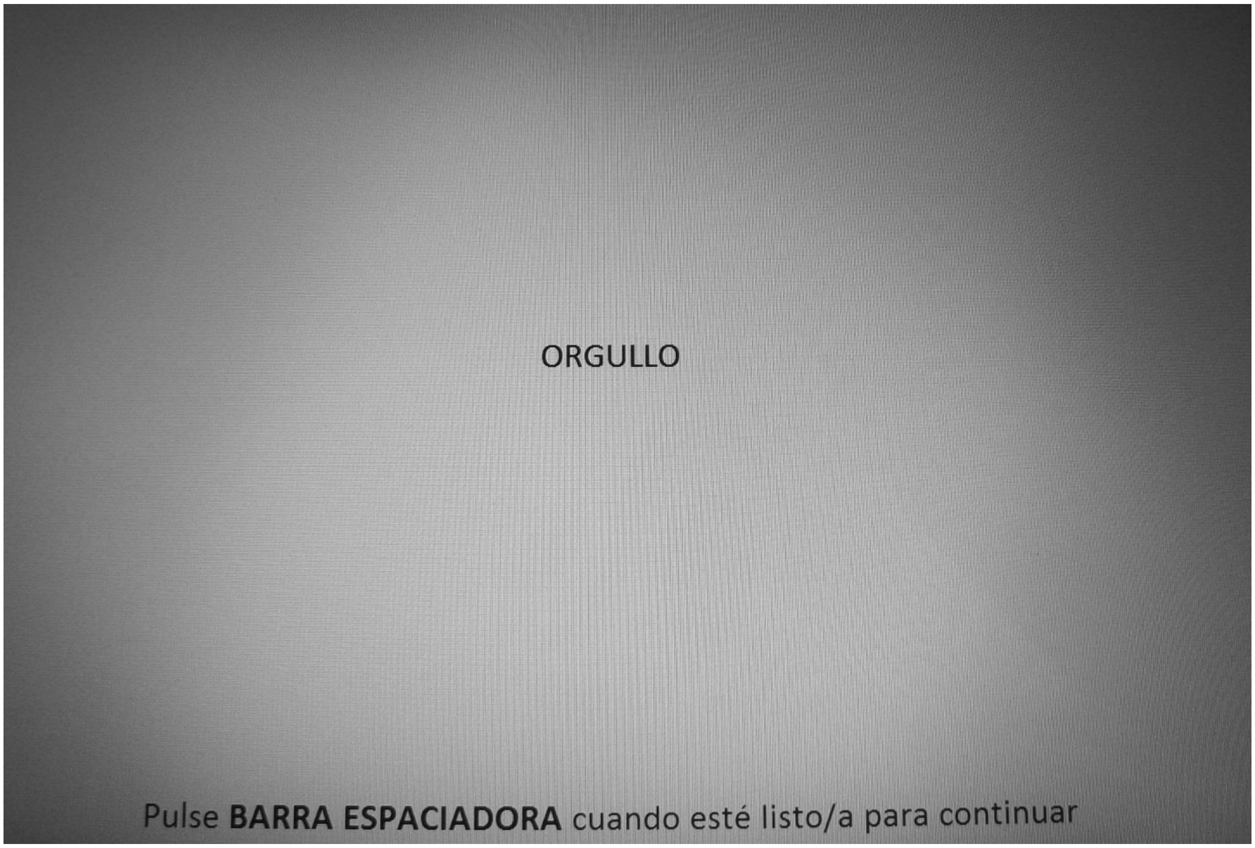
Appendix C
Study list one

Displayed is a screenshot of what participants saw as the first study list in the study session. All 32 words are presented. They appear in a different order than how they are shown in the second and third study lists.



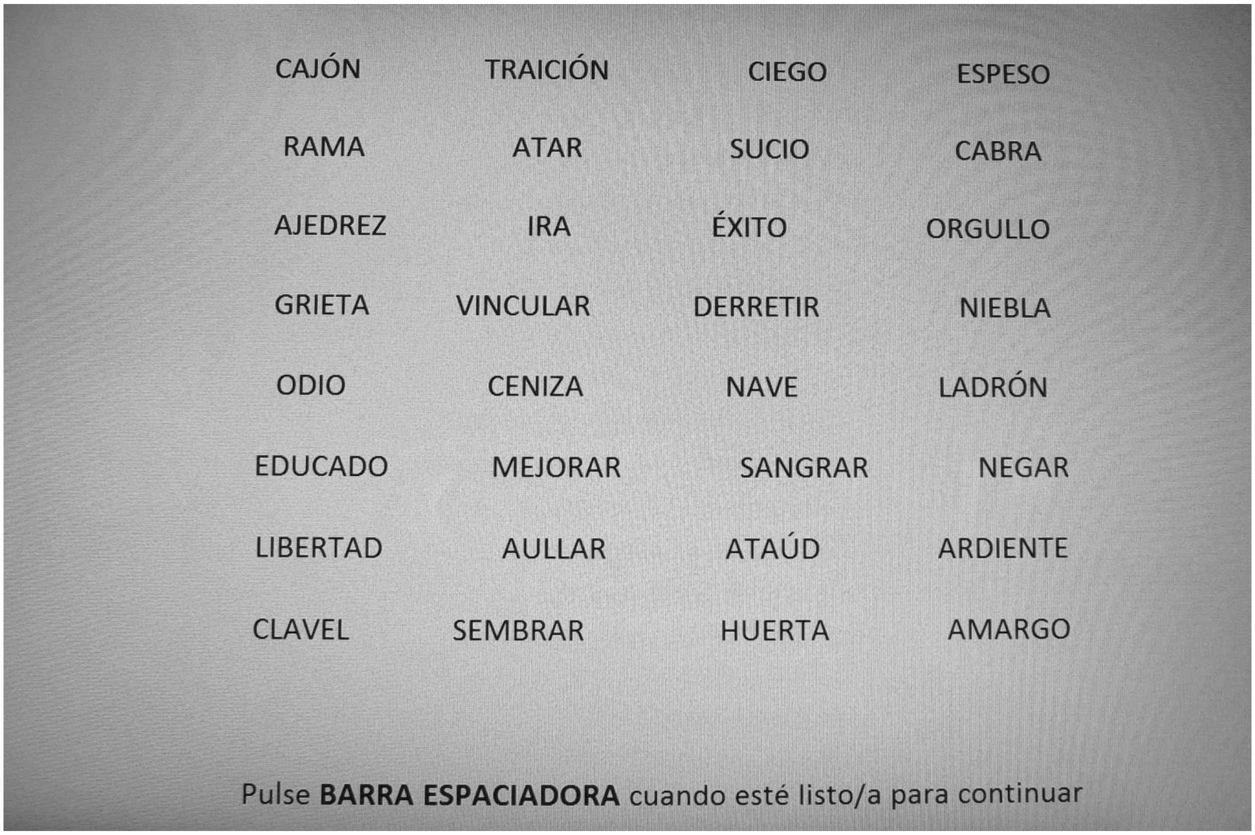
Appendix D
Study list two

Displayed is a screenshot of an example word from the second study list. The participant took a few moments to study each word individually. The order of the words in this section was different from that of study lists one and three.



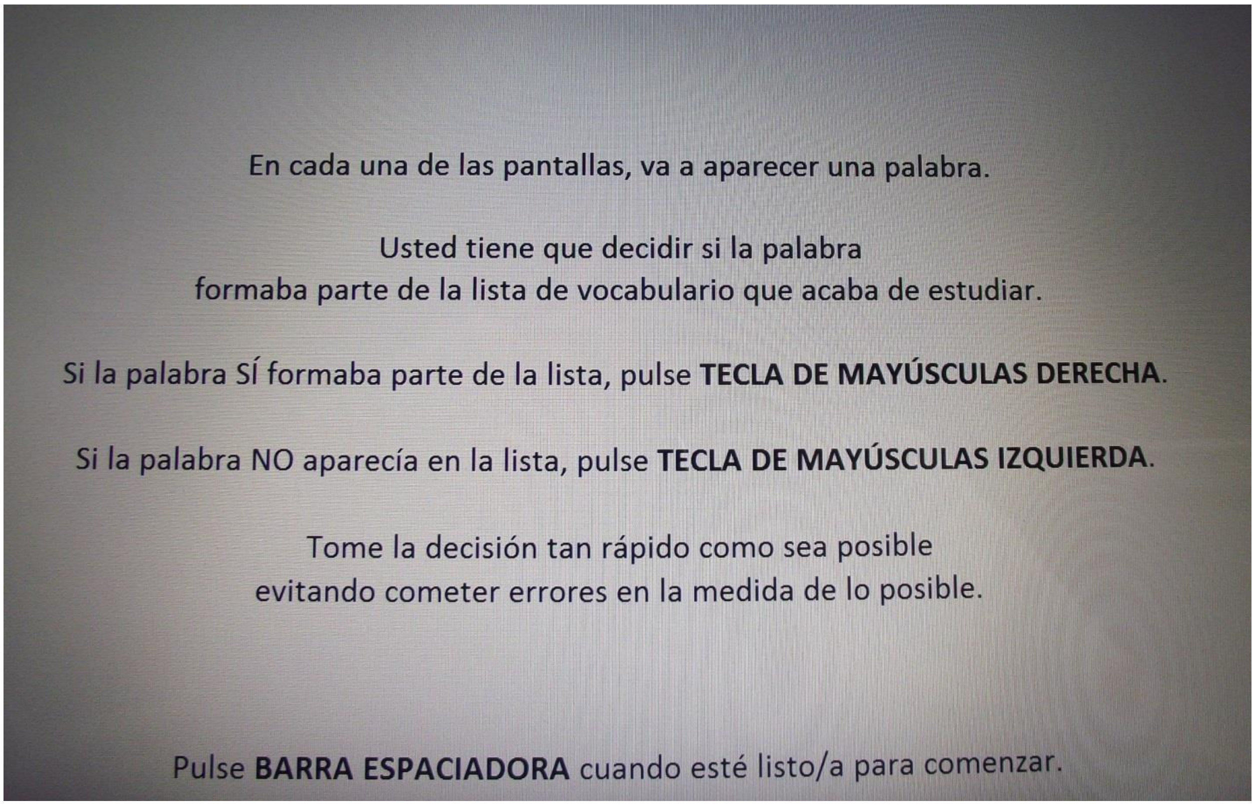
Appendix E
Study list three

Displayed is a screenshot of what participants saw as the third and final study list in the study session. All 32 words are presented again. They appear in a different order than how they are shown in the first and second study lists.



Appendix F
Test instructions

Displayed is a screenshot of what participants saw as instructions for the testing phase. Below is an English translation. These instructions were prepared for right-handed participants. Left-handed participants would see the shift keys inverted. Following this screen, the participants were then shown the 64 test items one by one preceded by the prime explained in *section 4.2.2*.



In each of the following screens, you will see a word.

You must decide whether or not the word appeared in the vocabulary list you just studied.

If the word DID appear in the list, press **RIGHT SHIFT**.

If the word DID NOT appear in the list, press **LEFT SHIFT**.

Decide as quickly as possible while trying not to make mistakes.

When you are ready to begin, press **SPACE BAR**.

Appendix G
Condition 1 word list

The Spanish words in this list appeared in the study list. The English words, which primed the targets in the testing phase, are direct translations of their Spanish counterparts. The reaction times to the words in this condition were compared those in condition 2 (see *Appendix H*).

Nouns	Spanish	English
1.	Ajedrez	Chess
2.	Ataúd	Coffin
3.	Cabra	Goat
4.	Cajón	Drawer
5.	Éxito	Success
6.	Ira	Anger
7.	Niebla	Fog
8.	Orgullo	Pride
9.	Rama	Branch
Verbs		
10.	Derretir	To melt
11.	Mejorar	To improve
12.	Negar	To deny
13.	Sangrar	To bleed
Adjectives		
14.	Amargo	Bitter
15.	Ciego	Blind
16.	Sucio	Dirty

Appendix H
Condition 2 word list

The Spanish words in this list appeared in the study list. The English words, which primed the targets in the testing phase, are not semantically related to their Spanish counterparts. The reaction times to the words in this condition were compared those in condition 1 (see *Appendix G*).

Nouns	Spanish	English
1.	Ceniza	Table
2.	Clavel	Duck
3.	Grieta	Queen
4.	Huerta	Test
5.	Ladrón	Spirit
6.	Libertad	Concern
7.	Nave	Couch
8.	Odio	Failure
9.	Traición	Hope
Verbs		
10.	Atar	To expire
11.	Aullar	To find
12.	Sembrar	To pollute
13.	Vincular	To behave
Adjectives		
14.	Ardiente	Strict
15.	Educado	Green
16.	Espeso	Peaceful

Appendix I
Condition 3 word list

The Spanish words in this list did not appear in the study list. With direct English translations as primes, they acted as fillers for Condition 1.

Nouns	Spanish	English
1.	Arena	Sand
2.	Clemencia	Mercy
3.	Cotilleo	Gossip
4.	Hipoteca	Mortgage
5.	Matrimonio	Marriage
6.	Puente	Bridge
7.	Puño	Fist
8.	Riqueza	Wealth
9.	Roble	Oak
Verbs		
10.	Borrar	To erase
11.	Hervir	To boil
12.	Perdonar	To forgive
13.	Respirar	To breathe
Adjectives		
14.	Ancho	Wide
15.	Profundo	Deep
16.	Vacío	Empty

Appendix J
Condition 4 word list

The Spanish words in this list did not appear in the study list. With unrelated English words as primes, they acted as fillers for Condition 2.

Nouns	Spanish	English
1.	Consejo	Envy
2.	Corbata	Sticker
3.	Cordura	Fatigue
4.	Faro	Dust
5.	Goma	Candle
6.	Granizo	Ridge
7.	Pobreza	Wisdom
8.	Puerro	Frost
9.	Sombra	Mop
Verbs		
10.	Enchufar	To earn
11.	Exprimir	To start
12.	Teclear	To deserve
13.	Untar	To bury
Adjectives		
14.	Débil	Hard
15.	Mandón	Lucky
16.	Valiente	Bald

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