Part I

Theoretical and Methodological Considerations

1 The Cross-Modal Lexical Priming Paradigm and Bilingual Exhaustive Access

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Introduction

Task selection is crucial in the investigation of bilingual lexical access. Such a statement, in the words of Swinney (1982), would seem *so self-evident as to be nearly tautologous* (p. 152); the question of whether bilingual lexical access is *selective* (i.e., involves the activation of contextually relevant language only) or *nonselective* (i.e., involves the simultaneous activation of both languages regardless of contextually relevant [language] information; Gerard & Scarborough, 1989) would be more appropriately resolved by taking into consideration the processing demands imposed by the experimental paradigm (Craik & Lockhart, 1972; Morris, Bransford, & Franks, 1977). In addition to the cognitive processes being measured by the orienting task (e.g., semantic vs. shallow), Craik and Lockhart underscore the importance of *incidental* tasks in which participants are not aware of, or told explicitly, that they are participating in a memory experiment (see also McLaughlin, 1965). Accordingly, these tasks prevent participants from actively engaging in strategic learning, thus making the task more *ecologically valid* to study memory and learning processes as they occur in the real world. A similar designation has been applied to *implicit* or *indirect memory* tasks (e.g., lexical decision) that assess retrieval without awareness or conscious recollection. *Explicit* or *direct memory* tasks are those that require awareness or conscious recollection (e.g., free recall; Roediger, 2008). However, the implicit-explicit dimension should be seen as a continuum. Other tasks tapping semantic memory are further classified as measuring automatic cognitive processes (i.e., early stages of lexical processing) taking place *online*, in real time, and on the fly and those taking place late that involve lexical integration and problem-solving strategies (e.g., Fernández & Sousa, 2016).

To illustrate, consider the *sentence verification task* typically used to measure semantic memory. Participants read or listen to sentences such as *Tomatoes are vegetables* and their task is to make a quick true/false judgment about the statement. Typically, amnesics perform equivalently

to a control group on implicit memory tasks (see, e.g., Baddeley, 1990). However, they experience retrieval difficulties on explicit tasks, suggesting that the sentence verification task requires conscious recollection, which is impaired in this population. At the bilingual level, the *translation recognition task* has received the most attention (De Groot, 1992; De Groot, Delmaar, & Lupker, 2000, Experiment 1). In this task, bilinguals are presented with an interlanguage homograph prime (e.g., *glad* in Dutch) and a target that is the English translation of the homograph (e.g., *slippery*). Briefly, interlanguage homographs are words sharing similar to identical orthographic representations but whose meaning is dissimilar across languages. The participant's objective in the translation task is to determine (yes/no) if the target is a translation of the prime. Although results from De Groot and colleagues (2000) supported bilingual nonselective activation, in regard to the implicit-explicit continuum, this task is closer to the explicit end since participants have to "consciously" determine if the word pairs are translation equivalents. Extensions of the original task (e.g., *translation priming paradigm*; Davis et al., 2010; and Keatley, Spinks, & De Gelder, 1994 for the *cross-language priming paradigm*) fit the profile of an implicit task. In the translation priming paradigm, participants are presented with a prime (*glad*) and its translation target (*slippery*) and a nontranslation control (e.g., *sneaky*). The participant's task is to determine if the target is a real word or a nonword, in English, in this case. At issue is whether participants are faster responding to translation targets, relative to their controls (facilitative priming), or whether nontranslation targets are actually faster than related ones, thus resulting in lexical inhibition. In this case, both facilitation and inhibition would unequivocally argue for bilingual exhaustive lexical access, the latter even more so than the former, on account of the negative priming it implicates (e.g., Libben & Titone, 2009; Macizo, Bajo, & Martín, 2010; see also De Groot et al., 2000).

For the translation task as implemented in sentence processing (van Hell & De Groot, 2008, Experiment 2), participants read sentences such as *The questions at the exam required knowledge and* – and after a 4,000 ms delay, dashes are replaced with an English cognate target (e.g., *insight*) or its Dutch cognate equivalent (e.g., *inzicht*) for a Dutch sentence that remains on the screen for 5,000 ms. (Cognates are words across languages that share similar to identical orthography and meaning.) The bilingual's task is to translate the English target into Dutch, in this case. The same procedure has been applied to the *rapid serial visual presentation* task in which words are presented for 200 ms, one at a time (van Hell & de Groot, 2008, Experiment 3). Although findings from these tasks

have been taken to support lexical selectivity under high-constraint contextual conditions and lexical nonselectivity under low-constraint contextual conditions, the global reading measures used by these tasks make them susceptible to lexical integration and strategic problem-solving, particularly the fragmented nature of the stimuli and the long response time manipulations. Therefore, results stemming from these types of tasks are difficult to reconcile with models emphasizing autonomous and automatic bilingual lexical access.

In this chapter, we provide a critical overview of the *cross-modal lexical priming paradigm* (CMLP; Blasko & Connine, 1993; Cieślicka, 2006; Cieślicka & Heredia, 2016; Felser & Roberts, 2007; Heredia & Blumentritt, 2002; Heredia & Muñoz, 2015; Li & Yip, 1998; Stewart & Heredia, 2002; Swaab, Brown, & Hagoort, 2003; Swinney, 1979; Swinney et al., 2007; Tabossi, 1996; see also García, Cieślicka, & Heredia, Chapter 8, this volume) and its variants, as used in bilingual lexical ambiguity resolution. We start out by providing a description of the task's functionality and applicability in bilingual lexical access. We then go on to discuss findings from the bilingual ambiguity resolution literature where the CMLP paradigm has been utilized to assess bilingual multiple language activation.

Cross-Modal Lexical Priming

In the CMLP paradigm, participants listen to uninterrupted sentences, presented aurally as in Sentence (1.1). At a designated probe position (1, 2, 3, 4, … n, represented as subscripts in Sentence [1.1]), participants make lexical decisions (i.e., decide if a presented string of letters is a word/nonword) or name a visually related/control target. Faster lexical decisions or naming responses, in reaction time, to related rather than nonrelated targets are interpreted as *facilitatory priming effect(s)*. Alternatively, the related targets might actually be slower than the nonrelated targets, in which case *lexical inhibition* or *negative priming* would occur (see Macizo et al., 2010). The *priming effect* in the CMLP is taken as an index of lexical activation, or how active/inactive a meaning of an ambiguous word following an ambiguous word as in Sentence (1.1). The critical prime (*floor*) in Sentence (1.1) is a Spanish-English *interlingual homophone* sounding very similar in both languages but semantically different (Spanish = *flor*: *flower*). This would be a contextually non-biased sentence since the preceding information says nothing about the meaning of the homophone. However, the preceding context

could be potentially biased toward the English (e.g., *linoleum*, *mat*) or Spanish (e.g., *garden*, *valentine*).

(1.1) *He said we needed*$_{[*1]}$ *a nice FLOOR*$_{[*2]}$ *that matched*$_{[*3]}$ *the new*$_{[*4]}$ *paint.*

Using the CMLP, it would be possible to probe at position 2 (prime offset) to determine exhaustive activation of both Spanish and English meanings by visually presenting Spanish or English–related/nonrelated control targets (*rose*/*suit*, *rug*/*rod*), respectively. Significant priming for both language meanings (*rose* and *rug*) would suggest automatic parallel activation for both languages, regardless of which meaning is more or less active. Multiple meaning activation for both languages could be further tested downstream in positions 3 or 4 (300 or 700 ms after the prime offset). Probe positions 2–3 would be analogous to eye-tracking measurements assessing early and automatic stages of lexical processing and position 4 would be equivalent to late stages involving lexical integration and problem-solving (Libben & Titone, 2009; Whitford, Pivneva, &Titone, 2016; see also Palma & Titone, Chapter 7, this volume). In turn, probing in position 1 would provide a baseline to serve as a comparison for positions 2–4. If the bilingual linguistic system is indeed nonselective, exhaustive activation would be evident in positions 2–3, regardless of the preceding contextual information (biased vs. nonbiased; see also Falandays & Spivey, Chapter 2, this volume). By position 4, language selectivity would occur, since by then postlexical and integrative processes have taken place, inhibiting or suppressing meanings that are irrelevant with the provided linguistic information (language context, biasing context).

To summarize, the CMLP is a highly reliable experimental task, sensitive to lexical access and processing reflecting *true online* psycholinguistic processes as they unfold in real time, moment-by-moment (Stewart & Heredia, 2002; Onifer & Swinney, 1981). It does not draw participants' attention to potential ambiguities being manipulated in the experimental material and prevents them from generating anticipatory strategies as it would be unpredictable (i.e., implicit and incidental) where in the sound stream the probing target would appear. The CMLP paradigm is an ecologically valid task providing a natural way to measure lexical activation. It avoids some of the issues encountered in the bilingual reading literature where bilinguals are not typically balanced in their reading abilities in both languages. Since it relies on spoken language, it controls for individual differences (e.g., *poor* vs. *good readers*) as encountered in the reading literature. Indeed, spoken language is so natural that, by

three to four years of age, children are expert speakers (see, e.g., Ferreira & Anes, 1994).

Cross-Language Activation

Bilingual lexical access has been typically studied using cross-linguistic instances producing lexical competition during retrieval (e.g., figurative language, homophone, homographs). Other sources of potential bilingual lexical ambiguity arise during the translation process. It turns out that bilinguals take significantly longer to generate a cross-language translation for words with multiple translations (e.g., *bark* = *ladrido*, *corteza*, *tecata* in Spanish) than words with fewer possible translations (e.g., *house* = *casa*; see Schwieter & Prior, Chapter 5, this volume). Is there any evidence that, during comprehension, bilinguals exhaustively activate all the possible second language (L2) translations of a first language (L1) target? More generally, is bilingual word recognition a further instantiation of lexical ambiguity in which, for example, activation of an L1 concept (e.g., *war*) would automatically trigger an L2 related concept (*guerra*)? General memory models such as *semantic spreading activation* (Mason, 1995) and the *bilingual language-nonselective hypothesis* would predict automatic multiple activation in such instances.

In perhaps the only study to date addressing this issue directly, Cieślicka and Heredia (2016; cf. Hernández, Bates, & Ávila, 1996) presented Spanish-English bilinguals with spoken Spanish sentences of the type described in Sentences (1.2) and (1.3).

(1.2) *Es difícil reconocer que una GUERRA$_{[*1]}$ trae más ganancias que pérdidas.*
Translation: It is difficult to admit that a WAR$_{[*1]}$ sometimes brings more profits than losses.

(1.3) *Los soldados se entrenan para el combate y la GUERRA$_{[*1]}$ y por eso se invierte en ellos.*
Translation: Soldiers are trained for combat and WAR$_{[*1]}$ and that is why so much is invested on them.

Sentence (1.3), unlike Sentence (1.2), is contextually biased toward the meaning of the critical prime. Using the cross-modal naming task, a variant of CMLP, at the offset of the critical prime (*guerra*), participants named a Spanish/English associate (*paz*/*peace*) and its control (*boca*/*road*). Not surprising, the priming effect was larger for the Spanish targets. More interesting, however, was the finding that the English targets produced a diminished but significant priming effect. Both sentence types exhibited

the same patterns. Follow-up studies utilizing English sentences (translations of Sentences 1.2 and 1.3) and similar procedures revealed significant priming effects for both sentence types. For these experiments, unexpectedly, the priming effect was larger for the Spanish targets.

Indeed, Cieślicka and Heredia's (2016) results are unequivocal and provide a clear demonstration of the possibility that bilingual word recognition might represent another expression of lexical ambiguity and bilingual multiple access. Cieślicka and Heredia used the cross-language priming paradigm involving prime-target associates (e.g., Keatley et al., 1994); however, the translation priming paradigm employing prime-target translations (Davis et al., 2010) would have yielded comparable results. Future research in translation ambiguity resolution would benefit from utilizing the CMLP and its variants to further explore the possible effects that multiple activation of translation candidates have on bilingual lexical access and translation processes.

Figurative Language Processing

Figurative language comprehension in its different expressions (e.g., idioms, metaphor, proverbs, irony, sarcasm, and metonymy) could be pragmatically challenging for bilinguals (Heredia & Cieślicka, 2015). A figurative expression or an *idiomatic expression*, as in Sentence (1.4), could be understood in terms of an intended or *figurative meaning*, referring to a marriage, or in terms of its *literal meaning* related to ropes. Sentence (1.5) includes a metaphoric expression intended to describe a lawyer that is cunning and vicious. The literal meaning, in turn, would imply that the defense lawyer is a fish and a great swimmer. How do bilinguals comprehend figurative expressions? Are bilinguals able to automatically trigger the intended meaning? Are bilinguals more likely to first trigger the literal sense of a figurative expression, and then decide that the intended meaning is the most appropriate? Alternatively, is it possible that the two meanings of the figurative expression remain active momentarily (i.e., exhaustive activation), and over time only the intended and pragmatically appropriate meaning remains active? In this section, we attempt to provide answers to these questions. We first review research findings from the idiom processing literature followed by a discussion of metaphor processing and bilingual lexical access.

(1.4) *Peter was planning to tie the$_{[*1]}$ knot$_{[*2]}$ later that month.*

(1.5) *The defense lawyer is a shark, known for his questionable money-making schemes.*

In one of the first studies to employ the CMLP, Cieślicka (2006) had Polish-English bilinguals listen to English sentences as in Sentence (1.4). Meaning activation of the literal vs. figurative meaning was measured at the idiom's penultimate word (position 1) and at idiom offset (position 2). Participants made lexical decisions to literal/control (*rope*/*ripe*) and figurative/control (*marry*/*limit*) targets. To summarize, results revealed comparable activation of the literal meaning at both positions. Beck and Weber (2016, Experiment 1), using similar experimental procedures and probing at position 2, as in Sentence (1.4), arrived at the same conclusion. This pattern of results is accounted for by Cieślicka's *literal salience hypothesis*, which assumes that the activation of a literal or figurative meaning is directly correlated with the degree of metaphorical proficiency and the learner's familiarity with a given L2 idiom. In this case, the literal meaning of the idiomatic expressions was more salient (i.e., more automatic and available more quickly in lexical access), given the overall English proficiency of the Polish-English bilinguals. Along similar lines, Beck and Weber's German speakers learned English late in life. One issue to consider, for example, is that, in Cieślicka's (2006) experiment, it is difficult to differentiate activation between positions 1 and 2, given their close proximity. As a methodological note, it is generally suggested that probe positions in the CMLP should be placed far apart as to avoid overlap between the probes. This is particularly true given the automatic and fast unfolding of the spoken sound wave.

At the metaphorical level, Heredia and Muñoz (2015) looked at referential metaphor or metaphoric reference in which, unlike the traditional metaphor, the *topic* or *subject* and the *vehicle* that serves as the comparison to the subject of the metaphor are further apart. As can be seen in Sentence (1.5), both the subject (*lawyer*) and the vehicle (*sharks*) are close in proximity. Sentence (1.6) is an example of a referential metaphor.

(1.6) *The appointment of the city official, known for his questionable moneymaking schemes, is encouraging voters to push for a citywide referendum to stop the* $\underline{\text{shark}}_{[\star 1]}$ *from taking office and*$_{[\star 2]}$ *becoming City Manager.*

In a referential metaphor, the vehicle is provided (*shark*). However, the subject has to be reactivated from the preceding context or inferred by the listener. In their experiments, Heredia and Muñoz measured literal/figurative activation (e.g., literal/control: *fish*/*roll* vs. figurative/control: *attorney*/*message*) at metaphor offset (position 1), 1,000 ms (Experiment 1), and 300 ms after metaphor offset (Experiment 2). The results of Experiment 1 revealed activation of the figurative interpretation at position 1 only and literal activation at position two. These results were qualified in Experiment

2, suggesting that, while both meanings were active at metaphor offset, the literal interpretation was more salient than the figurative interpretation of the referential metaphor. As in Cieślicka (2006), the literal salience hypothesis accounted for Heredia and Muñoz's (2015) results (see Heredia & Cieślicka, 2016 for similar findings using eye movements). Indeed, given that the Heredia and Muñoz study is the only one addressing metaphoric processing with the CMLP, further replications of this work are needed.

Homophone Processing

At the homophone and homograph level (see García, Cieślicka, & Heredia, Chapter 8, this volume), studies utilizing the CMLP or a variant are limited. One exception is Li and Yip (1998, Experiment 2). Li and Yip presented Chinese-English bilinguals with sentences in Cantonese with a critical English-Chinese homophone embedded within the sentence. The critical prime, in this case, was the English-Chinese homophone (e.g., *bike*) pronounced in Cantonese phonetics, since it reflected the natural course of code-switching. Sentences were either contextually biased or nonbiased toward the meaning of the Cantonese homophone. At 150 ms after onset of the critical homophone (cf. Sentence [1.1]), participants named a visual target in English that was identical to the critical homophone, a Cantonese counterpart that shared the same consonant-vowel structure as the homophone, or a Cantonese and English target with no apparent phonological overlap to the critical homophone. The overall results showed that, on average, the preceding context facilitated lexical access for both Cantonese and English targets. However, participants were quicker to name English targets that were identical to the critical homophone than the Cantonese targets that shared phonological similarity to the critical target. These results, as interpreted by Li and Yip, revealed a pattern in which the early acoustic identification of the auditory homophone (i.e., critical prime in the sentence) facilitated lexical access to the visual English target that identically matched the phonological structure of the critical spoken homophone, as opposed to the Chinese visual probes that were similar. Li and Yip's results underscore the usefulness of the cross-modal naming task to investigate the effects of context and the acoustic information required for lexical selection and, ultimately, the disambiguation of homophony in a tonal language.

General Conclusion

The purpose of the present chapter was to provide an overview of the CMLP. Although highly underutilized, the CMLP can be an important