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# Chapter 2

# Lexical Representation and Lexical Processing in the L2 User

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Psycholinguistic research into bilingualism during the past 15 years has been dominated by two related questions concerning representation and processing:

(1) How is the bilingual's vocabulary knowledge of his or her two languages represented in memory?
(2) What exactly happens within the bilingual's mental lexicon from the moment an externally presented word (whether in the L1 or the L2) is input to the language system to the moment it is understood (in comprehension), and from the moment a lexical concept is delivered by some internal conceptualiser to the moment it is verbalised in the appropriate language (in production)?

Research focusing on the representation question (1) tries to decide whether bilingual memory contains two separate language-specific stocks of knowledge, one for each of the bilingual's two languages, or, instead, a single stock that is shared between the two languages. Research addressing the processing question (2) tries to choose between selective access and non-selective access. In the non-selective access view, an external or internal input to the bilingual language system is processed by both of the bilingual's language subsystems that the system as a whole is assumed to consist of; in the selective-access view it is processed by the contextually-appropriate language subsystem only.

In this chapter I will review studies that have dealt with one or the other of these two research questions (or with both at the same time). I will present the common current models of bilingual lexical-memory representation and of how the stock of bilingual lexical knowledge is accessed during word comprehension and word production. I will also provide experimental support for these models, and discuss some of their defects.

Lexical knowledge consists of various different types of knowledge (e.g. 





what syntactic class the word belongs to; how it is morphologically structured; how it is spelled; what it means). The ensuing discussion will primarily focus on just two of these, namely, on knowledge of the words' surface forms (how they are spelled and sound) and of their meanings. Further constraints are that many of the studies to be reviewed have primarily tested nouns, and in many cases the tested nouns referred to concrete concepts only (that is, concepts that can be perceived by one or more of the senses). These facts evidently constrain the scope of the models to be presented.

## Bilingual Lexical Representation

### Three-component representation of translation pairs

The most common view of bilingual lexical memory is that it is 'hierarchical' in the sense that it consists of at least two layers of memory representations (or 'nodes'). One of these layers of nodes stores the meanings of words and the second stores their forms. The crucial support for the existence of such a layered structure comes from monolingual studies that have shown a dissociation between lexical and semantic factors (see Smith, 1997, for a review). For instance, in a study where participants had to judge whether pairs of letter strings contained the same letter (Besner *et al.*, 1990), performance was affected both by the lexical status of the letter strings in a pair and by the semantic relation between the two letter strings of a pair when both of these were words: response times were *shorter* for pairs in which the letter strings were real words (e.g. *table-cigar*) than for pairs consisting of two non-words (e.g. *nable-pigar*). Furthermore, when the letter strings of a pair were words, response times were *longer* when these words were semantically related to one another (e.g. *lion-tiger*) than when they were unrelated (e.g. *lion-flower*). The combined results of a facilitatory effect of the lexicality of the letter strings and an inhibitory effect of a semantic relation between the words in a pair suggests the existence of a two-layered memory structure, one layer storing the words themselves and a second storing their meanings.

Given such a two-layered structure, a question of interest for the bilingual research community is whether the memory units in each of the two levels are segregated by language or instead integrated across languages. Segregation implies that the stored units are language-specific; that is, there is a separate representation for each of the two words in a translation pair (e.g. one for the word *girl* and one for its French translation *fille* in an English/French bilingual). In the case of integrated representations the memory units for the two words in a translation pair are (partly or completely) shared between the two languages such that there is just one representation for the words *girl* and *fille*. A third alternative is that segregation by language holds for one of the two levels, whereas integration holds for the other level. This third view is supported by a set of pertinent studies: the surface forms of the two words that constitute a translation pair appear to be represented in two separate, language-specific representations (maybe with the exception of the surface forms of cognate translations, that is to say, translations that share surface form across a bilingual's two languages, e.g. *flower=fleure* in an English/French bilingual (Sánchez-Casas *et al.*, 1992); in contrast, word meanings appear to be stored in representations that are shared between the two languages. In other words, according to this view the representation of translation pairs (e.g. the English/French pair *apple-pomme*) in memory consists of (at least) three components: two word-form representations, one for each language, L1 and L2, and one meaning representation common to the two languages. Form representations are often referred to as 'lexical' representations, which can cause confusion, as a word's lexical knowledge consists of more than just the form of the word (indeed, its meaning is also part of its lexical knowledge). Similarly, meaning representations are often called 'conceptual' representations, because typically the relevant models do not distinguish between word meanings and concepts (but see Pavlenko, 1999, for an exception). Different versions of this hierarchical, three-component model have been proposed, which will be discussed in detail in the next section.

Crucial evidence for such three-component memory structures comes from studies that have looked at the effects of 'repetition priming' across languages. In monolingual studies, the term 'repetition priming' refers to the finding that the prior presentation of a word (the 'prime') speeds up the processing of this same word when it is presented again later in the experiment (e.g. Forbach *et al.*, 1974), typically with many unrelated words presented in between the two occurrences of the critical word. In this line of research, word recognition is thought to come about when the word's lexical (word-form) representation is activated beyond some critical activation threshold. The facilitatory effect of repetition priming is then attributed to residual activation in a word's lexical representation when it is presented once again; relatively little additional activation needs to be collected for the threshold to be exceeded. In the analogous bilingual studies, instead of presenting the same word twice, an earlier word (e.g. the French word *pomme*) is followed by its translation (the English word *apple*) at some later time. The question of interest is whether a 'cross-language repetition effect' or a 'translation-priming' effect occurs; that is, whether a



word (e.g. *apple*) is responded to faster when it follows the presentation of its translation (*pomme*) earlier on in the experiment than when not preceded by its translation but by some other, unrelated, word instead (say the French word *femme*, meaning 'woman'). The occurrence of such an effect would suggest that one and the same representation is contacted by each of the two words in a translation pair (and would then, again, be attributed to residual activation in this representation). In other words, it would suggest language integration. The absence of a translation-priming effect would indicate that different representations are accessed by the two words in the translation pair, thus suggesting language-specific representations.

The results obtained in the relevant experiments depend on what the participants are asked to do with the targets; more precisely, they depend on whether the participants have to perform a 'data-driven' task or a 'conceptually-driven' task instead (see e.g. Durgunoglu & Roediger, 1987). A data-driven task focuses the participant's attention on processing the surface forms of the stimuli. Examples are fragment completion (where the participants are presented with fragments of words and have to fill in the empty letter positions; e.g. *el--h-nt* = elephant) and lexical decision (where participants are presented with letter strings that constitute words and non-words and are asked to decide for each of these whether it is a word or not; so, when presented with the letter string *house*, they should press a 'yes' button and, when presented with the letter string *pouse*, they should press a 'no' button). Given a layered memory structure that consists of a word-form level of representation and a meaning-level of representation, data-driven tasks presumably tap activation in the form representations. In contrast, a conceptually-driven task focuses attention on the conceptual (meaning) information associated with the stimuli. Examples would be free recall of the words in a list presented earlier or some semantic-decision task (such as categorising the referents of the presented words as concrete or abstract, or as animate or inanimate). Conceptually-driven tasks presumably tap activation in the meaning (conceptual)-level of representation.

Data-driven tasks typically show null-effects of translation priming (e.g. no difference in response time between a response to *apple* preceded by *pomme* and a response to *apple* preceded by *femme*), at least when the translation pairs consist of non-cognates (translation pairs with completely different forms in the two languages concerned, such as in the pair *apple-pomme*; Gerard & Scarborough, 1989; Kirsner *et al.*, 1980; Kirsner *et al.*, 1984). These results suggest that different memory representations are contacted by each of the words in a non-cognate translation pair; in other words, they suggest that non-cognate translations are represented language-specifically at the form-level of representation. In contrast, conceptually-driven tasks *do* show a translation-priming effect, on cognate and non-cognate pairs alike, suggesting that one and the same representation is contacted by a word and its translation, and that this holds for both cognates and non-cognates. In other words, performance in conceptually-driven tasks suggests that, at the meaning-level of representation, cognates as well as non-cognates are stored in representations that are shared between the bilingual's two languages.

The conclusion that meaning representations of translation-equivalent words are shared between the two languages receives additional support from the finding that 'semantic-priming' effects occur not only within a language but between languages as well. Semantic priming is an experimental procedure where a target is preceded by a semantically related prime. In monolingual studies the prime and target are words from the same language (e.g. prime: *love*; target: *hatred*), whereas in cross-language studies prime and target are words from the different languages of the bilingual participant (prime: *love*; target: *haine*, in an English/French bilingual). One of the most robust findings in the word-recognition research field is that a word is processed faster when it follows a semantically related word than when it is preceded by an unrelated word. This semantic-priming effect occurs not only when prime and target are words from the same language (see Neely, 1991, for a review), but also when the prime is a word from one of the participant's two languages, and the target is taken from the other (Chen & Ng, 1989; De Groot & Nas, 1991; Jin, 1990; Kirsner *et al.*, 1984; Meyer & Ruddy, 1974; Schwanenflugel & Rey, 1986; Tzelgov & Eben-Ezra, 1992). In some of the critical studies the inter-language effect was in fact as large as the intralanguage effect. This latter finding constitutes particularly compelling evidence that meaning representations are shared between a bilingual's two languages.

In sum, the view that memory representations of translation pairs in bilinguals consist of two form components and a single meaning component receives support from a substantial number of studies. Nevertheless, many deficiencies and limitations of the model can be pointed out. But before doing so, I will present a number of different versions of the three-component model that have been proposed and the evidence on which they were based; the various alternative formulations of the three component, two level model are represented in Figures 2.2–2.5.



## Different versions of the hierarchical, three-component model

### *Word-association versus concept mediation*

Potter *et al.* (1984) reintroduced two versions of the hierarchical three-component model that about three decades earlier had already been advanced by Weinreich (1953), but under different names. The two versions differed from one another in terms of the connections between the assumed three components of the above hierarchical bilingual representations. In the version of the model that is called the word-association model (see Figure 2.2), the word-form representations in the first language (L1) and the second language (L2) of the translation pairs are directly connected with one another, and only the L1 word-form representation has a connection with conceptual memory.

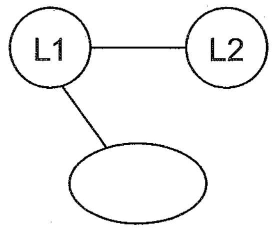


**Figure 2.2** The word-association model

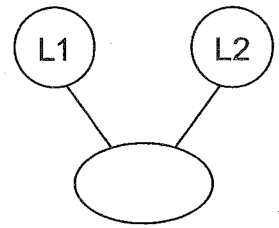


**Figure 2.3** The concept-mediation model

In the concept-mediation model (see Figure 2.3) the L1 and L2 word-form representations of a translation pair are not directly connected with one another, but both are connected to the conceptual representation common to the two words. Weinreich (1953) referred to the word-association and concept-mediation models as *subordinative* and *compound* structures, respectively.

Given a word-association structure, understanding and speaking the second language exploits the L1 word-form representations. For instance, a visually presented L2 word first accesses its L2 word-form representation; the corresponding L1 word-form representation is then accessed via the link between the two word-form representations; finally, the L2 word form is assigned a meaning via the connection between the L1 word-form representation and the associated meaning representation. In other words, the L2 word is in fact assigned the L1 word's meaning. Given a concept-mediation structure, L2 is processed in basically the same way as is L1; an L2 word is assigned meaning directly via the connection between the L2 word-form representation and the meaning representation shared between the L1 and L2 words. In these two versions of the model (as in the asymmetry model to be introduced below), the labels L1 and L2 not only indicate the order in which the two languages were acquired, but also the relative strength (dominance) of the two languages. The reason is that the two are typically confounded, with the language acquired first (the native language) typically being the stronger of the two (of course, there are exceptions). In fact, in the relevant studies (e.g. Kroll & Stewart, 1994; Potter *et al.*, 1984) differences in processing the two languages have been attributed to strength differences between them, not to a difference in acquisition order. Even though the reports of these studies were quite explicit about the pivotal role of language strength, the common labelling (L1 and L2) has unfortunately led to confusion and apparent misconceptions (Heredia, 1997). In this article I will follow the common practice of using the label L1 for the native and stronger language, and L2 for the second and weaker language.

Potter *et al.* (1984) considered an intermediate model, also referred to as the developmental model (Kroll & De Groot, 1997), which assumed that with practice the word-association links were replaced by the concept-mediation links between the L2 word forms and conceptual memory. They put the intermediate model to the test by comparing performance of a group of proficient (Chinese/English) bilinguals and a group of non-fluent (English/French) bilinguals on two tasks: picture naming in L2 and word translation from L1 into L2. The authors argued that a word-association memory structure predicts longer response times in the former task than in the latter, whereas a concept-mediation structure predicts equally long response times in the two tasks (see Potter *et al.*, 1984, for details). Both the proficient and the non-fluent groups responded equally quickly in the two tasks, a finding that disqualifies the intermediate (developmental) model and, instead, suggests concept-mediation memory structures at both levels of language proficiency.

Potter *et al.* (1984: 34) explicitly acknowledged the fact that the participants in their two experimental groups differed on more dimensions than L2 proficiency alone (e.g. the specific language combination; the age at which L2 acquisition started). But they deemed it unlikely that any of these were responsible for the fact that L2 proficiency did not critically affect the response pattern. However, they *did* acknowledge the possibility that proficiency effects might have been obtained if L2 users even less fluent than their non-fluent L2 users had been tested: 'It remains to be seen whether there is a stage at the very beginning of second-language learning ... in which direct word associates do play a role in second-language retrieval' (Potter *et al.*, 1984: 36). The validity of this suggestion is supported in studies by Kroll and Curley (1988) and Chen and Leung (1989). These authors also compared picture naming and translation in L2 in beginning and proficient bilinguals, but with beginners that presumably had a lower command of L2 than Potter *et al.*'s non-fluent bilinguals. The beginners in both of these studies indeed showed the response pattern that is consistent with the word-association model; in contrast, the proficient groups showed the concept-mediation pattern of results. In both studies the combined results for the two participant groups thus supported the developmental model.



*The revised hierarchical or asymmetry model.*

Kroll and her colleagues (Kroll, 1993; Kroll & Sholl, 1992; Kroll & Stewart, 1994; Sholl *et al.*, 1995) proposed a third version of the hierarchical three-component model (see Figure 2.4). It assumes both a direct link between a translation pair's L1 and L2 form representations (and vice versa) and an indirect connection between them through the conceptual node shared between L1 and L2 (a connection that includes a direct link between the L1/L2 conceptual node and the L2 word-form node). In a way this model combines the word-association and concept-mediation models into one. But the new model is more than a mere fusion of the earlier two. It explicates directional strength differences between the various types of connections and holds these responsible for, e.g. particular effects of translation direction in translation tasks (translating from L1 into L2 or from L2 into L1) and for asymmetrical semantic-priming effects in cross-language semantic-priming studies.

The broken lines in Figure 2.4 represent relatively weak connections; the solid lines represent strong(er) connections. The link between the L1/L2 conceptual node and the L1 form node is stronger than the link between this conceptual node and the L2 form node because of the differential command of the two languages, with L1 being the stronger of the two. The

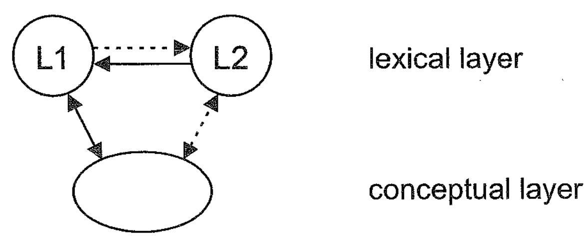


**Figure 2.4** The asymmetrical model

likely underlying source of this language imbalance is differential experience with the two languages, with L1 having been used more than L2. Furthermore, instead of just one connection between the two word-form nodes, as in the word-association model, the asymmetry model assumes two: a strong connection from L2 to L1 and a weak one in the opposite direction. The L2 to L1 link is assumed to be relatively strong because, according to the authors, second language learners first acquire L2 words through L2/L1 translation pairs (Kroll & Stewart, 1994: 158). Gradually, with increasing exposure to L2, direct connections between L2 word-form representations and the L1/L2 conceptual representations are established, but while this happens, the direct connections between the L1-form and L2-form representations do not disappear (or, worded more precisely, they do not pass into total disuse). It may be clear from this description that, in addition to specifying directional effects of L1 and L2 processing, the asymmetry model is a developmental model as well: the processing of L2 by non-fluent bilinguals will parasitise L1 word forms more often than will L2 processing by proficient bilinguals.

Kroll and Stewart (1994: Experiment 3) put this model to the test in a translation task where fluent bilinguals translated L1 words into L2, and vice versa. According to the authors, owing to the strength differences between the various connections in the underlying memory structures, translation proceeds qualitatively differently in the two directions of translation. L2 to L1 translation primarily employs the strong direct connections between the L2 and L1 form representations, whereas L1 to L2 translation primarily employs the indirect connections that implicate the L1/L2 conceptual representations. If this is true, response times for L2 to L1 translation may be expected to be shorter than response times for L1 to L2 translation, the reason being that the route to the translation response would be shorter in the former case. Furthermore, since conceptual (meaning) representations are usually implicated when L1 words are translated into L2, but not (or hardly ever), when translation proceeds in the opposite direction, meaning-related variables should clearly affect L1 to L2 translation, but they should not noticeably affect L2 to L1 translation. Both these findings were obtained by Kroll and Stewart (the meaning-related variable in question being whether the words to be translated were clustered in semantic categories during presentation or presented in random order instead), and provide support for the asymmetry model (see Kroll & Sholl, 1992, for other studies that produced the direction effect on response times). Further support for the model was obtained by Sholl *et al.* (1995), who observed a facilitatory effect of earlier picture naming on subsequent translation of the words depicted (and named) in the picture-naming task when translation was from L1 to L2, but not when it was from L2 to L1. Picture naming is known to involve access to conceptual memory. The priming effect of earlier picture naming on L1 to L2 translation thus suggests that concepts are also accessed while performing the latter task; in contrast, the absence of a priming effect of earlier picture naming on L2 to L1 translation suggests that concepts are not implicated when L2 words are translated into L1.



Other studies, however, have produced results that are problematic for the asymmetry model. A number of studies did not show the direction effect on translation speed that the model predicted. Instead, null-effects of translation direction on response times were obtained (De Groot *et al.*, 1994: Experiment 1; the highest-proficiency group in De Groot & Poot, 1997; La Heij *et al.*, 1996: Experiment 4; Van Hell & De Groot, 1998), whereas other studies have even obtained the opposite effect of faster translation from L1 into L2 (the two lowest-proficiency groups in De Groot & Poot, 1997; La Heij *et al.*, 1996: Experiment 3). Furthermore, several studies have shown an influence of semantic variables when words were translated from L2 into L1 (De Groot *et al.*, 1994; De Groot & Poot, 1997; La Heij *et al.*, 1996; Van Hell & De Groot, 1998a), and in some cases the size of the relevant semantic effects was equally large in both directions of translation. The latter studies in particular suggest that conceptual memory is implicated to the same extent in both translation directions. Kroll and De Groot (1997: 184–185) discuss possible reasons for these conflicting results.

A further set of results that is problematic for the asymmetry model (as well as for the developmental model discussed earlier) is that from the very initial stages of L2 vocabulary learning onwards, learning performance is better for concrete words than for abstract words (De Groot & Keijzer, 2000; Ellis & Beaton, 1993; Van Hell & Candia-Mahn, 1997). This finding suggests that new L2 words are immediately associated with meaning (see also Altarriba & Mathis, 1997, who arrived at the same conclusion using a different experimental procedure). The concreteness effects were equally large with productive testing (L1 words are presented and the newly learned L2 words have to be produced; i.e. translation from L1 into L2) as with receptive testing (the newly learned L2 words are presented and the corresponding L1 words have to be produced; i.e. translation from L2 into L1; De Groot & Keijzer, 2000). This finding also appears to challenge the asymmetry model, which would have predicted larger concreteness effects with productive testing.

## Determinants of Bilingual Memory Representation

The data patterns obtained in the studies by Chen and Leung (1989) and Kroll and Curley (1988) suggested word-association representations for bilinguals at a very low level of L2 proficiency, and concept-mediation representations for bilinguals relatively fluent in L2. An important conclusion to be drawn from this is that bilingual memory representation is not uniform across all bilingual populations. Apparently, level of L2 proficiency is a variable that determines how translation pairs are represented in bilingual memory. Other support for the same idea comes from bilingual Stroop studies (e.g. Chen & Ho, 1986; Tzelgov *et al.*, 1990).

De Groot and Hoeks (1995) further specified the role of language proficiency in bilingual memory representation. They tested trilinguals who had Dutch as their native language, English as their strongest foreign language, and French as a weaker foreign language (cf. Abunuwara, 1992). When concrete and abstract Dutch words were translated into English, a strong concreteness effect was obtained. This finding suggests concept mediation translation (and the concomitant memory structures) at a high level of foreign-language proficiency. In contrast, when concrete and abstract Dutch words were translated into the weaker language French, no such effect was obtained, a finding that suggests word-association translation (and the corresponding memory structures). It thus appears that foreign-language proficiency affects memory representation not only across subject populations but also within one and the same person. The important conclusion is that within one and the same multilingual mind different types of bilingual memory representations – word-association representations as well as concept-mediation representations – may co-exist.

In De Groot (1995) I discussed a number of other determinants of bilingual memory representation. One of them makes exactly this same point that different types of representations may coexist within multilingual memory, but takes it one step further by showing that, even for one and the same language combination, different structures may exist within one multilingual mind (and that the state of 'mixed-representations' may thus also hold for bilinguals). The determinant I am referring to here is word type. Many bilingual studies have shown that different types of words are processed differently in a number of tasks (e.g. primed lexical decision, word translation). The most robust effects are those of 'cognate status' and of concreteness. Words that have a cognate translation in the participant's other language (e.g. *appel-apple* in a Dutch/English bilingual) show a response pattern different from that of non-cognates (e.g. *pomme-apple* in a French/English bilingual), and words with a concrete referent (e.g. *wheelchair*) show results that are different from those obtained with abstract words (e.g. *mystery*). Typically the data suggest that the bilingual memory structures for cognates and concrete words are more integrated across a



bilingual's two languages than the structures for non-cognates and abstract words (for a review, see De Groot, 1993).

In addition to concreteness and cognate status, word frequency appears to determine bilingual memory representation. This can be concluded from the fact that, in translation studies, concreteness effects tend to be larger for high-frequency words than for low-frequency words (De Groot, 1992a), suggesting that the former are relatively often translated via the concept-mediation route and the latter relatively often via the direct connections between a translation pair's L1-form and L2-form representations. Worded in terms of memory structures, not processes, the results suggest that relatively many high-frequency words are stored in concept-mediation representations, whereas relatively many low-frequency words are stored in word-association representations. The important underlying variable is presumably the amount of practice that bilingual language users have had with a word and its translation in L2. By definition, high-frequency words will have been used more often than low-frequency words (this holds not only for L1 words but also for the corresponding L2 words; word frequency is highly correlated between languages). As a consequence, the direct connections between the representations of a word's surface forms in L1 and L2 on the one hand and the (shared) conceptual representation will both be strong, promoting concept mediation. For low-frequency words, the direct connections between the L2-form representation and conceptual memory will be relatively weak (owing to the lack of sufficient practice of particularly low-frequency L2 words), frustrating concept mediation; consequently word-association translation will have to be relied on relatively often.

It is likely that over time (more precisely, with increasing L2 experience) even low-frequency L2 words will ultimately have been practiced often enough to have developed sufficiently strong links between the L2 word-form representations and conceptual representations for these to be exploited efficiently in L2 processing and in cross-language tasks. In terms of the underlying representations, we could say that concept-mediation structures will have replaced the word-association structures that existed earlier for these words. This account of the relation between word frequency and the way it is reflected in bilingual memory is completely compatible with the view on the relation between L2 proficiency and bilingual memory presented earlier. Proficient bilinguals have presumably practised the L2 enough to have developed a preponderance of concept-mediation structures for frequent and infrequent words alike (and show the concept-mediation data pattern in the relevant experiments). Non-fluent users have had little practice in L2 and, as a result, the links between the L2 form representations and conceptual memory will still be weak for *all* words. They will therefore have to rely on word-association processing relatively often; in other words their memory consists primarily of word-association structures. In a way then, the present word-frequency variable mimics within one and the same bilingual mind the (between-individual) effect of language proficiency. The important new insight provided by this analysis is that lexical change is likely to take place at the level of individual words, rather than that, when some critical level of L2 proficiency has been reached, all representations in bilingual memory suddenly change from word-association structures to concept-mediation structures. Earlier I phrased this idea as follows:

> The representational structure for any given pair of translations gradually develops over use or disuse of that particular translation pair. This view is more plausible than the assumption that at one point in time all memory structures, all being of one type, are miraculously replaced by structures of a different type. (De Groot, 1995: 174)

In addition to L2 proficiency and word type, the L2 learning method, or more generally, the L2 learning environment, is yet a further possible determinant of bilingual memory organisation. The results of studies by Chen (1990) and Lotto and De Groot (1998) suggest that indeed learning method (e.g. whether the L2 word to be learned is presented with the corresponding L1 word during learning or instead with a picture representing the meaning of the L2 word) plays a role, at least during the very initial stages of L2 learning. Picture learning resulted in 'picture-association' representations (that contain links between the representations of the L2 word forms and those of pictures that depict the referents of these words), whereas word learning resulted in word-association representations. (In the same study, Chen ruled out the learner's age as a critical factor in bilingual representation.) However, Chen's study also demonstrated that already after a rather small number of learning trials, learning method no longer mattered: irrespective of learning method, concept-mediation patterns were obtained, suggesting concept-mediation representations for both learning conditions. These relatively recent studies on the effect of learning method on bilingual memory representation in fact exemplify the much older idea that the environment in which the L2 is learned affects what type of memory structures emerge (Ervin & Osgood, 1954; Lambert *et al.*, 1958). The results of Chen's (1990) study in particular may account for the fact that in this older work little support has been obtained for the idea that learning environment affects bilingual representation (Kolers, 1963): the memory structures may differ only during the very initial stages of L2 learning. If this is true, studies that test bilinguals beyond this stage will not show any effects of learning environment.



To summarise this section, the memory of a bilingual language user presumably contains structures of different types; the different structures occur in different proportions across bilinguals, and the individual structures change over time (with practice). The change involves the strengthening of initially weak links between the various components of the bilingual memory structures. The consequence of such strengthening of links that were weak before is that they will start to dominate processing, and that, accordingly, the response patterns change, e.g. from a word-association to a concept-mediation pattern. What this description of change highlights is that the different versions of the three-component model should not be viewed as qualitatively different from one another, but merely as functionally different.

## Caveats and Qualifications

So far I have presented a general model of bilingual memory that assumes three-component representations of translation pairs that each contain two language-specific word-form representations and one conceptual (meaning) representation that is shared between the languages. I then presented the various versions of this general model that have been suggested and some of the experimental evidence and counter evidence. Finally, I made the point that the different versions can co-occur within one and the same bilingual mind. Together, these views provide an account of bilingual memory that is lacking in several respects. In this section I will detail a number of its shortcomings.

A first obvious fault of the model is that it does not specify the exact nature of particular types of lexical knowledge in detail, and ignores other types altogether. For instance, I consistently talked about word-form representations, as if these were of a unitary type. But many languages come in two forms, one written and one spoken, and literate users of such a language must have stored representations for each of them in memory. These two types of form representations, one orthographic and one phonological, are likely to be stored in separate subsystems of the word-form store (plausibly with a connection between a word's form in each of the two subsystems), and the elements of *both* subsystems map onto the conceptual representations one way or the other. For bilinguals who are literate in both of their languages, this situation holds for both languages. All this has been ignored in the discussion so far, but will ultimately have to be taken into account. In doing so, many new questions will probably present themselves. For example, do direct connections between the L1 and L2 word-form representations exist only for form representations of the same kind (both orthographic or both phonological), or are there bilingual cross-form connections as well ( e.g. from the orthographic representation of *pomme* to the phonological representation of *apple*?)

Another caveat is that language users' knowledge about words obviously encompasses much more than what words look or sound like (their form) and what they mean. For instance, users may know what letters a word contains, to what syntactic class it belongs, and what its morphological structure is. Furthermore, bilingual language users will generally know to which one of their two languages a particular word belongs. Therefore, a complete description of monolingual and bilingual lexical representation should contain more layers than just the two distinguished above, and the content of the separate layers may be richer than suggested above. For instance, Levelt's serial model and Dell and O'Seaghdha's interactive model of monolingual speech production (Dell & O'Seaghdha, 1991; Levelt, 1989) specify morphological, phonological, semantic and syntactic lexical information, as do bilingual speech production models that are derived from these (for reviews, see Hermans, 2000; Poulisse, 1997). Moreover, the well-known bilingual representation models that have focused on the process of word recognition (rather than on how word forms and word meanings map onto one another) have distinguished between layers that were not explicit in the three-component model. The bilingual interactive activation (BIA) model for *visual* word recognition (Grainger & Dijkstra, 1992; Dijkstra & Van Heuven, 1998; see Figure 2.5) contains four layers that store the representations for letter features, letters, words, and language, respectively. The bilingual model of lexical access (BIMOLA), an interactive model of *spoken* word recognition (Léwy & Grosjean, 1999; Grosjean, 1997; see Figure 2.5), contains separate representation layers for phoneme features, phonemes and words (see Grosjean, 1997). The word layer in both models is similar to the word-form level in the present three-component model and, although both models include levels not specified in the three-component model, neither of the two models contains a layer that stores word meanings. Recently, however, Van Heuven (2000) extended the BIA model such that it also contains representations of word meanings as well as a phonological lexicon; the extended model is called SOPHIA (Semantic, Orthographic, and PHonological Interactive Activation Model). Which layers of representational units are specified in a particular model depends on the specific question posed by the bilingual researcher (for example: how does visual or spoken word recognition come about? how do words



map onto meaning? how are L2 words retrieved and output during L2 production?), and on the set of data the model is meant to account for.

Another distinction that several authors consider to be important, but that is nevertheless not reflected in the three-component model is one between semantic and conceptual representations (e.g. Paradis, 1997; Pavlenko, 1999). Pavlenko defines the semantic component of bilingual memory representations as 'explicitly available information which relates the word to other words, idioms and conventionalised expressions in the language; it is characterised by polysemy'. In contrast, the conceptual component is thought to store 'non-linguistic multi-modal information, which includes imagery, schemas, motor programs, and auditory, tactile

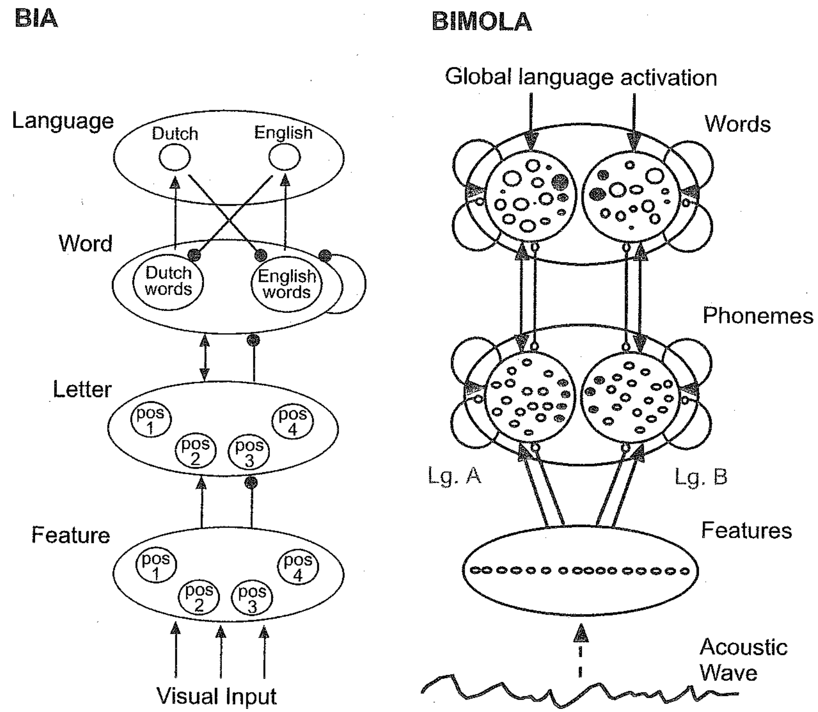


**Figure 2.5** The Bilingual Interactive Activation (BIA) model of bilingual visual word recognition (e.g. Grainger & Dijkstra, 1992) and the Bilingual Model Of Lexical Access (BIMOLA), a model of bilingual spoken word recognition (e.g. Léwy & Grosjean, 1999; Grosjean, 1997).

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and somatosensory representations, based on experiential world knowledge (Pavlenko, 1999: 212). The three-component model conflates these two types of knowledge. This may turn out to be a crucial flaw of the model, although I have argued elsewhere (De Groot, 2000) that conflating them may be the logical consequence of the facts that pinpointing the difference between semantic and conceptual knowledge is a tedious task, and that both types of knowledge plausibly originate from one and the same source.

Finally, the three-component model cannot readily account for the fact that the two words in translation pairs very often (maybe even most often) do not share meaning completely. In early research into bilingual memory this cross-language non-equivalence of meaning was a reason to assume completely separate conceptual memories for a bilingual's two languages (Kolers, 1963; Weinreich, 1953: coordinate bilinguals). However, given a word-association structure, the meaning assigned to an L2 word is simply the meaning of the L1 word. The way the concept-mediation model is usually described suggests the same (the crucial difference between the two models being that L2 words are directly assigned this meaning in the one case, but indirectly – via the L1 word forms – in the other case). Yet, I believe that the completely-shared-meaning assumption is not inextricably bound up with the concept-mediation hypothesis.

In an earlier paper (De Groot, 1992b), I zoomed in on the content of the conceptual representations in, *inter alia*, the concept-mediation structures to stress the point that these representations are likely to contain sets of more primitive-meaning elements. The exercise led to the proposal of a model of bilingual memory (see Masson, 1991, for the monolingual version) in which a word's meaning was presented as 'distributed' across a number of more elementary representation units that each stored some elementary part of the word's meaning (say, one semantic feature). From there on it was a small step to account for the non-equivalence of word meaning across languages, namely by assuming that the two words in a translation pair do not have to share exactly the same set of such elementary meaning elements. This state of affairs is depicted in Figure 2.6 (see Kroll & De Groot, 1997 and Van Hell & De Groot, 1998b, for more recent versions of this 'distributed' model that also assume distributed word-form representations). In addition to accounting for cross-language non-equivalence of meaning, this 'distributed' model can also readily explain the fact that conceptual knowledge is not static. It changes all the time and, furthermore, differs between individuals (Pavlenko, 1999). Elements may be added to the conceptual set or disappear from it, and across individuals differences may occur in the set that represents a particular word's meaning.



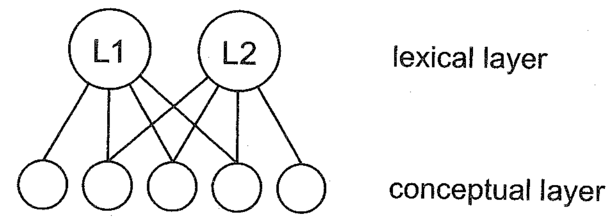


**Figure 2.6** Distributed model

The point to be made here (see also De Groot, 2000) is that, had the proponents of the present three-component models explicitly focused on the content of the conceptual representations, they might also have arrived at the conclusion that meaning representations may consist of sets of more primitive elements. The next step, again, might have been to allow for the existence of L1-specific and L2-specific meaning elements in the conceptual representations of the concept-mediation memory structures and the asymmetrical memory structures (but not in those of the word-association structures, because these store only L1 meanings). However, the fact remains that the three-component models do not explicitly split up conceptual representations in component parts and, consequently, provide no *ready* explanation for cross-language non-equivalence, the non-static nature of the content of conceptual representations, and for the fact that different individuals can assign different meanings to one and the same word.

The points raised in this section all lead to the conclusion that the various versions of the hierarchical three-component model are all still rather incomplete accounts of bilingual memory. Because of their focus on representation, and in particular on how word forms map onto meaning within the memory structures, they have ignored the question of how other types of linguistic knowledge than a word's surface form and meaning are stored, and they also have had little to say about the way bilingual memory is accessed. The next section reviews work that primarily dealt with the latter question.

## Bilingual Lexical Access

Presumably the currently most central question in research on lexical processing by bilinguals is whether or not they can somehow 'switch off' the contextually inappropriate language during comprehension or production in the targeted language, or, phrased in today's more common terminology, whether bilingual lexical access is language-non-selective or language-selective instead. The selective-access view of language comprehension holds that the visual or spoken input is processed by the contextually appropriate language system only. Similarly, the selective-access view of language production holds that during the process of speech production, lexical elements from the non-target language do not compete to be output with lexical elements from the targeted language system. In contrast, the corresponding non-selective-access views hold that in comprehension both of a bilingual's language systems respond to a language input and that in production lexical elements of both language systems compete for selection. The occurrence of unintentional use of words from the non-target language in the speech of bilinguals suggests that bilingual language production is non-selective. Similarly, the accidental assignment of the non-target language's meaning to an input letter string that constitutes a word in both of a bilingual's two languages (e.g. the letter string *coin* in a French/English bilingual; *coin* means 'corner' in French) would suggest that access during comprehension is non-selective. These errors do occur, though in surprisingly small numbers. For instance, Poulisse (1999) reported an average of just one L1 speech error among 350 L2 words produced by unbalanced bilinguals whose stronger language is L1. The opposite, that is, intrusions from the weaker L2 into the stronger L1 is likely to occur even less often. The low incidence of such errors might well be taken to indicate that bilingual language comprehension and production are generally language-selective. Yet, the majority of the pertinent studies suggest that, instead, non-selectivity is the rule.

### Support for language-selective access?

Apparent support for selective access comes from a set of studies that looked at the effect of language switching (or language mixing) on performance. The typical result is that alternating between the two languages in input and/or output slows down the response. For instance, MacNamara & Kushnir (1971; see also Kolers, 1966) showed that silent reading of paragraphs that contained language switches took longer than silent reading of unilingual paragraphs. Similarly, true–false judgements took longer for written and spoken sentences containing switches than for monolingual sentences. Response times increased as the number of language switches within the sentences increased. For instance, a sentence such as *Un citron est* <u>*yellow*</u> (one switch) took shorter to respond to than a sentence such as <u>*Turnips*</u> *sont* <u>*vegetables*</u> (two switches; examples taken from MacNamara & Kushnir, 1971). The data suggested that every switch took about 200 milliseconds. The authors interpreted these results as support for the existence of an automatically operating input switch that directs the input to



the appropriate linguistic system. In case of a change of language in the input, the input switch has to be pulled over, as it were, to the other linguistic system in order for the latter to be able to process the input. This operation takes time and, hence, leads to an increase in response time.

Soares and Grosjean (1984) examined the effects of language-switching locally (that is, at the exact position of the switch) instead of globally (by measuring response times for whole sentences), by registering response times to targets in a phoneme-triggered lexical-decision task (see Soares & Grosjean, 1984, for details). Response times were shorter when all the words in the sentence, including the target, were in the same language than when the target involved a change of language. Finally, Grainger and Beauvillain (1987) obtained the analogous pattern of results, but this time for English and French words that were presented not as parts of sentences but in lists of unrelated words and non-words to which the participants performed 'language-neutral' lexical decisions (respond 'yes' if the letter string is a word in either French or English; respond 'no' if it is not a word in either of these languages). The critical words were presented either in pure lists (containing, in addition to non-words, exclusively French or exclusively English words) or in mixed lists (containing words from both languages). Mixing the two languages again slowed down performance. This finding is consistent with the idea that the language-context information provided by the pure lists always directed the incoming information straight to the appropriate language system, which is then searched immediately. In the mixed list the incoming information may initially be directed to the inappropriate language system. Only after a search through this system has failed will the information be directed to the appropriate language system. Longer response times for the mixed condition will consequently be obtained. Another set of studies (MacNamara *et al.*, 1968; Meuter & Allport, 1999) has examined the effect of switching the language of *output* (e.g. in number naming tasks), unconfounded by input switching. The results agree with those of the input-switch studies in that, again, language switching was detrimental for performance.

At first sight, the data from the above comprehension and production studies all appear to support the views that:

(1) A bilingual's mind contains two separate language subsystems (e.g. the two word-form systems assumed by the hierarchical three-component model discussed earlier, and also by the BIA and BIMOLA word-recognition models depicted in Figure 2.5).
(2) During the process of word comprehension and production the two subsystems are not searched (or activated) simultaneously but serially

(and the second of the two only if the first has not come up with a satisfactory output).

The first view is generally not contested, but in most of the more recent work the latter is, because it does not fit the data of a large set of (especially comprehension) studies, to be discussed later, which suggest that the two language subsystems of a bilingual are simultaneously active during language processing.

Grainger and Beauvillain (1987) and Grainger (1993) solve the puzzle by pointing out that a detrimental effect of a language switch in the input does not provide unequivocal support for selective access (and an associated switching device), but is perfectly compatible with the view that at least the initial stages of lexical access are language-non-selective. Similarly, Grosjean (1997: 250) points out that the slowing-down effect of mixing the language input provides 'insubstantial and indirect' support for the existence of some mental language-switch device. He remarks that 'It is not because bilinguals may, at times, process code-switches more slowly than base language words that researchers can conclude there is a language switch/monitor involved in the processing; the delay could be due to numerous other factors' (Grosjean, 1997: 250; see also Grosjean, 1988). Grainger and Beauvillain (1987) present two initially non-selective bilingual word-recognition models that could account for their data. One of these two models is the Bilingual Activation Verification (BAV) model; the second is (an earlier version of) the Bilingual Interactive Activation Model introduced earlier (see Figure 2.5). Because this latter model in particular has been advanced in much of the very latest work on bilingual visual word recognition (e.g. Dijkstra & Van Heuven, 1998; Van Heuven *et al.*, 1998), I will briefly explain Grainger and Beauvillain's (1997) language-switch data in terms of this model (see e.g. Grainger, 1993, for an account in terms of the BAV model).

BIA is an extension of McClelland and Rumelhart's (1981) interactive activation model of visual word (and letter) recognition in monolinguals, which consists of three layers of memory nodes, representing letter features, letters and words, respectively. In the BIA model, a fourth layer of language nodes is added, containing one node for each of the bilingual's two languages, and mounted on top of the word-nodes layer. Irrespective of language context, when a word is presented to the language system, it activates (through the relevant feature and letter nodes) word-level nodes in both language subsystems. Subsequently, each of the activated word nodes passes activation on to the corresponding language node through the excitatory connection that connects the two (see Figure 2.5). The activated language node then sends back inhibitory excitation through the inhibitory connections between this language node and the other language's word nodes, or in other words, it suppresses the activation of all words in the other language's lexicon. The effect will be that the subsequent processing of a word from this other language (that is, the word presented on a switch trial) will be slowed down as compared to processing a word on a no-switch trial.

The important conclusion is that Grainger and Beauvillain's (1987) language-mixing effect can be explained in terms of a model that assumes lexical access to be initially language-non-selective. Moreover, there is no a priori reason why the switch data obtained in the mixed-paragraph and mixed-sentence experiments discussed above could not be explained similarly. As already pointed out above, researchers of spoken word recognition also reject the idea of a language-switching device and the selective-access process that it imposes (Grosjean, 1988; 1997).



## Support for language-non-selective access

In this section, four sources of support for the view that bilingual lexical access is initially language-non-selective will be presented. Because of space limitations, I will focus entirely on comprehension studies. Therefore, the conclusion to be drawn – that bilingual lexical access is non-selective – should not thoughtlessly be generalised to production studies. Indeed, the relevant production studies (e.g. Costa *et al.*, 1999; Hermans, 2000; Hermans, *et al.*, 1998) do seem to arrive at conflicting conclusions.

### *Interlexical homograph studies*

A set of studies on the processing of 'interlexical' (or 'interlanguage') homographs by bilinguals has provided compelling support for the view that bilingual lexical access in comprehension tasks is (initially) non-selective (Beauvillain & Grainger, 1987: Experiment 1; De Groot *et al.*, 2000; Dijkstra *et al.*, 1998; Dijkstra *et al.*, 1999). Interlexical homographs are words that have one and the same written word form but different meanings in the two languages of a bilingual. An example is the word form *glad*, meaning 'slippery' in Dutch, in a Dutch/English bilingual. The studies just mentioned have all shown that processing times for interlexical homographs differ from those of frequency-matched control words. No obvious difference exists between the homographs and their controls other than the fact that the former mean different things in the bilingual's two languages whereas the latter mean something in only one of her two languages. This *homograph effect* suggests that a homograph activates both of the language subsystems. In other words, it suggests that lexical access is language-non-selective. If the bilingual participants in these experiments had managed to 'switch-off' (deactivate) one of their languages, homographs and controls might have been expected to be processed equally rapidly.

Importantly, the homograph effect does not occur only in *bilingual* tasks, that is, tasks that can be performed only if both language systems are simultaneously activated (e.g. word translation). It also occurs in *monolingual* tasks, that is, tasks that *per se* do not require the simultaneous activation of the two lexicons of the bilingual, and that, in fact, under certain circumstances would be easier to perform when the non-target language is deactivated (see De Groot *et al.*, 2000, for example tasks and more detail). The fact that the effect occurs even when completely deactivating the non-target language would have produced better results constitutes strong evidence that switching off the non-target language is simply no option. In contrast, on the basis of the results of an earlier, similar study, Gerard and Scarborough (1989) concluded that access to bilingual memory *is* language-selective, but other authors have suggested that, in fact, Gerard and Scarborough's findings are largely compatible with the language-non-selective view (e.g. De Groot *et al.*, 2000).

Analogous to the interlexical homograph effect, Dijkstra *et al.* (1999) obtained – with *visual* stimulus presentation – an interlexical *homophone* effect, that is, a difference in processing time for matched controls and words that sound approximately the same in a particular bilingual's two languages but that carry different meanings in these two languages (e.g. the pair *leaf-lief* in a Dutch/English bilingual; *lief* means 'sweet' in Dutch). Interestingly, the direction of the homophone effect (slower than their controls, i.e. homophone inhibition) differed from the direction of the homograph effect in the same study (faster than their controls, i.e. homograph facilitation). However, inhibition for interlexical homographs has been obtained in other studies (De Groot *et al.*, 2000; Dijkstra *et al.*, 1998), and Dijkstra *et al.* (1998) demonstrated that the direction of the homograph effect may vary, depending upon task demands. What is presently more important than the direction of the homograph (and homophone) effect, however, is the fact that an effect is obtained at all. Whatever its direction, the occurrence of the effect *per se* supports the non-selective-access view.

### Phonological activation studies

A second source of support for the non-selective-access view comes from a set of studies that, in various ways, all suggest that upon the visual presentation of a word, non-target-language phonology is activated (in addition to target-language phonology). For instance, Nas (1983) had



Dutch/English bilinguals perform English lexical decisions to visually presented letter strings (if the letter string is a word in English, respond 'yes'; if not, respond 'no'). 'No' decisions took longer for non-words that sounded like a Dutch word if pronounced according to English grapheme–phoneme correspondence (GPC) rules (e.g. *deef* and *vay*, when pronounced according to English GPC rules, sound like the Dutch words *dief en vee*, respectively, meaning 'thief' and 'cattle') than for non-word controls (such as *prusk* or *blane)*, that, if pronounced according to English GPC rules do not sound like Dutch words). Apparently the phonological forms, encoded according to the English GPC rules, activate the phonological forms of the Dutch words *dief en vee*, inducing a bias towards responding 'yes' (these are words). This bias has to be overcome, thus delaying the correct 'no' response.

Conceptually similar studies by Altenberg and Cairns (1983), Jared and Kroll (2001), Tzelgov *et al.* (1996), and Van Leerdam *et al.* (in preparation), also all showed, in different ways and employing different tasks, phonological activation in the non-target language subsystem. The latter authors employed an interesting new matching task, in which on each trial a *printed* English (L2) word and a 'phonological word body' (that is, the medial vowel(s) and final consonant(s) of a one-syllable word) were simultaneously presented and the participants had to decide whether or not the two match, that is, whether or not the final part of the printed word would, when pronounced, sound like the phonological body. For example, when the printed word *blood* is presented together with the phonological body /aɪd/, as in *bride*, the participant should respond 'no'. The result that is of particular interest here is that relatively many errors were made on mismatch trials where the phonological body concerned the typical L1 pronunciation of the printed L2 word's 'orthographic' body (the letter sequence that corresponds with the phonological body). For instance, the orthographic body *ood* of the English L2 word *blood* is typically pronounced as /əʊd/ (as in the English word *load*) in Dutch. Trials of this type (e.g. the printed English word *blood* presented with the Dutch /əʊd/ pronunciation of the 'ood' letter cluster) resulted in extremely poor performance (47% errors; in other words, 47% incorrect 'yes' responses). This finding strongly suggests that the visual presentation of an English word (e.g. *blood*) not only activates representations in the English language subsystem, but also in the Dutch subsystem (e.g. *brood, nood, dood*). On this specific example trial, the phonological representations of the activated elements in the Dutch subsystem match with the /əʊd/ phonological body presented on that trial, thus leading to an incorrect 'yes' response.

*Interlanguage neighbourhood studies*

The study by Van Leerdam *et al.* (in preparation) demonstrates that the non-target language's 'phonological neighbourhood' affects target language processing. This finding converges with results of a set of earlier studies that looked at 'orthographic neighbourhood' effects across a bilingual's two languages. A word's neighbourhood is the set of words in the language user's mental lexicon that are to a large extent similar to the target word. In early monolingual work, a word's neighbourhood was specifically defined in terms of orthography, namely, as all the other words in the target language that share all but one letter with the target word (for instance, the English word *hand* has, among others, the words *land*, *band*, *hang* and *hind* as English neighbours). Related bilingual work (Grainger & Dijkstra, 1992; Grainger & O'Regan, 1992; Van Heuven *et al.*, 1998) distinguished between a word's intralanguage orthographic neighbourhood and its interlanguage orthographic neighbourhood. The latter consists of the words in the non-target language that share all but one letter with the target word; for example, the Dutch word *hond*, meaning 'dog', is an interlanguage orthographic neighbour of English *hand*). The main question addressed by this bilingual work was whether or not a word's neighbours in the non-target language affect processing the word in the target language. This finding would, again, demonstrate language-non-selectivity of bilingual lexical processing. In different ways the studies just mentioned indeed show this interlanguage effect, e.g. in lexical decision (Grainger & Dijkstra, 1992) and in a so-called 'progressive demasking' task (see Van Heuven *et al.*, 1998). The above study by Van Leerdam *et al.* (in preparation) shows the analogous effect of a word's interlanguage 'phonological' neighbourhood (the set of words in the non-target language that share a large part of their phonological structure with the target word), as does a conceptually similar study by Jared and Kroll (2001) that employed the word-naming task (in which presented words simply have to be read aloud).

*Studies on the effect of 'cognate status'*

A final source of support for initially language-non-selective bilingual lexical access comes from a number of studies that have looked at the effect of a word's 'cognate status' on task performance. Cognates are words that translate into the bilingual's other language into largely similar (or exactly the same) word forms (e.g. the Dutch words *appel* and *hand*, that translate into the English *apple* and *hand*, respectively). Non-cognates share only meaning, not form, across languages (e.g. the Dutch words *hond* and *fiets*, that translate into *dog* and *bike*, respectively). (Note that, in contrast, the interlexical homographs discussed earlier share form but not meaning across languages.)



At least three lexical-decision studies have shown that lexical decisions in the weaker language of a bilingual are faster for cognates than for non-cognates (Caramazza & Brones, 1979; Dijkstra *et al.*, 1998: Experiment 1; Van Hell, 1998: Chapter 4). Moreover, a recent study by Van Hell and Dijkstra (submitted) showed the analogous result for lexical decision in the stronger language. Again, these studies support the view of language-non-selective bilingual lexical access: the representation of the cognate's similar or identical form in the non-target language appears to be coactivated when a cognate is presented, a coactivation that somehow speeds up the target word's processing. The study by Van Hell and Dijkstra is especially important, because it shows that not only is the processing of the weaker language affected by activation of the stronger language, but also that processing the dominant language is not immune to influences from the non-target language (see also De Groot *et al.*, 2000: Experiment 3). However, these authors also show that, for this interlanguage influence from the weaker to the stronger language to occur, some minimal level of L2 proficiency has to be attained.

*Control*

In sum, many studies support the conclusion that bilingual lexical access is initially language-non-selective. It is still a topic of debate whether initial non-selectivity is total or only partial. Total non-selectivity would mean that, irrespective of contextual factors (such as the characteristics of the addressee, the conversational topic, the specifics of an experimental setting) a particular external language input (in comprehension) or a conceptual content (in production) always initially activates both of the bilingual's two language subsystems – and always to the same extent. Of course, an external language input will ultimately have to be recognised by the targeted language subsystem (in comprehension) and a concept will ultimately have to be verbalised in the targeted language (in production). An initially non-selective system could reach this goal through a process of inhibitory control that reactively suppresses the activated elements of the non-target language (see Green, 1998, and the peer commentaries to that article).

The alternative view is that to some extent language control can be exerted proactively (a term dubbed by De Groot, 1998), by adapting the relative activation levels of the 'guest' (non-targeted; non-selected) and 'base' (targeted; selected) languages to the specific characteristics and demands of the communicative context (or experimental task). For instance, according to Grosjean (e.g. 1997; 2001) bilinguals respond to the specifics of a conversational setting (such as the topic of the conversation and the L2 proficiency level of the addressee) by moving on a 'language mode continuum' where the various positions on the continuum are reflected in differences in the relative activation levels of the base language and the guest language. The bilingual language user is said to be in a 'bilingual' mode if both the guest language and the base language are highly activated (but the base language more so than the guest language); she is said to be in a 'monolingual' mode if she has deactivated the guest language as best as possible. According to Grosjean, in the monolingual mode the guest language is also activated to some extent. One could therefore say that language non-selectivity also holds for this mode, but only partially.

That bilinguals can adapt to the specific demands of the conversational context is uncontested and is, indeed, convincingly demonstrated experimentally by Grosjean (1997). For example, he showed that the number of switches to the L2 guest language increases as the L2 fluency level of an imaginary addressee increases. It remains to be seen, however, whether such adaptation indeed involves variability in pre-set activation levels (proactive control), which is the view defended by Grosjean. A qualitatively different but equally plausible view is that adaptation to the task and setting involves variability in the degree in which the output of the bilingual lexical system (that may be totally non-selective initially) is monitored and censored (before it is actually articulated). For instance, a situation where a switch to the L2 guest language is likely to cause a communicative breakdown (because of the low L2 proficiency of the addressee) might invite more stringent monitoring and censoring than a situation where a language switch would not harm communicative fluency.

In sum, the exact locus of control and the nature of the mechanism(s) exerting control have yet to be determined. A full understanding of these issues of control will not only complement the current models of language processing in normally functioning bilinguals but is also likely to impact on theories of bilingual aphasia (for details see Green, 1986; Paradis, 1997).

To conclude this section, most of the pertinent studies suggest that bilingual lexical access in comprehension is initially language-non-selective, that is, that both of a bilingual's language sub-systems initially respond to a language input. Whether or not non-selectivity also holds for bilingual language production is a question that was only briefly touched upon, and remains unanswered, in the present review of the literature.



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