

# 5 Cognitive Processes in Second Language Learners and Bilinguals: The Development of Lexical and Conceptual Representations

---

JUDITH F. KROLL AND  
GRETCHEN SUNDERMAN

## 1 Introduction

In the past decade there has been increasing interest on the part of cognitive psychologists and psycholinguists in characterizing the cognitive processes that support second language acquisition. One focus is to understand how cognitive systems are constrained by the context and timing of acquisition and to identify the source of these constraints (e.g., Birdsong, 1999; Hyltenstam and Abramsson, this volume; Long, 1990, 1993; MacWhinney, 1999). A second concerns the cognitive consequences of having two languages active in early childhood (e.g., Bialystok, 1997). A third addresses the representations, processes, and strategies that are used when skilled adult bilinguals read and speak words and process sentences in each of their two languages (e.g., Costa, Miozzo, and Caramazza, 1999; Dijkstra, Van Jaarsveld, and Ten Brinke, 1998; Dussias, 2001; Jared and Kroll, 2001). These strategies include processes that are a feature of monolingual performance as well as those that peculiarly reflect the specific demands of juggling two languages in a single mind (e.g., Green, 1998; Grosjean, 2001). It is this third focus that is the topic of our chapter. From a psycholinguistic perspective, understanding the basis of proficient bilingual performance reveals the cognitive processes that are necessarily recruited during second language acquisition as well.

We first review the recent psycholinguistic evidence on reading and speaking in two languages. In each section, we summarize studies on skilled bilingual

performance and, where available, the corresponding data for second language learners. Our review will address issues of lexical acquisition and representation because it is this topic on which the greatest research efforts have been focused. In the course of the chapter we will also attempt to illustrate the methods that psycholinguists use to examine these issues. Within each section we also illustrate the manner in which psycholinguistic models of lexical representation and processing have been extended to accommodate the presence of two languages. Finally, we consider the implications of the recent psycholinguistic research for second language pedagogy.

## **2 Reading and Speaking Words in Two Languages**

Early research on the bilingual lexicon investigated the question of whether the bilingual or second language learner possessed one or two lexicons for words in each language (for recent reviews see Gollan and Kroll, 2001; Francis, 1999). It eventually became clear that this question alone was too unconstrained to provide an adequate model of either the developing or proficient lexicon. For one thing, there was disagreement about what the lexicon itself might include and whether the conclusion that the lexicon was integrated or separated for words in two languages applied to all aspects of lexical representation or only to some. For example, an initial proposal was that lexical forms were represented separately but that words in the bilingual's two languages shared a common semantic system (e.g., Potter, So, Von Eckardt, and Feldman, 1984; Smith, 1997). However, subsequent research suggested that, at least under some circumstances, the representation of lexical forms may be integrated (e.g., Van Heuven, Dijkstra, and Grainger, 1998) and that although some core aspects of semantic representation may be similar across languages, differences in usage and context may limit the degree to which even the semantics are shared (e.g., De Groot, 1993; Pavlenko, 1999).

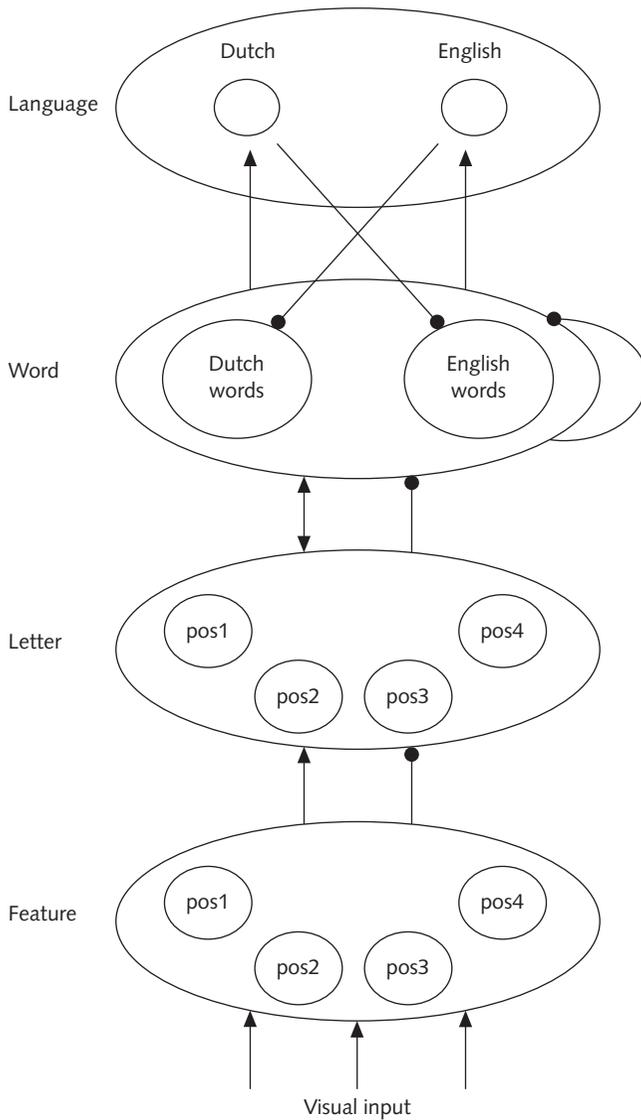
A second source of confusion in thinking about the number of lexicons in bilinguals was that assumptions about representation were typically confounded with assumptions about access. Van Heuven et al. (1998) point out that separate lexicon models tended to be associated with selective access whereas integrated models assumed non-selective access. In other words, models which assume separate lexical representations are likely to claim that it is possible to selectively activate words in one language only, whereas models which assume an integrated lexicon are likely to claim non-selective and parallel activation of word forms in both languages. Because the form of representation and the mode of access are potentially independent, a number of additional alternatives are logically possible, although rarely considered. For example, there might be separate lexicons, one for words in each language, but with non-selective access to both in parallel.

More recent research has addressed five questions that will serve to frame our review: (1) How are lexical forms in each language represented and activated during reading?; (2) Are semantic representations shared across the bilingual's two languages?; (3) On what basis are lexical and semantic representations connected for words and concepts in each language?; (4) How are words spoken in the second language when a more dominant alternative almost always exists in the first language?; and (5) How is the activation of lexical form and meaning controlled so that bilinguals recognize and speak words in the intended language?

## **2.1 *How are lexical forms in each language represented and activated during reading?***

Psycholinguists use a variety of tasks to investigate word recognition during reading. One of the most common is lexical decision, a paradigm in which a letter string is presented on a computer screen and the participant is simply asked to judge, as quickly as possible, whether it forms a real word. By manipulating the properties of the task and the properties of the letter string, it is possible to identify those aspects of lexical representation that are involved when words are identified and to examine the extent to which information in the bilingual's two languages interact during this process. For example, in a study by Van Heuven et al. (1998) proficient Dutch-English bilinguals performed lexical decision in each of their languages. The main question was whether the time to decide that a letter string was a word in either language would be influenced by the presence of orthographic neighbors in the other language. Past research on word recognition within a single language has shown that the time to recognize a word is influenced by the number and frequency of its neighbors (see Andrews, 1997, for a review). The question in the Van Heuven et al. study was whether the time for Dutch-English bilinguals to judge a string of letters as an English word would be affected by the presence of neighbors in both languages (e.g., for a Dutch-English bilingual the letter string *word* has the neighbors *work* and *wore* in English but also the neighbors *bord* and *worp* in Dutch). The results showed that even when only one of the bilingual's two languages was required for lexical decision, performance was influenced by the presence of neighbors in both languages, suggesting that access to the lexicon is non-selective and that the lexicon may be integrated, at least for languages that are similar, like Dutch and English.

Van Heuven et al. (1998) interpreted the presence of cross-language effects of lexical form as support for a bilingual version of the interactive activation model (McClelland and Rumelhart, 1981), or BIA (see also Dijkstra and Van Heuven, 1998; Dijkstra, Van Heuven, and Grainger, 1998). The main claim of the BIA model is that the bilingual's lexicon is integrated and that lexical access is non-selective, with candidates in both languages activated whenever the input shares features with alternatives in either language. The model (see figure 5.1) assumes that upon receiving some orthographic input, a set of letter



**Figure 5.1** Bilingual interaction activation (BIA) model  
 Source: Adapted from Dijkstra, Van Heuven, and Grainger (1998)

and then word units is activated in parallel for words in both languages. Inhibitory connections then create competition among same and other-language alternatives. Unlike monolingual models, BIA includes an additional language node level so that it is possible to bias the activation of one language relative to the other. BIA has been implemented as a computer model and the

subsequent simulations closely parallel the empirical results reported by Van Heuven et al.

Subsequent research has provided converging support for the conclusion that lexical access is non-selective and driven by the stimulus properties of the input, not by the intentions of the reader. For example, the time to recognize interlingual homographs or false friends (e.g., the word *room* in English, which also means “cream” in Dutch) is a function of the frequency of the alternative reading and relative activation of the non-target language (Dijkstra, Van Jaarsveld, and Ten Brinke, 1998). Bilinguals are slow to accept interlingual homographs as real words in their L2 when the L1 reading of the word is also active and must be ignored. Moreover, the activation of the alternative in the other language does not appear to be under the bilingual’s control. Dijkstra, De Bruijn, Schriefers, and Ten Brinke (2000) recently showed that these effects are apparently immune to the effects of instructions. Other recent studies have shown that not only orthographic but also phonological features of the non-target language are activated during word recognition (e.g., Brysbaert, Van Dyck, and Van de Poel, 1999; Dijkstra, Grainger, and Van Heuven, 1999; Jared and Kroll, 2001).

The results we have reviewed are based primarily on the performance of highly skilled bilinguals. Remarkably little research has traced the development of lexical form activation across L2 acquisition. The few studies which have included comparisons of second language speakers who differ in their L2 proficiency suggest that the pattern of cross-language influence changes with level of skill in L2 (e.g., Bijeljac-Babic, Biardeau, and Grainger, 1997; Jared and Kroll, 2001; Talamas, Kroll, and Dufour, 1999). In general, there is more of an asymmetry at early stages of L2 acquisition with stronger effects from L1 to L2 than the reverse. However, when the activation of even a weak L2 is increased, it is possible to observe cross-language interactions that suggest that the processing mechanisms that characterize the fully formed lexicon of the proficient bilingual are in place.

A recent study by Jared and Kroll (2001) illustrates the change in the effect of L2 on L1 with increasing L2 proficiency (see box 5.1). Native English speakers named words aloud in English, their L1. The dependent measures were the time to begin to articulate the word and the corresponding accuracy. The words were chosen on the basis of the properties of their neighbors in English and in French, the L2 of these learners. Some words had enemies in English (i.e., words with similar orthography but distinct phonology), some had enemies in French, and others had no enemies. The question was whether native English speakers naming words in English would be affected by the presence of enemies in French. The results showed that when these speakers performed the naming task in English without prior activation of French, there were effects only of the English enemies, that is, no cross-language influence. However, when French was activated by requiring participants to name a block of French words aloud, there was then an effect of the French enemies on the time to name English words, but only for the most proficient L2 speakers. When the

### Box 5.1 Illustrating psycholinguistic approaches to second language acquisition

Jared and Kroll (2001) examined the degree to which native speakers of English were influenced by their knowledge of French when reading words in English. According to a selective model of lexical access, reading words in one language alone, particularly when it is the first and dominant language (L1), should not be affected by the second language (L2). However, as the evidence we have reviewed suggests, there is a great deal of support for the alternative non-selective model, whereby lexical candidates in both languages are active during word recognition.

In this study, native English speakers who had been assessed to have relatively high or low levels of proficiency in French performed a simple word-naming task. A letter string was presented on a computer screen and participants simply had to pronounce the word aloud as quickly and as accurately as possible. The dependent measure was the speed of word naming.

Participants were pre-screened for their knowledge of French but then recruited to the experiment in English only. French was not mentioned when participants were recruited or during the first part of the experiment. They were simply asked to name a series of English words, presented one at a time, as quickly as possible. Following the first portion of the experiment, an interpolated French naming task was introduced. The interpolated task also involved simple naming but now the words to be pronounced aloud were French words. Following the French naming task, a final series of English words was presented and participants again were asked to name them aloud in English. The logic of the design was to assess English naming performance when participants were in a monolingual English mode, as best as could be established, and then to compare performance before and after French was activated explicitly.

To test whether word naming in L1 is influenced by L2, Jared and Kroll (2001) manipulated the types of English words that participants were asked to name. The English words varied according to whether they had enemies in English or French. An enemy is a word that is an orthographic neighbor of the target word but pronounced differently. For example, in English, the word “gave” is an enemy of the word “have” because although they are orthographic neighbors (they differ by only a single letter), they have distinct pronunciations.

Jared and Kroll included three types of English words that are listed below. Some words had no enemies in either language, some had enemies only in French, and others had enemies only in English:

- 1 No enemies: *stump, poke, drip*
- 2 French enemies: *strobe, pier, died*
- 3 English enemies: *steak, pear, dough*

If the phonology of French is activated when native English speakers are naming words in English, as the non-selective model supposes, then enemies in French as well as English would be expected to affect the time to name English words.

Jared and Kroll (2001) found that before the interpolated French naming task, neither less nor more proficient English–French bilinguals showed any effect of the presence of French enemies; only words with English enemies were named more

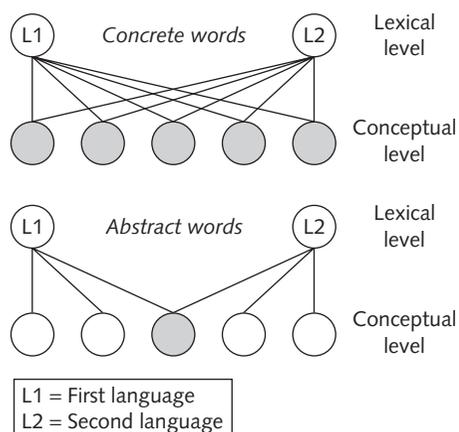
slowly than the no-enemy controls. However, following the French naming task, the performance of the more proficient bilinguals was affected by the activation of French; they were slower to name English words when they had either English or French enemies relative to controls.

How does a non-selective model account for the absence of the cross-language effects in the first block of English word naming? These results are most consistent with a non-selective model in which it is assumed that the degree of cross-language interaction is a function of the relative activity of the non-target language. When the non-target language, French in this case, was not sufficiently active, there was little apparent influence on processing. However, once it became active, by virtue of explicitly requiring bilinguals to use French by naming words in French, or by the level of the bilingual's proficiency in French, or both, then regardless of the intention to name words in English only, there was an effect of the presence of competitors in both languages.

block of French words contained the enemies themselves (i.e., the French words that looked like but did not sound like the English words to be named), there were then inhibitory effects of French enemies on English naming for even the less skilled L2 speakers. These results converge closely with the findings for proficient bilinguals in that whether non-target words function as competitors during word recognition appears to depend on the degree to which both languages are active. When both languages are active, the system appears to be functionally non-selective with respect to language.

## **2.2 *Are semantic representations shared across the bilingual's two languages?***

The evidence reviewed above suggests that information about the lexical form of words in both of the bilingual's languages is active during word recognition. But what about meaning? It is perhaps surprising given the interest in issues of linguistic relativity (for recent reviews see Green, 1998; Pavlenko, 1999) that most models of bilingual representation and processing have assumed that words in each of the bilingual's languages access a common semantic code. For a number of reasons, the view that semantics are shared across languages has been dominant in the psycholinguistic literature. First, bilinguals are able to translate most words from one language to the other to a level that is at least functionally acceptable. Second, experiments using the semantic priming paradigm have shown that it is possible to observe priming across languages (e.g., Altarriba, 1990; Chen and Ng, 1989; Keatley, Spinks, and De Gelder, 1994; Meyer and Ruddy, 1974; Schwanenflugel and Rey, 1986; Tzelgov and Eben-Ezra, 1992). Third, semantically related words in both of the bilingual's languages tend to interfere with picture naming in either language (e.g., Costa et al., 1999; Hermans, 2000; Hermans, Bongaerts, de Bot, and Schreuder, 1998). If words in the two languages accessed fundamentally different representations,



**Figure 5.2** Distributed feature model

Source: Adapted from Van Hell and De Groot (1998)

then under the conditions of speeded timing in these tasks, we should not expect to see cross-language interactions. Fourth, models of lexical development suggest that during initial L2 acquisition, L1 semantics may be transferred to the new L2 word (e.g., Jiang, 2000). A note of caution in interpreting these findings is in order because much of the research on bilingual processing has used tasks limited to pictured objects and their names, thereby restricting the scope of the semantics to concrete nouns.

Recent developments in the realm of computational modeling have enabled a view of semantic representation that is graded so that concepts are not simply the same or different but differentiated in the degree to which they share types of semantic features (see McRae, de Sa, and Seidenberg, 1997, for an illustration of this approach in the monolingual domain). In the bilingual domain, De Groot and her colleagues (De Groot, 1992, 1993, 1995; De Groot, Dannenburg, and Van Hell, 1994; Van Hell, 1998; Van Hell and De Groot, 1998) proposed the distributed feature model shown in figure 5.2. The model represents concepts as constellations of activated semantic features. Across languages, the degree to which concepts are shared is hypothesized to be a function of word type, with more overlap for concrete than abstract nouns and for cognates than for non-cognate translations. The empirical results that support the model come from experiments on word translation. The time to translate words from one language to the other is generally faster for concrete words and cognates than for abstract words and non-cognates. To the extent that translation requires access to meaning, an issue that we will address in the next section, the time to perform translation will be fast when there is a high degree of overlap across languages and slow when there is a low degree of overlap.

A further qualification to the distributed feature model was described in a series of recent papers showing that ambiguity is also an important factor.

Schönplflug (1997) and Tokowicz and Kroll (forthcoming) examined the consequence of having more than a single translation equivalent for a given word. Words with more than a single dominant translation equivalent took longer to translate than words with only one, suggesting that both semantic alternatives were available and competing for selection. Tokowicz and Kroll also showed that at least for the English–Spanish bilinguals in their study, these effects were restricted to abstract words. Because abstract words are more likely to be ambiguous than concrete words, the initial demonstration of a concreteness effect in translation was likely to have been confounded with the number of available translation equivalents. This finding suggests that factors that influence the ease of computing a single meaning or the likelihood of having a set of semantic competitors available will determine bilingual performance, particularly when spoken production requires the selection of only a single candidate. Existing research does not allow a precise estimate of the manner in which each of these factors influences semantic processing within and across languages.

Like the work described above on lexical form activation in word recognition, the research on semantic access has focused largely on the performance of proficient bilinguals. A few studies have investigated changes in the ability to access semantics for L2 words with increasing L2 skill. Talamas et al. (1999) examined the ability of learners and proficient bilinguals to judge that two words were translation equivalents. In one condition of the experiment, the words were not translations of one another, but closely related semantically. For example, the English word *man* might be followed by the Spanish word *mujer* and the participant would be required to respond that they are not translation equivalents. Talamas et al. found that it took longer to reject these semantically related pairs than matched controls, but only for the proficient bilinguals; the learners did not appear to process the semantics directly. However, a pair-by-pair analysis based on the degree of semantic similarity between word pairs showed that the learners were sensitive to the semantics when pairs were very highly related. The results suggest that access to semantics for learners is a matter of degree.

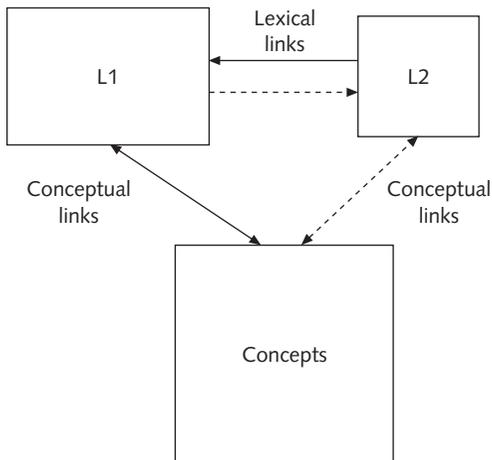
The same general conclusion was reached in a study by Dufour and Kroll (1995) in which two groups of native English speakers, less and more proficient in French, performed a categorization task within and across the two languages. Participants saw a category prompt (e.g., *fruit*) and then an exemplar which was or was not a member of that category (e.g., *pear* or *table*). Their task was simply to decide whether the exemplar was a member of the category. Not surprisingly, Dufour and Kroll found that the less proficient French speakers were slower to respond in French than in English. However, they also found that the less proficient group was faster to respond in French when the category prompt was also in French than when it was in English. They hypothesized that the effect of the category prompt in English, the participants' L1, was to activate semantics too broadly for L2. Because the less proficient individuals were unlikely to know the names of all of the category members in French, the initial activation of the category in English may have

increased the number of competitors from which the exemplar was selected. Dufour and Kroll proposed that learners do have access to semantics for L2 words, but only in a limited manner. In the next section we will return to the issue of how early in acquisition semantics are available directly for L2 words.

### ***2.3 On what basis are lexical and semantic representations connected for words and concepts in each language?***

Regardless of the commitment one makes to the architecture of lexical and semantic representations, a complete model of the lexicon must specify the manner in which lexical forms are mapped to their respective meanings. Potter et al. (1984) contrasted two alternatives for how these mappings might operate. According to the word association model, associations are formed between new L2 words and their corresponding translation equivalents in L1. L2 is therefore always mediated through L1. However, according to the concept mediation model, concepts can be accessed directly by and for L2 words, without L1 activation. To test the two models, Potter et al. contrasted the performance of a group of highly proficient Chinese–English bilinguals on picture naming and translation. If L2 is mediated via L1 as the word association model predicts, then word-to-word translation should bypass semantics and thereby be faster than picture naming, a task which cannot bypass conceptual access. However, if concepts can be accessed directly for L2 words as the concept mediation model predicts, then both translation and picture naming should require approximately the same amount of processing time to be performed. Potter et al. found no evidence that translation was faster than picture naming and therefore concluded in favor of the concept mediation alternative. Surprisingly, they found precisely the same pattern of results for a group of less proficient L2 speakers, suggesting that direct conceptual processing of L2 was in place very early in acquisition (for additional evidence for direct conceptual access for L2, even for learners at early phases of acquisition, see Altarriba and Mathis, 1997; Frenck-Mestre and Prince, 1997).

The conclusions of the Potter et al. (1984) study were subsequently challenged by a series of experiments (Chen and Leung, 1989; Kroll and Curley, 1988) which showed that individuals at very early stages of L2 acquisition were indeed faster to translate than to name pictures, consistently with the predictions of the word association model. The results for the more proficient bilinguals in each of these studies replicated the pattern reported by Potter et al., suggesting that early in acquisition there is reliance on word-to-word mappings across the two languages, but with increasing proficiency there is an increasing ability to conceptually mediate L2. The evidence for concept mediation for less proficient learners in the Potter et al. study can be understood as a reflection of the nature of the participants tested. Potter et al.'s less proficient bilinguals were native English-speaking high school students about to leave



**Figure 5.3** Revised hierarchical model

Source: Adapted from Kroll and Stewart (1994)

for a summer in France. It seems likely that they were highly motivated to learn French and therefore past a very early stage of L2 acquisition that characterizes more typical classroom learners. The less proficient participants in the subsequent studies were at an earlier stage of acquisition and therefore more likely to reveal the word association pattern.

How does the shift from word association to concept mediation occur? Kroll and Stewart (1994) proposed the revised hierarchical model (RHM) shown in figure 5.3 to account for the development of conceptual processing with increasing L2 skill. The model includes the direct lexical connections of the word association model in addition to the word-to-concept connections of the concept mediation model. However, unlike the earlier models, the RHM proposes differential weighting of the strength of the word-to-word and word-to-concept connections for L1 and L2. The model assumes that early in L2 acquisition, L2 words are associated with their L1 translations for the purpose of accessing the meaning that is already represented for those concepts. Thus strong lexical links map L2 to L1. At the lexical level, only weak activation of associative links from L1 to L2 is assumed. Initially, only word-to-word associations will link L2 to L1. With increasing L2 proficiency, direct conceptual connections from L2 words to semantics will begin to develop. However, for all but the most balanced bilinguals, the word-to-concept connections will be stronger for L1 than for L2. (For recent reviews of research based on the RHM, see also Kroll and De Groot, 1997; Kroll, Michael, and Sankaranarayanan, 1998; Kroll and Tokowicz, 2001.)

Kroll and Stewart (1994) tested two predictions of the RHM. First, if lexical associations link words in L2 to their translation equivalents in L1, then translation from L2 to L1 should be faster than translation from L1 to L2, because it

reflects a more direct processing route. Second, if L1 words are more likely to activate semantics than L2 words, then translation from L1 to L2 should also be more likely to be influenced by the manipulation of semantic variables than translation from L2 to L1. Each of these predictions was examined in an experiment in which highly proficient, but L1 dominant, Dutch–English bilinguals translated words in both directions. The words were presented in lists that were organized by semantic category (e.g., all fruits or all vehicles) or randomly mixed. The results supported both predictions. Translation was faster from L2 to L1 than from L1 to L2, a phenomenon termed the *translation asymmetry*. Furthermore, only translation from L1 to L2 was affected by the context of a semantically organized list; there was no effect from L2 to L1.

More recent research has provided mixed support for the claims of the RHM. Sholl, Sankaranarayanan, and Kroll (1995) demonstrated that transfer from a picture-naming task to translation was differential for the two directions of translation, with priming from the conceptual picture-naming task only to translation from L1 to L2, the direction hypothesized to be conceptually mediated. This result provides strong support for the asymmetry assumed within the RHM. In contrast, in a study examining the effects of semantically related picture context on translation, La Heij, Kerling, and Van der Velden (1996) found semantic effects in both directions of translation, contrary to the claims of the RHM. Because La Heij et al.'s participants were Dutch–English bilinguals very similar to those used in the Kroll and Stewart (1994) study, it is unlikely that the nature of the participants' bilingualism or the nature of the two languages can account for the observed differences. (For further discussion of this issue, see Kroll and De Groot, 1997; Kroll and Tokowicz, 2001.)

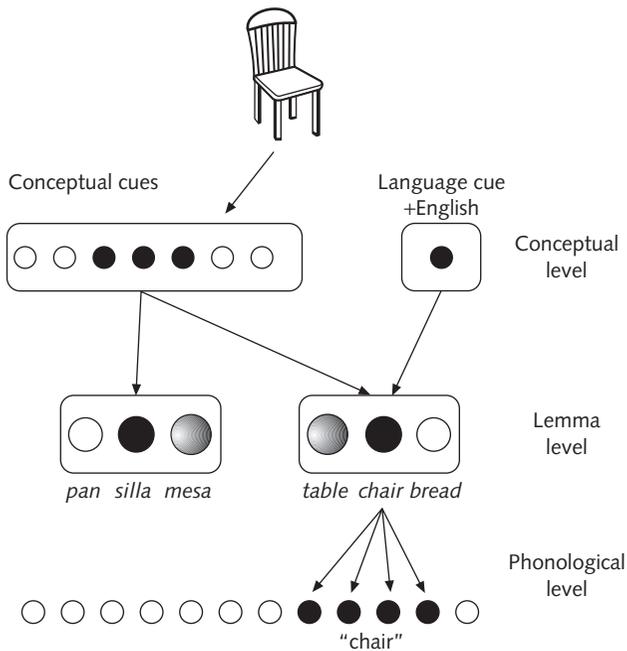
Unlike the BIA or distributed feature models described in the previous sections, the RHM is explicitly a developmental model. It assumes that the connections between words and concepts in bilingual memory change with increasing proficiency in the L2. At early stages of acquisition, the cross-language lexical connections will be critical, whereas with greater L2 proficiency there will be increasingly direct semantic processing of L2. A clear prediction of the RHM is that translation from L2 to L1, the direction of translation hypothesized to operate by direct access to translation equivalents, should be in place early in acquisition, whereas L1 to L2 translation, the direction of translation hypothesized to require conceptual access, will be more difficult for learners to perform. If L2 is linked to L1 initially for the purpose of accessing meaning, then those connections should be the first available to the learner. A recent study by Kroll, Michael, Tokowicz, and Dufour (forthcoming) examined the developmental predictions of the RHM by having learners at different levels of L2 proficiency translate in each direction and name words in each language. The results supported the prediction that translation from L1 to L2, the route hypothesized to be conceptually mediated, changes more over the course of acquisition than translation from L2 to L1. Although learners' L2 vocabularies increase over time, they are capable of translating from L2 to L1 as quickly and almost as accurately as more proficient speakers. In contrast,

translation from L1 to L2 is very slow and error prone for learners. The comparison with simple word naming (i.e., naming aloud) further demonstrates that the problem in L1 to L2 translation is not simply one of producing the L2 phonology. Learners are indeed slower to name words in L2 than in L1, but that difference is generally small relative to the magnitude of the translation asymmetry. Because learners at this stage appear able to access concepts for some L2 words (e.g., Dufour and Kroll, 1995; Talamas et al., 1999), the difficulty in performing L1 to L2 translation suggests that it is not access to concepts that is the central problem, but rather difficulty in lexicalizing concepts into L2 words. We take up this issue in the next section.

#### ***2.4 How are words spoken in the second language when a more dominant alternative almost always exists in the first language?***

How do speakers of more than one language manage to speak their ideas in the intended language? Although even highly skilled bilinguals occasionally make speech errors (e.g., Poulisse, 1997, 1999) and have more tip-of-the-tongue experiences than monolinguals (e.g., Gollan and Silverberg, forthcoming), their speech is not typically marked by random language mixtures. Rather, bilinguals appear able to modulate their spoken production so that they speak in one language alone or code switch with another bilingual. How is this finely tuned control achieved? One possibility was proposed by Grosjean (1997, 2001), who suggested that bilinguals adjust the relative activation of their two languages along a continuum from a monolingual mode, in which one language is spoken primarily, to a bilingual mode, in which there is a high level of activation of both languages. However, it is not entirely clear what factors determine the control of language mode itself: hearing someone speak a language that is known, or processing contextual information in one language only, or anticipating that listeners also speak both of the speaker's languages?

The issue of how the intended language is selected prior to speaking is particularly problematic because a set of recent picture-naming studies suggests that lexical alternatives in both of the bilingual's languages may be active for some period of time prior to the selection of the word to be produced. The intention to speak in one language does not appear to be sufficient to achieve selective access to information in that language alone. A model of language production based on work by Poulisse and Bongaerts (1994) and Hermans (2000) is shown in figure 5.4. The model adapts monolingual production models (e.g., Levelt, 1989; Levelt, Roelofs, and Meyer, 1999) for the bilingual case (see also De Bot and Schreuder, 1993, for another example of a bilingual model of production). The figure illustrates the case in which a bilingual who speaks both English and Spanish is attempting to name the pictured object as *chair* in English. Three levels of representation are depicted. First, at the conceptual level, semantic features are activated corresponding to the meaning of the



**Figure 5.4** Models of bilingual language production

Source: Adapted from Poulisse and Bongaerts (1994); Hermans (2000)

pictured object. At the same level, there is also information about the intended language of the utterance, in this case English. At the next level, lemmas, or abstract lexical representations, are specified for each of the lexical alternatives in the two languages. At the lemma level, both language alternatives, *chair* in English and *silla* in Spanish, will be active to some degree as will lemmas that are semantically related to the meaning of the object, such as *table* in English and *mesa* in Spanish. Finally, at the phonological level, the form of the spoken utterance is specified. In the model depicted in figure 5.4, lexical access is assumed to be language non-selective through the level of the lemma. Notice that although both *chair* and *silla* are assumed to be available as abstract lexical representations, only the phonology of *chair* is actually specified.

Without going into much more detail about the workings of the model, one can appreciate immediately that the further into the production process alternatives in the non-target language are active, the more potential competition there will be across languages. What is the evidence for cross-language competition? To investigate this issue, research on language production has used the picture–word interference paradigm. A picture is presented briefly and preceded or followed by a word, presented visually or auditorily, after a variable time interval. The task is to name the picture and ignore the word. By manipulating the relation of the word distractor to the picture’s name, it is possible to infer

the nature of the processes that are active at a given point in planning the spoken utterance. In monolingual versions of the task, words that are semantically related to the picture's name generally produce interference and words that are related to the phonological form of the picture's name produce facilitation (e.g., Lupker, 1979, 1982; Rosinski, 1977; Starreveld and La Heij, 1995). Moreover, semantic effects tend to be greater early in the planning of an utterance and phonological effects tend to be observed late, although there is some debate about the precise timing of these processes (e.g., Levelt et al., 1991; Schriefers, Meyer, and Levelt, 1990; Starreveld, 2000; Starreveld and La Heij, 1995).

A recent set of monolingual production studies holds particularly important implications for bilinguals. Peterson and Savoy (1998) and Jescheniak and Schriefers (1998) showed that when an object has more than one name (i.e., it could be named by either of two close synonyms, such as *sofa* or *couch*), the unintended alternative appears to be active in the process of speech planning to the point of having specified its phonology. For a monolingual, there may be consequences of having a competitor active on only rare occasions, since few words have synonyms that are close enough to cause a delay in production. However, for a proficient bilingual, for whom most words have a translation equivalent in the other language, having a word in the other language ready to speak will have serious implications for the speed and accuracy of production unless one language alone can be selected.

The evidence on bilingual speakers suggests that the other-language alternative is available well into the process of planning to speak a word in one language alone. A series of cross-language picture-word interference studies (Costa et al., 1999; Hermans, 2000; Hermans et al., 1998) showed that production in one language is influenced by the presence of a distractor word in the other language. Semantically related distractor words produce interference in naming a picture even when the picture is named in one language and the distractor word appears in the other language. Like the example illustrated in figure 5.4, this result suggests that at the lemma level, alternatives in both languages compete for selection. In picture-word interference, when the word distractor is itself the name of the picture, there is facilitation of naming latencies relative to unrelated controls. Both Costa et al. (1999) and Hermans (2000) showed that there was also facilitation, although smaller in magnitude, when the distractor was the translation of the word to be produced. Furthermore, when the picture has a cognate name that is phonologically similar in the bilingual's two languages, there is facilitation of picture-naming latencies relative to non-cognate controls (Costa, Caramazza, and Sebastian-Galles, 2000; Kroll, Dijkstra, Janssen, and Schriefers, 2000). Because cognates are unlikely to share the same lemma (e.g., even similar sounding translation equivalents may differ on dimensions such as grammatical gender), the effect is likely to reflect the activation of shared phonology. Although there is some debate about the interpretation of these results with respect to the level at which the language is selected (see Costa et al., 1999, for a language-selective model based on these findings), the findings can be viewed as support for a model in

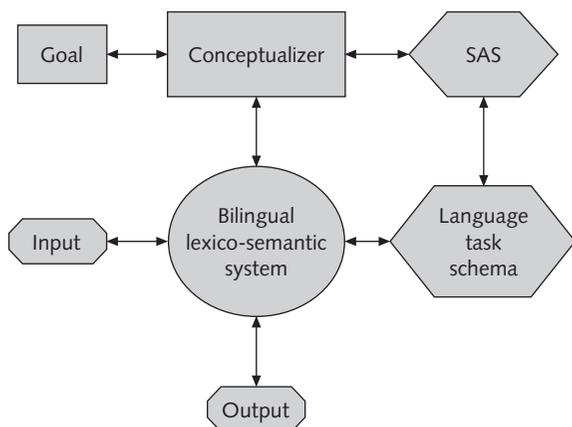
which lexical alternatives in both languages are active, at least through the level of the lemma and possibly all the way to the phonology. The few studies of production in L2 learners also suggest that much of the difficulty that learners have in producing words in L2 is attributable to competition from more active L1 alternatives (Kroll et al., forthcoming).

Research on language production is at an early stage, so caution is warranted in drawing strong conclusions on the basis of the available evidence. Finding that lexical access appears to be language non-selective access in production is quite surprising given the top-down nature of processing in production tasks (see Kroll and Dijkstra, forthcoming, for a comparison of comprehension and production). It is also surprising given observations of fluent bilingual speech in context, where there is little suggestion of interference from the non-target language unless the speaker is intentionally code switching. Because most of the experimental evidence on language production has used picture-naming tasks, it is also likely that task-specific factors contribute to the observed results. It may be possible to select the language of production early in speech planning under some circumstances, for example when strong cues are present, but not in others (see Miller and Kroll, forthcoming, for an argument about selection in translation). However, what is very clear from the available evidence is that the intention to speak words in one language is not sufficient, in and of itself, to prevent the activation of words in the other language. In the next section we consider other ways in which control might be achieved.

## ***2.5 How is the activation of lexical form and meaning controlled so that bilinguals recognize and speak words in the intended language?***

The evidence we have reviewed provides a much more open picture of the bilingual lexicon than the early literature on this topic implied. Research on comprehension suggests that orthographic and phonological information about words in both languages is activated even when a bilingual is reading in one language alone. Likewise, research on production suggests that the translation equivalent and related words are active prior to speaking even when the bilingual intends to speak only in one of his or her two languages.

How is the activation and potential competition between candidates in the two languages modulated to achieve accurate comprehension and production? In past research, two general solutions have been proposed to explain how cross-language competition is resolved. One places the locus of selection and control within the functioning of the lexicon itself such that the factors that modulate the relative activation of words in each language determine the word that is selected (e.g., Dijkstra et al., 1998). The alternative is to assume that mechanisms external to the lexicon constrain the manner in which the output of lexical activity is utilized (e.g., Green, 1998; Thomas and Allport, 2000).



**Figure 5.5** Inhibitory control model

Source: Adapted from Green (1998)

Green (1998) proposed the inhibitory control (IC) model to describe one way in which external regulation of the two languages might be achieved. The model, shown in figure 5.5, includes a set of mechanisms outside the lexical system itself that are hypothesized to work together with the output from the system to accomplish proficient performance. A full consideration of the workings of the model is beyond the scope of the present chapter (see Green, 1998, and associated commentaries for a more detailed discussion). In brief, the idea is that performance is determined by an interaction between a set of attentional mechanisms that serve to effect the goals associated with particular tasks and the activity within the bilingual lexicon that we have characterized in the preceding sections of this chapter. A focus within the IC model is to account for the ability of bilinguals to perform the intended task in the intended language. For example, when presented with a word to translate, how does a bilingual prevent himself or herself from naming the word aloud instead of translating it? According to the IC model, prior to the production of a spoken utterance, a conceptual representation is generated. This in turn activates the lexico-semantic system and also the supervisory attentional system or SAS. The SAS is hypothesized to control the activation of language task schemas.

To illustrate, the IC model offers an alternative interpretation of the translation asymmetry whereby translation is slower from L1 to L2 than from L2 to L1 (Kroll and Stewart, 1994). To translate from L1 to L2 it will be necessary to inhibit L1 lemmas in order to produce words in L2. Because L1 lemmas are assumed to be more active than L2 lemmas, they will require greater attentional resources to be suppressed so that L2 production can proceed. L1 to L2 translation will therefore be slower than L2 to L1 translation, not because the two

routes to translation necessarily require different component processes, as the RHM proposed, but rather because the two translation tasks impose differential inhibitory demands.

An important source of evidence regarding inhibitory control comes from experiments on deliberate language switching. In a recent study, Meuter and Allport (1999) examined switching performance on a number-naming task in which the individual was instructed to name the number in one of their two languages depending on the color of the background on which the number appeared. They observed switch costs, with longer response times following language switches, but the switch costs were greater when bilinguals switched into their L1 than into their L2. The result may seem counter-intuitive, because we might think that L1 would always be more available. However, it can be understood in the context of models of inhibitory control, such as Green's (1998), in which it is assumed that more attentional resources are required to suppress the more active language. Switch costs are taken to be the consequence of having inhibited L1.

If inhibitory control is a central characteristic of bilingual language processing, then we need to expand our view of acquisition to include the development of control mechanisms in addition to the development of the lexicon and grammar. That is, L2 learners may need to acquire a new set of processing skills that fall outside the language itself to be able to effectively use both languages. In previous work we have argued that this may be a particularly difficult task for L2 learners who are restricted to classroom exposure because it will be difficult to acquire cues that are unique to the new L2 (Kroll et al., 1998; Kroll and Tokowicz, 2001). In immersion contexts, the availability of linguistic and non-linguistic information that specifically marks the use of L2 may facilitate this process.

Kroll et al. (1998) described a study that attempted to examine the manner in which cues might be used to inhibit L1 during L2 acquisition. A group of native English-speaking students who had no knowledge of Dutch or German were taught 40 Dutch words. In one study condition, the Dutch words were presented together with their English translations. In another study condition, they were presented with pictures of the objects that they named. For half of the pictures, the objects were shown in their normal orientation. For the remaining pictures, the objects were presented in a non-canonical orientation (e.g., upside down or to one side). Kroll et al. hypothesized that the non-canonical presentation of the objects might facilitate acquisition of the new Dutch name because it would slow down the process of retrieving the L1 name. At test, participants either named pictures in Dutch or translated English words into Dutch. The results showed a clear processing advantage for the Dutch words that had been learned by association with the non-canonical pictures. More surprising was the fact that this advantage held even when participants were tested on a translation task, in the absence of the picture itself. We would not suggest that having students in classroom settings slant their heads to one side might facilitate L2 vocabulary acquisition. More modestly,

the results suggest that identifying factors that reduce the activity of L1 or uniquely cue L2 may facilitate learning.

### **3 Implications of Psycholinguistic Research for Second Language Pedagogy**

As we have discussed in this chapter, recent research on language and cognitive processes in proficient bilinguals suggests that lexical and semantic information in L1 is activated during both comprehension and production in L2. If this is the case for skilled bilinguals, then we might logically assume that less skilled second language learners would be similarly affected, if not to a greater degree, by unintended L1 activation and might have a more difficult time controlling the cross-linguistic competition. As mentioned previously, there is little psycholinguistic research investigating cross-linguistic competition in second language learners. However, second language teaching methods have long been aware of cross-language competition and have been striving to minimize it.

In examining second language pedagogy, we find methods for teaching a second language that are predicated on notions of inhibiting L1 activation. For example, in today's communicative second language classroom, the use of the first language is typically avoided. Learners in a Spanish classroom are often told to think of that classroom as a "little Spain or Mexico." Spanish teachers, in an attempt to simulate this cultural oasis, go to great lengths to maintain Spanish in the class at all times. In teaching vocabulary, they use various techniques that avoid the L1, such as pictures, context, miming, and circumlocution, in an attempt to promote "form-meaning" connections for the learners in the L2. This process of making form-meaning connections is what Terrell (1986) terms "binding" (p. 214). He explains that binding is "the cognitive and affective mental process that occurs when an instructor insists that a new word ultimately be associated directly with its meaning and not with a translation" (p. 214). The use of the L1 is almost seen as detrimental to the learning process. Maintaining L2 at all times and keeping learners in the L2 mode is a critical component of the communicative second language classroom.

Historically, if we look at other second language teaching methods, we see similar assumptions regarding L1 emerge. For example, the Direct method (commonly known as the Berlitz method) assumed that learners would acquire language much like children, through direct association of words and phrases with objects and actions and an enormous amount of input. The native language was not used and translation was strictly forbidden. Definitions of new vocabulary were given via paraphrases in the target language. In the same vein, the overarching goal of the Audiolingual method of the 1950s was to develop in learners the same abilities that native speakers have, handling the language at an unconscious level. L1 was to be banned from the classroom and a "cultural island" was to be maintained. Essentially, one was to teach L2 without reference to L1.

In the 1960s Total Physical Response (TPR) was proposed (Asher, 1977). The underlying philosophy of TPR is that language comprehension should develop before any oral participation, as it does with children. It is based on the belief that skills can be acquired more rapidly if you involve the kinesthetic-sensory system. In fact, TPR is linked to the *trace theory* of memory (e.g., Katona, 1940), which claims that activities such as motor activity or verbal rehearsal will strengthen the memory connection and will then facilitate recall. Accordingly, this method uses oral commands of which students show their understanding by performing an action. The target language is the exclusive language of instruction. Asher describes TPR: "Understanding should be developed through movement of the student's body" (p. 4). "When you cast material in the imperative there is no translation" (p. 20). It was therefore assumed that by using the kinesthetic-sensory system, one could bypass the L1 linguistic system, thus facilitating acquisition.

In the 1970s the Natural approach (Terrell, 1986) emerged. This methodology was based on Krashen's (1982) theory of second language acquisition that made the strong claim that comprehensible input causes acquisition. The use of the L2 was then seen as the only tool for providing comprehensible input to the learners; L1 had no place in the Natural approach. Another method that avoided the L1 was *The Silent Way* (Gattegno, 1976), a method which used colored wooden sticks called Cuisenaire rods, language charts, and the L2 exclusively. This method seemed to be predicated on the notion of language control. In fact, Gattegno states "Throughout our oral work with rods and the visual diction on the charts, we have carefully avoided the use of the students' native language. We have even succeeded in blocking the native language so that the students relate to the new language directly" (p. 99). Clearly, controlling any cross-linguistic interference was a critical aspect of this approach.

The assumption that it is beneficial for foreign language learners to think as much as possible through the language they are learning is not new and not specific to any one teaching method. As early as 1966, Mario Pei, in his book *How to Learn Languages and What Languages to Learn*, gave students specific learning hints. He states, "Link the content of the foreign phrase to its mental concept rather than to its English translation. If possible, link it to a pictorial object or action. The trick is to link the thought concept not with your own language, but with the language you are learning" (p. 101). This assumption is still prevalent among teachers today.

These teaching methods, in the past and today, whether intended to or not, are based on ideas about language activation and control (i.e., use of only L2 in the classroom and avoidance of L1). While the evidence from the psycholinguistic literature overwhelmingly suggests that words are active simultaneously in the proficient bilingual, we know that it is not the case that skilled bilinguals often produce words in the "wrong" language. Therefore, as noted above, a regulatory mechanism must control cross-language competition in skilled bilinguals. However, we do know that beginning bilinguals in the second language classroom often produce words in the wrong language. The critical

question then becomes how learners begin to modulate the cross-linguistic activation that is present in the system in a manner similar to proficient bilinguals, and why some learners are more successful at it than others.

There are many questions in second language pedagogy that could be answered by psycholinguistic research. For example, do certain learners struggle in communicative classrooms that use only the L2 because they fail to inhibit the L1 as easily as others? Is it the case that inhibition of cross-linguistic interference is a critical component of second language acquisition? Moreover, is the communicative second language classroom that essentially imposes a specific L2 language mode helping or hindering the development of cross-linguistic control? Are there processing costs when less proficient individuals are forced to assume a monolingual mode in L2? And, if so, are those initial processing costs beneficial for the development of an inhibitory control mechanism? Finally, is it simply the case that some learners, due to certain cognitive differences, are better able to generate internal strategies for suppressing L1 and processing L2?

The answers to these questions hold important implications for teaching methods and psycholinguistic models alike. Research on skilled bilingual lexical processing will help to inform our understanding of second language acquisition. If we begin to understand what it is that allows one to become a proficient bilingual, we can then re-evaluate our teaching methodologies and attempt to modify them to facilitate the developmental process. Similarly, many psycholinguistic models, such as the BIA model, address skilled bilingual processing but make no explicit claims about the nature of lexical competition during acquisition. Currently absent from the psycholinguistic literature is a comprehensive picture of how lexical activity changes and is controlled from early stages of learning through high levels of skilled performance. Second language learners can provide this much needed information. In future research we anticipate that the cognitive processes underlying the development of second language acquisition and the proficient use of two languages by bilinguals will be the focus of unified models that relate developmental processes to the skilled state.

## ACKNOWLEDGMENT

---

The writing of this chapter was supported in part by NSF Grant BCS-9905850 to Judith F. Kroll. Correspondence concerning this article should be addressed to Judith F. Kroll, Department of Psychology, 641 Moore Building, The Pennsylvania State University, University Park, PA 16802, USA. Electronic mail may be sent to [jfk7@psu.edu](mailto:jfk7@psu.edu).

## REFERENCES

- Altarriba, J. 1990: Constraints on interlingual facilitation effects in priming in Spanish–English bilinguals. Dissertation. Vanderbilt University.
- Altarriba, J. and Mathis, K. M. 1997: Conceptual and lexical development in second language acquisition. *Journal of Memory and Language*, 36, 550–68.
- Andrews, S. 1997: The effect of orthographic similarity on lexical retrieval: resolving neighborhood conflicts. *Psychonomic Bulletin and Review*, 4, 439–61.
- Asher, J. 1977: *Learning Another Language Through Actions: The Complete Teacher's Guidebook*. Los Gatos, CA: Sky Oaks Productions.
- Bialystok, E. 1997: Effects of bilingualism and biliteracy on children's emerging concepts of print. *Developmental Psychology*, 33, 429–40.
- Bijeljac-Babic, R., Biardeau, A., and Grainger, J. 1997: Masked orthographic priming in bilingual word recognition. *Memory and Cognition*, 25, 447–57.
- Birdsong, D. 1999: *Second Language Acquisition and the Critical Period Hypothesis*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Brysbaert, M., Van Dyck, G., and Van de Poel, M. 1999: Visual word recognition in bilinguals: evidence from masked phonological priming. *Journal of Experimental Psychology: Human Perception and Performance*, 25, 137–48.
- Chen, H.-C. and Leung, Y.-S. 1989: Patterns of lexical processing in a nonnative language. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 316–25.
- Chen, H.-C. and Ng, M.-L. 1989: Semantic facilitation and translation priming effects in Chinese–English bilinguals. *Memory and Cognition*, 17, 454–62.
- Costa, A., Caramazza, A., and Sebastian-Galles, N. 2000: The cognate facilitation effect: implications for models of lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 26, 1283–96.
- Costa, A., Miozzo, M., and Caramazza, A. 1999: Lexical selection in bilinguals: do words in the bilingual's two lexicons compete for selection? *Journal of Memory and Language*, 41, 365–97.
- De Bot, K. and Schreuder, R. 1993: Word production and the bilingual lexicon. In R. Schreuder and B. Weltens (eds), *The Bilingual Lexicon*. Amsterdam: John Benjamins, 191–214.
- De Groot, A. M. B. 1992: Determinants of word translation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18, 1001–18.
- De Groot, A. M. B. 1993: Word-type effects in bilingual processing tasks: support for a mixed representational system. In R. Schreuder and B. Weltens (eds), *The Bilingual Lexicon*. Amsterdam: John Benjamins, 27–51.
- De Groot, A. M. B. 1995: Determinants of bilingual lexicosemantic organization. *Computer Assisted Language Learning*, 8, 151–80.
- De Groot, A. M. B., Dannenburg, L., and van Hell, J. G. 1994: Forward and backward word translation by bilinguals. *Journal of Memory and Language*, 33, 600–29.
- Dijkstra, A. and Van Heuven, W. J. B. 1998: The BIA model and bilingual word recognition. In J. Grainger and A. Jacobs (eds), *Localist Connectionist Approaches to Human Cognition*. Hillsdale, NJ: Lawrence Erlbaum Associates, 189–225.
- Dijkstra, A., Grainger, J., and Van Heuven, W. J. B. 1999: Recognition of cognates and interlingual homographs: the neglected role of phonology. *Journal of Memory and Language*, 41, 496–518.

- Dijkstra, A., Van Heuven, W. J. B., and Grainger, J. 1998: Simulating competitor effects with the Bilingual Interactive Activation model. *Psychologica Belgica*, 38, 177–96.
- Dijkstra, A., Van Jaarsveld, H., and Ten Brinke, S. 1998: Interlingual homograph recognition: effects of task demands and language intermixing. *Bilingualism: Language and Cognition*, 1, 51–66.
- Dijkstra, A., De Bruijn, E., Schriefers, H., and Ten Brinke, S. 2000: More on interlingual homograph recognition: language intermixing versus explicitness of instruction. *Bilingualism: Language and Cognition*, 3, 69–78.
- Dufour, R. and Kroll, J. F. 1995: Matching words to concepts in two languages: a test of the concept mediation model of bilingual representation. *Memory and Cognition*, 23, 166–80.
- Dussias, P. 2001: Bilingual sentence parsing. In J. L. Nicol (ed.), *One Mind, Two Languages: Bilingual Language Processing*. Cambridge, MA: Blackwell, 159–76.
- Francis, W. 1999: Cognitive integration of language and memory in bilinguals: semantic representation. *Psychological Bulletin*, 125, 193–222.
- Frenck-Mestre, C. and Prince, P. 1997: Second language autonomy. *Journal of Memory and Language*, 37, 481–501.
- Gattegno, C. 1976: *The Common Sense of Teaching Foreign Languages*. New York: Educational Solutions.
- Gollan, T. and Kroll, J. F. 2001: Bilingual lexical access. In B. Rapp (ed.), *The Handbook of Cognitive Neuropsychology: What Deficits Reveal about the Human Mind*. Philadelphia, PA: Psychology Press, 321–45.
- Gollan, T. and Silverberg, N. forthcoming: Tip-of-the-tongue states in Hebrew–English bilinguals. *Bilingualism: Language and Cognition*.
- Green, D. W. 1998: Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition*, 1, 67–81.
- Grosjean, F. 1997: Processing mixed language: issues, findings, and models. In A. M. B. De Groot and J. F. Kroll (eds), *Tutorials in Bilingualism: Psycholinguistic Perspectives*. Mahwah, NJ: Lawrence Erlbaum Associates, 225–54.
- Grosjean, F. 2001: The bilingual's language modes. In J. L. Nicol (ed.), *One Mind, Two Languages: Bilingual Language Processing*. Cambridge, MA: Blackwell, 1–22.
- Hermans, D. 2000: Word production in a foreign language. Doctoral dissertation. University of Nijmegen.
- Hermans, D., Bongaerts, T., De Bot, K., and Schreuder, R. 1998: Producing words in a foreign language: can speakers prevent interference from their first language? *Bilingualism: Language and Cognition*, 1, 213–29.
- Jared, D. and Kroll, J. F. 2001: Do bilinguals activate phonological representations in one or both of their languages when naming words? *Journal of Memory and Language*, 44, 2–31.
- Jescheniak, J. D. and Schriefers, K. I. 1998: Discrete serial versus cascading processing in lexical access in speech production: further evidence from the coactivation of near-synonyms. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, 1256–74.
- Jiang, N. 2000: Lexical representation and development in a second language. *Applied Linguistics*, 21, 47–77.
- Katona, G. 1940: *Organizing and Memorizing: Studies in the Psychology of Learning and Teaching*. New York: Columbia University Press.
- Keatley, C., Spinks, J., and De Gelder, B. 1994: Asymmetrical semantic facilitation between languages. *Memory and Cognition*, 22, 70–84.

- Krashen 1982: *Principles and Practices in Second Language Acquisition*. New York: Pergamon.
- Kroll, J. F. and Curley, J. 1988: Lexical memory in novice bilinguals: the role of concepts in retrieving second language words. In M. Gruneberg, P. Morris, and R. Sykes (eds), *Practical Aspects of Memory*. Vol. 2. London: John Wiley, 389–95.
- Kroll, J. F. and De Groot, A. M. B. 1997: Lexical and conceptual memory in the bilingual: mapping form to meaning in two languages. In A. M. B. De Groot and J. F. Kroll (eds), *Tutorials in Bilingualism: Psycholinguistic Perspectives*. Mahwah, NJ: Lawrence Erlbaum Associates, 169–99.
- Kroll, J. F. and Dijkstra, A. forthcoming: The bilingual lexicon. In R. Kaplan (ed.), *Handbook of Applied Linguistics*. Oxford: Oxford University Press.
- Kroll, J. F. and Stewart, E. 1994: Category interference in translation and picture naming: evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language*, 33, 149–74.
- Kroll, J. F. and Tokowicz, N. 2001: The development of conceptual representation for words in a second language. In J. L. Nicol (ed.), *One Mind, Two Languages: Bilingual Language Processing*. Cambridge, MA: Blackwell, 49–71.
- Kroll, J. F., Michael, E., and Sankaranarayanan, A. 1998: A model of bilingual representation and its implications for second language acquisition. In A. F. Healy and L. E. Bourne (eds), *Foreign Language Learning: Psycholinguistic Experiments on Training and Retention*. Mahwah, NJ: Lawrence Erlbaum Associates, 365–95.
- Kroll, J. F., Dijkstra, A., Janssen, N., and Schriefers, H. 2000: Selecting the language in which to speak: Experiments on lexical access in bilingual production. Paper presented at the 41st Annual Meeting of the Psychonomic Society. New Orleans, LA.
- Kroll, J. F., Michael, E., Tokowicz, N., and Dufour, R. forthcoming: The development of lexical fluency in a second language.
- La Heij, W., Kerling, R., and Van der Velden, E. 1996: Nonverbal context effects in forward and backward translation: evidence for concept mediation. *Journal of Memory and Language*, 35, 648–65.
- Levelt, W. J. M. 1989: *Speaking: From Intention to Articulation*. Cambridge, MA: MIT Press.
- Levelt, W. J. M., Roelofs, A., and Meyer, A. S. 1999: A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22, 1–75.
- Levelt, W. J. M., Schriefers, H., Vorberg, D., Meyer, A. S., Pechman, T., and Havinga, J. 1991: The time course of lexical access in speech production: a study of picture naming. *Psychological Review*, 98, 122–42.
- Long, M. H. 1990: maturational constraints on language development. *Studies in Second Language Acquisition*, 12, 251–85.
- Long, M. H. 1993: Second language acquisition as a function of age: substantive findings and methodological issues. In K. Hyltenstam and A. Viberg (eds), *Progression and Regression in Language*. Cambridge: Cambridge University Press, 196–221.
- Lupker, S. J. 1979: The semantic nature of response competition in the picture–word interference task. *Memory and Cognition*, 7, 485–95.
- Lupker, S. J. 1982: The role of phonetic and orthographic similarity in picture–word interference. *Canadian Journal of Psychology*, 36, 349–67.
- MacWhinney, B. 1999: *The Emergence of Language*. Cambridge, MA: MIT Press.

- McClelland, J. L. and Rumelhart, D. E. 1981: An interactive activation model of context effects in letter perception. Part 1: an account of basic findings. *Psychological Review*, 88, 375–405.
- McRae, J., de Sa, V. R., and Seidenberg, M. S. 1997: On the nature and scope of featural representations of word meaning. *Journal of Experimental Psychology: General*, 126, 99–130.
- Meuter, R. F. I. and Allport, A. 1999: Bilingual language switching in naming: asymmetrical costs of language selection. *Journal of Memory and Language*, 40, 25–40.
- Meyer, D. E. and Ruddy, M. G. 1974: Bilingual word recognition: organization and retrieval of alternative lexical codes. Paper presented at the Eastern Psychological Association Meeting, Philadelphia, PA.
- Miller, N. A. and Kroll, J. F. forthcoming: Stroop effects in bilingual translation.
- Pavlenko, A. 1999: New approaches to concepts in bilingual memory. *Bilingualism: Language and Cognition*, 2, 209–30.
- Pei, M. 1966: *How to Learn Languages and What Languages to Learn*. New York: Harper and Row.
- Peterson, R. R. and Savoy, P. 1998: Lexical selection and phonological encoding during language production: evidence for cascaded processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, 539–57.
- Potter, M. C., So, K.-F., Von Eckardt, B., and Feldman, L. B. 1984: Lexical and conceptual representation in beginning and more proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior*, 23, 23–38.
- Poulisse, N. 1997: Language production in bilinguals. In A. M. B. De Groot and J. F. Kroll (eds), *Tutorials in Bilingualism: Psycholinguistic Perspectives*. Mahwah, NJ: Lawrence Erlbaum Associates, 201–24.
- Poulisse, N. 1999: *Slips of the Tongue. Speech Errors in First and Second Language Acquisition*. Amsterdam and Philadelphia: John Benjamins.
- Poulisse, N. and Bongaerts, T. 1994: First language use in second language production. *Applied Linguistics*, 15, 36–57.
- Rosinski, R. R. 1977: Picture–word interference is semantically based. *Child Development*, 48, 643–7.
- Sánchez-Casas, R. M., Davis, C. W., and García-Albea, J. E. 1992: Bilingual lexical processing: exploring the cognate–noncognate distinction. *European Journal of Cognitive Psychology*, 4, 293–310.
- Schönpluf, U. 1997: Bilingualism and memory. Paper presented at the International Symposium on Bilingualism. Newcastle-upon-Tyne.
- Schriefers, H., Meyer, A. S., and Levelt, W. J. M. 1990: Exploring the time-course of lexical access in production: picture–word interference studies. *Journal of Memory and Language*, 29, 86–102.
- Schwanenflugel, P. J. and Rey, M. 1986: Interlingual semantic facilitation: evidence for a common representational system in the bilingual. *Journal of Memory and Language*, 25, 605–18.
- Sholl, A., Sankaranarayanan, A., and Kroll, J. F. 1995: Transfer between picture naming and translation: a test of asymmetries in bilingual memory. *Psychological Science*, 6, 45–9.
- Smith, M. C. 1997: How do bilinguals access lexical information? In A. M. B. De Groot and J. F. Kroll (eds), *Tutorials in Bilingualism: Psycholinguistic Perspectives*. Mahwah, NJ: Lawrence Erlbaum Associates, 145–68.
- Starreveld, P. A. 2000: On the interpretation of onsets of auditory context effects in word production. *Journal of Memory and Language*, 42, 497–525.

- Starreveld, P. A. and La Heij, W. 1995: Semantic interference, orthographic facilitation, and their interaction in naming tasks. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 686–98.
- Talamas, A., Kroll, J. F., and Dufour, R. 1999: From form to meaning: stages in the acquisition of second language vocabulary. *Bilingualism: Language and Cognition*, 2, 45–58.
- Terrell, T. D. 1986: Acquisition in the natural approach: the binding/access framework. *Modern Language Journal*, 75, 52–63.
- Thomas, M. S. C. and Allport, A. 2000: Language switching costs in bilingual visual word recognition. *Journal of Memory and Language*, 43, 44–66.
- Tokowicz, N. and Kroll, J. F. forthcoming: Accessing meaning for words in two languages: the effects of concreteness and multiple translations in production.
- Tzelgov, J. and Eben-Ezra, S. 1992: Components of the between-language semantic priming effect. *European Journal of Cognitive Psychology*, 4, 253–72.
- Van Hell, J. G. 1998: Cross-language processing and bilingual memory organization. Doctoral dissertation. University of Amsterdam.
- Van Hell, J. G. and De Groot, A. M. B. 1998: Conceptual representation in bilingual memory: effects of concreteness and cognate status in word association. *Bilingualism: Language and Cognition*, 1, 193–211.
- Van Heuven, W. J. B., Dijkstra, A., and Grainger, J. 1998: Orthographic neighborhood effects in bilingual word recognition. *Journal of Memory and Language*, 39, 458–83.