

BILINGUAL LEXICAL ORGANIZATION: IS THERE A SENSITIVE PERIOD?*

*Laura Sabourin, Jean-Christophe Leclerc, Michèle Burkholder, and Christie Brien
University of Ottawa*

While many Canadians speak both official languages, the ways in which bilinguals acquire their two languages varies greatly from place to place, and even from individual to individual. The current study investigates how bilinguals represent their two lexical systems mentally, and in particular, how this organization is affected by the manner in which they have acquired their second language (L2).

1. Background

Over the past several decades, there has been some disagreement as to whether evidence supports separate or integrated bilingual mental lexicons (Gollan, Forster, and Frost 1997; Finkbeiner, Forster, Nicol, and Nakamura 2004). While several studies have provided evidence for an integrated lexical memory system, where both languages are simultaneously activated during language processing (e.g., Dijkstra, Timmermans, and Schriefers 2000; de Groot, Delmaar, and Lupker 2000; Finkbeiner et al. 2004; Costa 2005), others have supported the view that the two lexicons are stored separately such that the activation of one language does not entail the activation of the other (e.g., Soares and Grosjean 1984; Gerard and Scarborough 1989; Ibrahim 2009; Li, Mo, Wang, Luo, and Chen 2009). More recently, a consensus is beginning to emerge that the two lexicons are indeed integrated (Kroll and Stewart 1994; Fabbro 2001; Paradis 2001; Dijkstra and van Heuven 1998, 2002; Costa 2005), though the level of representation at which this integration occurs is still under some debate. Two of the most influential models of the bilingual lexicon differ somewhat in this respect.

The first, the Revised Hierarchical Model (RHM; Kroll and Stewart 1994; Kroll, van Hell, Tokowicz, and Green 2010; see Figure 1A), posits that the two lexicons access a shared conceptual store, but that each language has a separate store at the lexical level of representation.¹ The links from first language (L1) words to their corresponding concepts are very strong, as these are learned in conjunction with one another during the process of L1 acquisition. L2 lexical representations, on the other hand, have stronger links to the L1 lexical store, as they are most often learned by direct “lexical association” to their already-learned translation equivalent during the process of sequential L2

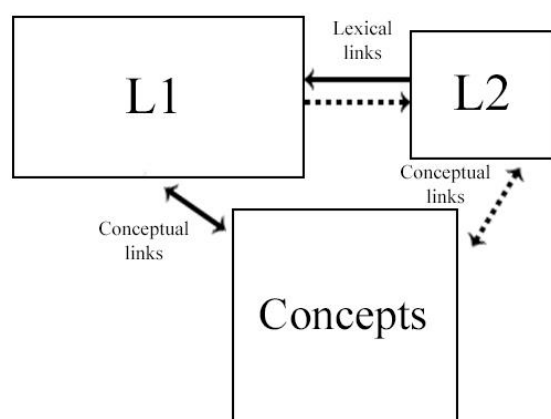
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¹ Note that the RHM proposes that *storage* at the lexical level is separate, yet *access* may be language non-selective (Kroll et al., 2010). The issue of separate storage versus selective access is difficult to tease apart.

acquisition. Crucially, the links between each of the three stores are directionally asymmetrical, such that those from the L1 to the L2 lexical store are weak, and those from the L2 lexical store to the joint conceptual store are also weak.

The Bilingual Interactive Activation (BIA) model (Dijkstra and van Heuven 1998) and its more recent version, the BIA+ model (Dijkstra and van Heuven 2002; see Figure 1B), posit that the bilingual lexicon is integrated at all levels of representation, including sublexical, lexical and semantic/conceptual. These computational models follow in the connectionist tradition, and assume a mechanism of both bottom-up and top-down spreading activation that can be both facilitative and inhibitory. Access is considered to be language non-selective and is controlled by top-down inhibitory activation from L1 and L2 language nodes.

(A) The RHM (Kroll and Stewart 1994)



(B) The BIA+ (Dijkstra and van Heuven 2002)

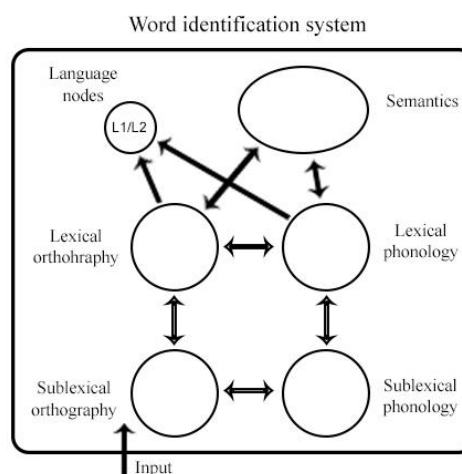


Figure 1. Prominent models of the bilingual mental lexicon.

These two models also differ significantly in terms of what they predict occurs when L2 proficiency increases. The RHM is very explicit about this developmental aspect: it postulates that, as L2 proficiency increases, the links between the L2 lexical store and the joint conceptual store become stronger through a process referred to as “concept mediation”. The BIA models are less explicit about developmental aspects; however, increased L2 proficiency would essentially result in higher L2 word frequency, which in turn results in greater resting activation levels for L2 lexical items. This results in faster, more L1-like, activation patterns.

L2 proficiency, however, is not the only factor that is thought to affect bilingual lexical organization. The precise roles of other factors, such as age of exposure, age of immersion, frequency of use, language dominance and manner of acquisition, are also likely to be involved, yet they remain largely unexplored. An important reason for this is that these factors are often confounded and, as such, their respective roles and relative contributions are difficult to tease apart. For example, individuals who are exposed to their L2 early in life are usually also immersed in it earlier, acquire it in a more

naturalistic manner, become more proficient in it, and are more likely to use it frequently (to the point where they may even be more dominant in it).

One of the first studies that attempted to disentangle some of these factors was that of Silverberg and Samuel (2004). In order to explain the large amount of mixed data when highly proficient bilinguals are tested, they decided to investigate the role of AoA and found evidence that, when L2 proficiency is controlled for, a shared semantic level is only present for early bilinguals and not late bilinguals. This study, however, employed an unmasked priming task, which is considered to tap into a post-lexical level of more controlled processing. Conscious strategies may be used during these tasks and thus strong claims cannot be made based on these results. Crucially though, this study was the one of the first attempts to tease apart the factors of L2 proficiency and AoA. We will now turn to recent research that has used a more subconscious methodology to investigate the organization of the bilingual lexicon and the factors that affect it.

1.1. The Masked Priming Paradigm

Studies employing priming paradigms have shed considerable light on the issues of lexical organization discussed above. This paradigm assumes that when a word is activated in memory, its activation spreads through a semantic network to other related words, thus activating them as well (Collins and Quillian 1969, Collins and Loftus 1975). For example, seeing the word "snow" causes activation to spread to the semantically-related word "ice". In a lexical priming paradigm, spreading activation thus spreads from the prime word to the subsequently presented and semantically related target word. Because the target word is pre-activated by the prime, access to it is facilitated, resulting in a faster response time (RT) to an overt question involving that target. When the priming paradigm is combined with a lexical decision task (LDT), participants are required to determine whether targets are real words of a particular language, or a non-word (i.e. a phonotactically-legal pseudoword).

In *masked* priming, the prime is presented so quickly that participants are not usually aware that they have seen it. In this manner, participants are unable to employ strategies that affect the results, for example post-lexical integration or a top-down translation strategy (Rastle, Davis, Marslen-Wilson, and Tyler 2000). In order for automatic, subconscious priming to occur, the stimulus onset asynchrony (SOA) must be less than 167ms (Altarriba and Basnight-Brown 2007). The standard paradigm used in most recent studies is based on that of Forster and Davis (1984), with an SOA of approximately 50ms. Crucially, when the prime and target are presented in different languages, this paradigm can provide evidence for a shared bilingual lexicon (Altarriba and Basnight-Brown 2007). For example, if seeing the English prime "snow" results in a faster RT to a target consisting of its French translation equivalent, "neige", this suggests that activation spreads automatically between the two lexicons, and is thus evidence that they access a shared system.

While some have argued that priming across languages is only possible with more controlled processes (Grainger and Beauvillain 1988), many recent studies employing the cross-language masked priming paradigm have found significant translation priming

effects. Interestingly, in some of these studies, priming effects are only found when the prime is in the L1 and the target is in the L2, and not when the prime is in the L2 and the target is in the L1 (Keatley, Spinks, and de Gelder 1994; Larsen, Fritsch, and Grava 1994; Williams 1994; Gollan et al. 1997; Jiang 1999; Jiang and Forster 2001). This is referred to as the masked translation priming asymmetry. In contrast, other studies have indeed found that automatic priming occurs in both directions (L1-to-L2 and L2-to-L1; Basnight-Brown and Altarriba 2007; Duyck and Warlop 2009; Duñabeitia, Perea, and Carreiras 2010). These studies, however, tended to have participants who were highly proficient and/or early L2 learners, whereas those that found the asymmetry have tended to have less proficient, sequential L2 learners. This suggests that priming in the L2-to-L1 direction is more sensitive to factors such as L2 proficiency and AoA.

Interestingly, this asymmetry also disappears when the task used in conjunction with the masked priming is changed from lexical decision (i.e. “is it a word”) to semantic categorization (i.e. “is it a member of category X?”). To account for these patterns, Finkbeiner et al. (2004) proposed the Sense Model. This model posits that L1 lexical items have more senses associated to them than do L2 lexical items, and as a result, L1 words activate a high proportion of L2 senses, whereas L2 words activate a relatively low proportion of L1 senses. In a semantic categorization task, this sense asymmetry does not matter as only the L1/L2 sense that is related to the semantic category being questioned is activated. For a more general lexical decision task, however, all senses of the L1 and L2 are activated, and as such, any existing sense asymmetry results in a priming asymmetry (i.e. L2 words provide less pre-activation to L1 words because they activate a smaller proportion of L1 senses). Like the BIA models, the Sense Model does not make explicit claims about the effects of increasing L2 proficiency; however, it seems to predict that more proficient L2 speakers have more senses associated to L2 lexical items, thus reducing the L1/L2 sense asymmetry and, consequently, the translation priming asymmetry in lexical decision tasks.

A recent study by Sabourin, Brien, and Burkholder (2014) employed the masked priming paradigm in the L2-to-L1 direction in order to tease apart the effects of AoA versus L2 proficiency. Participants were 102 native speakers of English from the Ottawa-Gatineau region, divided into four groups based on their experience with French: Simultaneous bilinguals, who had been immersed in both languages since birth; Early bilinguals, who had been immersed in French as an L2 before the age of six through “early immersion” school programs; Late bilinguals, who had been immersed in French as an L2 after the age of six through “late immersion” school programs; and L2 learners, who had never been immersed in French, but who had received some exposure through basic but compulsory “core French” programs at school.² In terms of L2 proficiency, the L2 learners had the lowest, and the Simultaneous bilinguals had the highest level. Crucially, however, the Early and Late bilinguals did not differ significantly in terms of L2 proficiency. Participants performed a LDT, with targets in the L1 (English) and translation primes in the L2 (French). Within-language (L1) repetition, semantic/associative, and unrelated primes were also used. While all groups showed the

² These participants had very low L2 French proficiency and so were essentially functional monolinguals.

expected repetition and semantic/associative priming effects, only the Simultaneous and Early bilinguals showed significant translation priming. Late bilinguals, like the functional monolinguals (“L2 learners”), did not. Because the Early and Late bilinguals were matched for L2 proficiency, this allowed the authors to conclude that AoA, as it was operationalized (the age at which they were immersed in the L2) is a crucial factor in the organization of the bilingual mental lexicon. As such, this data presented evidence that there is a sensitive period for bilingual lexical organization.

Before such a conclusion can really be drawn, however, it is necessary to investigate other factors that may affect bilingual lexical organization. For example, is it possible that even late bilinguals could show evidence of an integrated system if they learn their L2 in a more naturalistic manner? Early L2 learning may be inherently more naturalistic than late L2 learning, even when both occur in a similar “immersion program” instructional setting, as younger children may rely less on their still-developing and less entrenched L1. As such, they may be able to acquire the L2 in a more L1-like way. It is therefore possible that the evidence for a shared lexicon for the Early bilinguals found in the Sabourin et al. study is less reflective of a sensitive period in the traditional sense, and more so a consequence of the way in which the L2 was learned at this early age. Late bilinguals, on the other hand, have a well-established L1 and so may inherently rely more on that language during L2 learning, particularly in an instructional setting. In a more naturalistic setting, however, this may not be the case and therefore even these late bilinguals could show evidence of a more integrated bilingual lexicon.

The present study aims to investigate the effect of manner of acquisition (MoA) on the organization of the bilingual mental lexicon. This factor has received very little attention in relation to the issue of bilingual lexical organization. Before presenting this study, however, MoA will be more explicitly defined and discussed, with a particular emphasis on the importance of this factor for the bilingual population being investigated.

1.2. Manner of Acquisition

Manner of acquisition is most often cited in studies taking interest in different factors affecting the bilingual lexicon. While these have not investigated MoA directly, they mention that it is either embedded into a combination of factors such as proficiency, environment and AoA, or that it has been overlooked and most likely influences the organization of the bilingual lexicon (Ekiert 2005, Reiterer, Pareda and Bhattacharya 2009, Correa 2011, Sabourin et al. 2014). In either case, the results of the present study may indicate whether it has been erroneously included amongst other factors, or if it is relevant and thus has been overlooked.

To our knowledge, no research has yet attempted to investigate the effect of MoA on the bilingual mental lexicon or to use it as a factor in a masked priming study. While there seems to be few behavioural studies using MoA as a factor, some studies have tried to locate its influence in the brain (e.g., Vaid and Hall 1991).

The MoA dichotomy has been referred to using varied terminology (e.g., nurture versus nature, formal versus informal, naturalistic versus instructional); however, the terms “naturalistic” and “instructional” will be used in the present study. Naturalistic

learning is defined by Crezee (2012) as the “process of learners acquiring a second language with little formal training or teaching (p. 407)”. This is different from Ellis’ (1994) definition, who refers to these naturalistic learners as “mixed” learners, as even though they receive substantial input from the naturalistic setting, they also receive some from the school setting, as is required from different educational programs. While the “mixed learners” definition seems to fit modern Canada’s infrastructure, we will use the term “naturalistic” in order to emphasize the fact that, for certain groups of bilinguals, the largest contribution comes from that particular manner of learning. Similarly, “instructional” learners may often have a certain degree of “naturalistic” exposure, but learn their L2 predominantly in an institutional setting and so there is a larger contribution from the “instructional” manner of learning.

The present study was motivated by the observation that L1 English and L1 French bilinguals in the Ottawa-Gatineau region tend to have a different MoA, the former being more instructional and the latter being more naturalistic. This presents an interesting opportunity to investigate MoA; despite living in the same geographical area and speaking the same languages, they learn their L2 in a different way due to many factors.

While English and French are both official languages in Canada, the use of English is much higher than French in Ottawa. Here, English is exclusively spoken in 74.85% of households, while French is exclusively spoken in only 9.9% of households. This is more “bilingual” than Ontario as whole, where the corresponding statistics are 79% and 2.2%, respectively.³ Following a dominant-dominated dichotomy, English is dominant. Ottawa, however, has a neighbouring city, Gatineau, which is separated only by the Ottawa River. Here, French is dominant, with English being exclusively spoken in only 13.4% of households and French being exclusively spoken in 78.1% of households. Even though Gatineau’s population is only 30.0% of Ottawa’s, this causes a great influx of French speakers, notably at the University of Ottawa, creating a dominant English environment with a considerable amount of French L1 speakers.

As in any dominant-dominated setting, learners will get more exposure to the dominant language outside of instructional institutions. This makes for an interesting learning environment for both English and French bilinguals. Presumably, the English bilinguals would mostly learn their L2 in school, in a relatively instructional setting, as French is seldom used outside of that environment. Muñoz (2008) mentions problems with instructional education: the language is limited in source (the teacher), quantity, and quality and is not the main language of communication between peers and/or is not used outside the classroom. This is very often the case even in so-called “French Immersion” programs, where the primary language of instruction for most subjects is the L2.

However, while L1 French bilinguals do get instructional exposure (see mixed learning), they tend to also get a lot of exposure out of the classroom. They will hear English words everywhere in town, at home on television, in songs on the radio. All this additional exposure gives the French learners a more naturalistic learning experience.

³ This information is taken from the 2011 Census (statcan.gc.ca). It should be highlighted here that the values are for the exclusive use of French in households in Ontario and thus likely under-estimates the amount of French used in the city.

To be able to compare the two types of learning, it is necessary to contrast groups of sequential bilinguals, since simultaneous bilinguals rarely receive an instructional learning experience. By definition, simultaneous bilinguals are immersed in both languages early in their life (i.e. during infancy), usually at home through primary caregivers. As they get into school, the possibility of instructional learning without previous naturalistic exposure is low, which make them less attractive to MoA research.

Research on the bilingual mental lexicon has shown that L1 English late learners of French from the Ottawa region do not exhibit translation priming effects (Sabourin et al. 2014), suggesting that they have a separate store for the two languages. This sets up the outcome for instructional learning. On the other hand, if naturalistic learning is more efficient (Muñoz 2008, Reiterer 2009, Sumara 2014), we could see evidence of an integrated lexicon for a group composed of L1 French late learners of English from Ottawa. These trends introduce our hypothesis: naturalistic learners will show evidence of having an integrated lexicon even if they acquired their L2 late, and as such they will show similar masked translation priming patterns to early (and simultaneous) bilinguals.

1.2.1. Modeling MoA

While it is clear how some of the models of the bilingual lexicon discussed above could account for the effects of MoA on lexical organization, it is less clear for others. For the RHM (Kroll and Stewart 1994), it could be said that naturalistic exposure to the L2 may lead to stronger links from the L2 lexical store to the joint conceptual store, because using/hearing the L2 in real communicative situations may promote conceptual mediation and reduce lexical association as a strategy for lexical acquisition.⁴ If masked priming makes use of the conceptually mediated route (i.e. activation spreads from the L2 word, to the concept, to the L1 word) as opposed to the direct links between L2 and L1 words (Kroll and Stewart 1994; Altarriba and Basnight-Brown 2007; Brysbaert and Duyck 2010; Grainger, Midgley, and Holcomb 2010), then this would predict greater translation priming effects for those who acquired their L2 more naturalistically.

In terms of the Sense Model (Finkbeiner et al. 2004), it could be argued that naturalistic exposure could promote the acquisition of more rich and detailed semantic representations for L2 lexical items, and as such, L2 lexical items may have a greater number of senses associated to them when they are learned naturalistically as opposed to in an instructional setting. As such, the L2-to-L1 priming effect may be greater for those with naturalistic exposure as there would be less of an L2:L1 sense asymmetry.

The BIA models, on the other, do not make very clear predictions regarding the role of MoA. Smaller translation priming effects for late/less proficient bilinguals (in the L2-to-L1 direction) have essentially been attributed to frequency effects: low frequency L2 lexical representations have low resting activation levels, and so cannot provide a

⁴ Indeed, the relationship between naturalistic exposure and conceptual mediation seems more intuitive than that between high L2 proficiency and conceptual mediation, as “high” proficiency may simply reflect a high level of explicitly-learned information and does not necessarily involve concept-based native-like processing.

sufficient activation boost to L1 lexical representations to result in priming effects (though see Jiang and Forster (2001) for further discussion). Because factors like length of exposure (which is often correlated with AoA), L2 proficiency and frequency of L2 use can modulate L2 word frequency, such quantitative factors are more easily incorporated into these models. It is unclear, however, how a more naturalistic MoA could lead to increased L2 word frequency, and so it seems that the BIA models would not predict any effect of MoA on translation priming.

2. The Present Study

The main goal of the study presented here is to investigate how a more naturalistic MoA may interact and possibly change the organization of the bilingual mental lexicon. According to our previous research (Sabourin et al. 2014) an early (before age 6) AoA is an important determining factor in whether or not an integrated bilingual mental lexicon is present. Participants in the earlier study (with English L1 and French L2), only showed evidence for an integrated lexicon if they were either simultaneous or early bilinguals. The late bilinguals (even with equal L2 proficiency to the early bilinguals) did not show such evidence. However, for various reasons, discussed above, we feel that another important factor that may impact whether the lexicons are separated or integrated is MoA. While the late bilinguals (with L1 English) in the Sabourin et al. study were all, at one point after the age of six, immersed in the French language, this was mostly in late immersion programs within the educational system. This is very different from how L1 French speakers are immersed in the L2 English environment, at least as university students in the Ottawa region. To test for an effect of a more naturalistic MoA we have implemented a similar masked priming lexical decision task to that used in Sabourin et al. (2014), but with L1 (French) target words. This paradigm will not only allow us to investigate a group of L1 French speakers but will allow us to directly compare our present results (both the presence/absence of priming effects as well as the magnitude of priming effects) with those obtained with the L1 English participants in the Sabourin et al. (2014) study. In particular, the translation condition (where the prime and target are the non-cognate translation equivalents of each other) is of interest as this condition will allow us to identify how cross-language items are organized for bilinguals.

The current experiment, outlined below, investigates whether having a more naturalistic MoA will result in late bilinguals representing the items from their two languages in a joined lexicon. This will be seen by having a translation priming effect by L1 French, late L2 English participants and this is counter to our previous claim that an early AoA (operationalized with age of immersion) is a critical factor in finding L2-to-L1 non-cognate priming effects. For the current purposes only the data from the translation priming condition and the control condition are analyzed as it is the presence vs. absence of a translation priming effect (compared to the control) which is key to determining whether or not the lexicons are integrated or separate (Altarriba and Basnight-Brown 2007).

3. Methods

The methods used for the current study follow that of the previous research (Sabourin et al. 2014). In particular, the data for the L1 English participants presented here is from this previous study. Additionally, in order to investigate the effects of MoA on the L2-L1 priming direction, a French version of the same experiment was developed. In the description below we focus on this new French version of the experiment and direct the readers to Sabourin et al. (2014) when necessary for specific details about the English version of the experiment.

3.1. Participants

The data from 61 participants were analyzed. Forty-two of the participants (a subset of the participants tested in Sabourin et al. 2014) had L1 English and L2 French (25 participants are early bilinguals and 17 are late bilinguals) and 19 of the participants were late bilinguals with L1 French and L2 English. All participants resided in the Ottawa-Gatineau region at time of testing. See Table 1 below for participant information.

Table 1. Participant information.

Participants	n	AoA (range)	Mean L2 Proficiency (std. dev.)
L1-English Early Bilinguals	25	3 – 5 yrs old	6.54/10 (1.41)
L1-English Late Bilinguals	17	9 – 19 yrs old	5.94/10 (1.25)
L1-French Late Bilinguals	19	7 – 16 yrs old	7.3/10 (0.97)

3.2. Materials

Two sets of stimuli were used for the study presented here. L1-English participants conducted an English lexical decision task on English words and pseudowords. Details are provided in Sabourin et al. (2014). The L1-French participants conducted a French lexical decision task on French words and pseudowords. One hundred and forty-six words of varied frequency (using Lexique 3: New, Pallier, Ferrand, and Matos 2001; target word frequency ranged from 0.14 to 955.68) and their non-cognate English translations were used. An equal number of pseudowords were also used. Four different prime types for each target word was created such that, like in the previous study, there were four experimental conditions: repetition, association/semantic, translation and control. For example, for the target word *RENARD* ("fox"), the repetition prime was *renard*, the association prime was *loup* ("wolf"), the translation prime was *fox*, and the unrelated prime was *rusé* ("sly"). All primes for pseudoword targets were in French.

Participants were randomly assigned to different lists of the experiment such that no one saw any target word more than once. Each list presented all target words in one of the experimental conditions counterbalanced across all lists. Items were presented in a semi-random order such that no single condition was presented more than twice in a row.

3.3. Procedure

Participants were seated in a sound attenuated room in front of a computer screen. Instructions were provided in French both verbally by the experimenter and on the computer screen. All participants were told to make a French lexical decision (as quickly and as accurately as possible) on the target word appearing in upper case letters. The task was a forward masking paradigm with the prime presented for 52ms between the forward mask and the target item (e.g., Forster and Davis 1984, Wang and Forster 2010). Specific paradigm details are provided in Sabourin et al. (2014). The experiment was controlled using the *Presentation* software (Neurobehavioral Systems).

4. Results

For each participant, incorrect responses as well as responses under 300ms and above 1200ms were excluded from the beginning. In addition, response times (RTs) that were more than two standard deviations above or below each participant mean were removed. Two different sets of analyses were conducted. In Analysis 1, the three participant groups were compared to investigate the effects of AoA. AoA was defined as age of immersion in the L2 (following Sabourin et al. 2014). In Analysis 2, to further isolate MoA, the analysis was conducted on the data from 11 L1-French participants who reported having relatively more naturalistic current L2 input.⁵ The data from these participants were then compared to 11 of the highest proficiency L1-English participants with late L2 French.

4.1. Analysis 1

A two-way mixed ANOVA was conducted investigating *Condition* (Translation, Unrelated) and *Participant Group* (L1-English Early Bilinguals, L1-English Late Bilinguals, L1-French Late Bilinguals). Although the interaction between condition and group was not determined to be significant ($F(2,58) = 1.331, p=.272$), follow-up t-tests were conducted based on our specific predictions in order to determine which, if any, of the groups showed translation priming effects. Both the L1-English Early Bilinguals (difference of 14.79ms: $t(24)=2.37, p=.026$) and the L1-French Late Bilinguals (difference of 13.69ms: $t(18)=1.91, p=.073$) showed significant translation priming. The L1-English Late Bilinguals, however, did not show significant priming effects (difference of 3.37ms: $t(16)=.052, p=.959$). These effects are shown graphically in Figure 2.

4.2. Analysis 2

To further isolate the issue of MoA, we chose a subset of the L1-English Late Bilinguals who best represented those with a more instructional MoA ($n=11$), and a subset of L1-French Late Bilinguals who best represented those with a more naturalistic MoA ($n=11$).

⁵ We operationalized this more naturalistic MoA as more than 25% use of English in a more naturalistic setting (with friends, at work, at university, watching television, etc.).

In order to make these two groups as comparable as possible in terms of L2 proficiency, we chose 11 L1-English participants with the highest self-rated L2 proficiency (average rating 6.4/10); however, the L1 French participants still rated their L2 proficiency as being somewhat higher (average rating = 7.36/10). Due to the low N's, t-tests (and not an overall ANOVA) comparing the Translation and Unrelated conditions were conducted for each participant group in order to determine whether either group showed a translation priming effect. Similar to Analysis 1, the L1-English Late Bilinguals did not show a significant translation priming effect (difference of 6.19ms: $t(10)=.907$, $p=.386$). The t-test for the L1-French Late Bilinguals, however, did reveal a marginally significant translation priming effect (difference of 17.27ms: $t(10)=2.13$, $p=.059$).

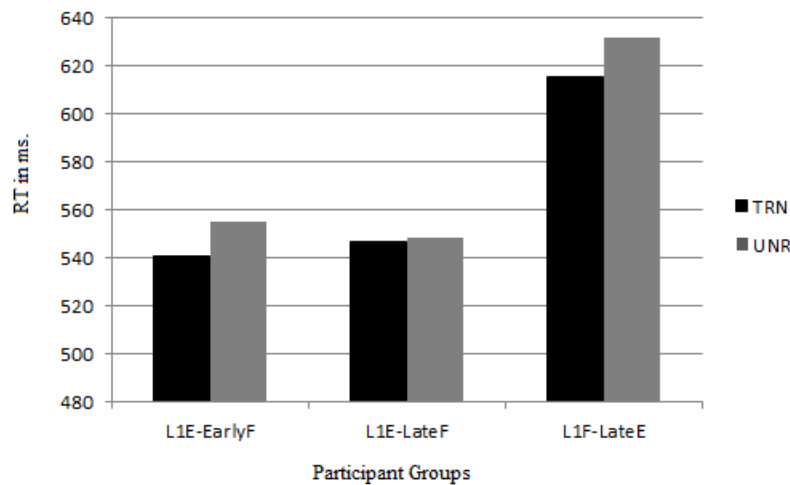


Figure 2. Results for Analysis 1. RTs for the translation and control conditions.

5. Discussion

The main finding of the present study is that the group of L1-French Late Bilinguals displayed (marginally) significant translation priming effects despite having a Late AoA (> 6 years), suggesting that they do have an integrated lexicon. This contrasts with previous results from Sabourin et al. (2014), which indicated that Late bilinguals, who happened to have a more instructional MoA, do not have an integrated lexicon. The present results thus suggest that such late bilinguals can indeed have a shared bilingual lexicon, if the L2 was acquired in a more naturalistic manner. Consequently, MoA appears to be a factor that should be taken into account in such investigations.

These results also constitute preliminary evidence *against* a sensitive period for bilingual lexical organization, since a late AoA for the L1 French participants did not prevent an integrated lexicon. This has interesting implications for the interpretation of Sabourin et al. (2014)'s previous results. Recall that their main finding was that, despite being matched for L2 (French) proficiency, the L1-English Early bilinguals showed significant masked translation priming effects, while the L1-English Late bilinguals did not. They took this as evidence that an early AoA was necessary for bilingual lexical

integration to occur, and consequently, that a sensitive period was involved. As discussed earlier, however, they did not control for the possibility that early L2 learning may be inherently more naturalistic than late L2 learning, even when both occur in a similar instructional setting, such as the French Immersion programs popular in the Ottawa region. Again, this may be because younger children rely less on their still-developing and less entrenched L1 and so may be able to acquire the L2 in a more L1-like way. We hypothesized that the evidence that was found for a shared lexicon for the Early bilinguals was perhaps less reflective of a sensitive period in the traditional sense, and more so a consequence of the way in which the L2 was learned at this early age. The preliminary findings of the present study, that late bilinguals with a more naturalistic MoA show evidence of an integrated lexicon, suggests that this may indeed be the case.

Of course, it must be said that these conclusions are based on an only marginally significant translation priming effect ($p=.073$), which may or may not be a result of the relatively small number of participants tested ($n=19$). Interestingly though, the translation priming effect for the L1-French Late Bilinguals was of similar magnitude (approximately 14ms) to that of the L1-English Early Bilinguals tested by Sabourin et al. (or at least the subset re-examined here), where it was more strongly significant ($p=.059$) and based on a larger sample size ($n=25$). This suggests that the effects were indeed comparable between the two groups, thus giving some strength to the results for the L1-French Late Bilinguals.

It should also be noted that the language background questionnaire used to assess participants was not specifically designed to collect information regarding MoA, and as such, the distinction that was made between the groups of "naturalistic" versus "instructional" learners was largely based on the assumption that L1-French speakers tend to learn their L2 in a more naturalistic manner than do L1-English speakers. While this is not an unjustified assumption (as participants' self-reported "current use" of their L2 reflected the fact that L1-French speakers use their L2 in more diverse and naturalistic ways than do L1-English speakers), future studies investigating the effects of MoA on bilingual lexical organization should better isolate and operationalize this variable in order to draw stronger conclusions. We are currently in the process of developing a language background questionnaire that has precisely this objective.

The conclusion that a naturalistic MoA impacts bilingual lexical organization has interesting implications for models of the bilingual lexicon. As discussed in section 1.2.1, the concept of MoA fits well in models such as the RHM, and the Sense Model, but less so with the BIA models.

For the RHM, we suggest that naturalistic exposure to the L2 may lead to stronger links from the L2 lexical store to the joint conceptual store, because using/hearing the L2 in real communicative situations may promote conceptual mediation and reduce lexical association as a strategy for lexical acquisition. For the Sense Model, we suggest that naturalistic exposure could promote the acquisition of more rich and detailed semantic representations for L2 lexical items, and as such, L2 lexical items may have a greater number of senses associated to them when they are learned naturalistically.

For the BIA and BIA+ models, on the other hand, it is unclear how a more naturalistic MoA could affect the presence/magnitude of translation priming effects, as it

would not have a direct effect on L2 word frequency. However, Grainger et al. (2010), have proposed a developmental framework that encompasses the BIA models (the BIA-d model) in order to account for L2 vocabulary learning. This model appears to be promising on many levels. First, it incorporates the RHM model at an initial stage which then develops into a BIA model. As such, it combines the two most prominent bilingual lexical processing models in such a way as to be able to represent many aspects of L2 lexical processing. Second, this model focuses on late learners which is probably the group of learners that is important to study in order to see MoA effects on lexical organization that are above and beyond those that are due to an early AoA. Finally, the BIA-d model focuses on the role of inhibition of the L1 for the development of the L2 word forms. It has been suggested that for this inhibition of the L1 to develop, naturalistic immersion in the L2 language is important (Linck, Kroll, & Sunderman 2009).

6. Conclusion

While the results of the present study are preliminary, they suggest that late L2 learners may indeed have an integrated bilingual lexicon if L2 acquisition occurred in a relatively naturalistic manner. If this is the case, then it constitutes evidence against a sensitive period for bilingual lexical organization. Minimally, the current study demonstrates that MoA warrants further investigation.

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