Bilingual lexical organization and access

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Bilingual lexical organization and access: a literature overview

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Bilingual Lexical Organization and Access: A Literature Overview.

Contents

1. Introduction

The general purpose of this chapter is to present a review of the literature in order to examine and evaluate the current models of Bilingual Lexical Organization. Research on bilingualism presents the opportunity to address fundamental issues in language processing, such as memory organization, lexical organization and lexical access. In this section the general outline of the document is presented.

The initial studies on bilingualism took place in the middle of this century. Bilingual subjects were classified according to their proficiency and level of learning in their different languages. In these classifications bilingual subjects were considered to be exceptional, as opposed to 'normal' monolingual subjects (see Grosjean, 1992, for an extended overview).

Examples of classifications are those of Weinreich (1953/1968), and Ervin & Osgood (1954). Weinreich's (1953/1968) description of the language processing system includes two different types of memory: a conceptual memory where meanings are stored; and a lexicon where the lexical entries and the information attached to them are stored. This distinction is crucial since it gave rise to specific research on lexical organization independently of semantic information.

Weinreich proposed three different types of word knowledge organization in bilinguals (see Figure 1).

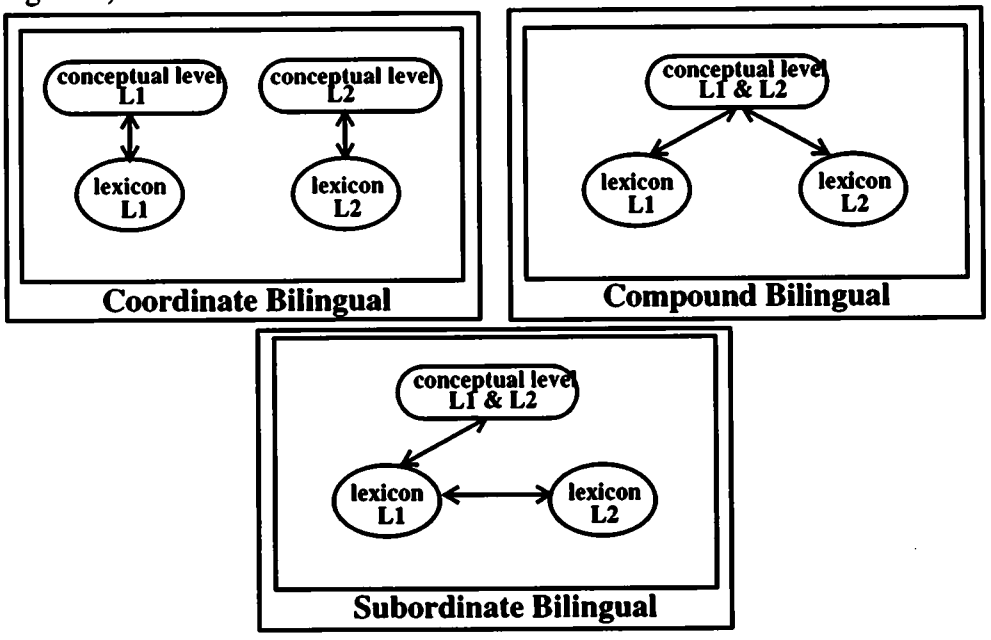

Figure 1. Weinreich's classification of bilingual subjects.

For Coordinate bilinguals words and meanings of the two languages are separately structured. For Compound bilinguals one conceptual representation is linked to two lexical systems. Finally, for Subordinate bilinguals the second language is related to the conceptual level only by means of the first language. The classification of Ervin &

Osgood (1954) is quite similar to Weinreich's. Due to their behaviorist background, they described the classifications in terms of how languages are acquired, and not from the point of view of internal memory organization. As will be seen in the following sections, these classifications are very similar to the current models of lexical organization

During the sixties, research in the bilingual field focused on linguistic processing and internal representation of the languages, which can be called cognitive research on bilingualism. According to Keatley (1992) three main research lines developed as a consequence of this new trend. One line of research concentrated on bilingual memory whereas another concentrated on second language learning. A third line developed in the mid eighties and reoriented the research of the first group. These three lines will be briefly described.

The first group of studies was devoted to the basic processes of human cognition, especially to mnemonic processes related to the knowledge of more than one language. The main subject of the research of this group is memory for meaning in bilinguals, more specifically whether there is a common linguistic system for both languages. These studies are closely related to the above cited classitication of Weinreich.

Our literature review takes these studies as a starting point. Kolers (1963) proposed two alternative hypotheses, namely the Independence vs. Interdependence of languages, which will be discussed in next section. He supported the Independence Hypothesis, claiming that bilingual subjects possess two completely independent language systems, one for each language (as for the Coordinate bilingual in Weinreich's). Other models were developed based on Kolers' work, as MacNamara's Switch-model (MacNamara, 1967a; 1967b; MacNamara & Kushnir, 1971); and the Dual Coding System of Paivio & Desrochers (1980). These models are presented Section 2, **Bilingual Memory Storage**.

The second area of research is more applied, and concerns the studies devoted to Second Language Learning, with the aim of improving teaching techniques and the learner's performance. The main topic is language interference. This line of research focuses on a functional model of language to describe how an inactive language (the one not actually in use) influences the active language (the one the subject is using). These studies are not considered in this review, because their research motivation is mainly applied research on acquiring a second language, and not fundamental research on cognitive processing.

The third line of research appeared in the mid-eighties and it is related to the first one. Hence, the language processing system is described as a two-level system, with a lexical level and a conceptual level. At the lexical level each word-entry is represented by a unique node of information. The main difference with the former research is the idea that languages must share a common substrate at the semantic level. It is assumed that there is a conceptual representation of the meaning of a word which is not language-specific. From this point of view, a single linguistic system copes with bilingual language processing, but the structures of this system are in certain cases language-specific.

The issues which arose were the level at which the language representations are independent and the level at which they are common (Grainger, 1987). The generally accepted hypothesis is a language system consisting of a common semantic level and two independent lexicons connected to the semantic level, but there are two different hypotheses concerning the relationship between these two lexicons: the Word Association Hypothesis (Kirsner, K., Smith, M.C.; Lockart, R.S.: King, M.L. & Jain, M.,1984) and the Concept Mediation Hypothesis (Potter, M.C.; So, K.F.; von Eckart, B.; & Feldman, L.B., 1984). The experimental paradigm most often used to test these hypotheses is the priming paradigm on lexical decision, naming and translation tasks. The two hypotheses and subsequent experiments are reviewed in section 3, **Models proposing two lexical systems**. This section reviews as well the research done within this framework on learning and language-specific factors (orthography and speech-segmentation) and includes a discussion about the models proposed.

In the present decade two interesting trends have emerged on bilingual lexical organization. First there is the application of the connectionist framework for the description of a bilingual lexical system. For instance, a neural network model for bilingual organization has been proposed by Grainger and Dijkstra (1992), namely the Bilingual Activation Model, based on McClelland & Rumelhart's (1981) Interactive Activation model. It is described in Section 4, **Parallel Access to Bilingual Lexicon**.

The second trend is experimental. The masked priming paradigm turns out to be a very interesting tool to study internal organization in bilingual subjects. In contrast to the priming paradigm, where subjects are aware of seeing the prime, the masked priming paradigm is able to leave out of account subject's higher-level strategies such as expectation, meaning integration, and episodic traces of memory. For this reason masked priming makes it possible to study the links between words without interference from the semantic level.

Using this paradigm, some authors have found evidence to support a different model of bilingual lexical organization based on morphology. This model also claims the existence of two separate lexicons, one for each language. The results obtained using the masked priming paradigm seem to indicate that a separate kind of organization could apply to cognate words. Cognate words are words that have a similar form and meaning across languages. It is suggested that the two language lexicons have an overlapping part where these cognate words are stored. Both the new model, proposed by Beauvillain (1992), and the related masked form-priming experiments are described and discussed in Section 5, **The Overlapping Bilingual Lexicon**.

Section 6 contains a general discussion and suggests a new direction for research on bilingual lexical organization and access.

2. Bilingual Memory Storage.

2.1. The Independence/Interdependence Hypothesis.

The research of Kolers (1963) will be taken as a starting point to review the research on bilingual memory. Kolers was the first one to formulate the Independence/ Interdependence Hypothesis. The Independence Hypothesis claims that languages are stored separately in the bilingual's memory, thus the words of the two different languages are not connected. Independent storage also means that it is not possible to find between-language effects such as priming in a Lexical Decision Task (henceforth, LDT) or repetition effect, as they occur within languages. In contrast, the Interdependence Hypothesis claims that languages share a common memory store. Thus, the representations at the semantic-conceptual level should be the same for both languages, implying that semantic priming can occur between languages..

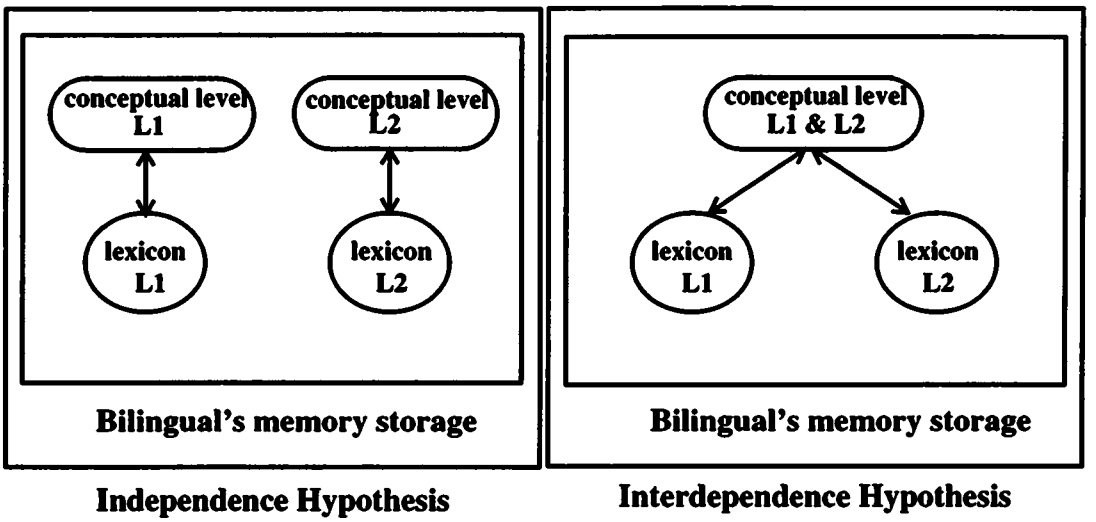

Figure 2. Model of Kolers (1963). The Independent Hypothesis suggests two completely independent linguistic systems for each language in the bilingual's memory. The Interdependence Hypothesis suggests the conceptual information is shared by the two languages[1]

Kolers (1963) did find evidence that subjects could associate a word and its translation with different concepts, depending on the language they were using. He interpreted these results as evidence for a separate semantic representation of equivalent words in different languages. Kolers concluded that there is no common linguistic representation at any level for the different languages of a bilingual speaker; rather memories are stored in the language in which the subject experienced a concrete situation.

In a free-recall experiment with monolingual, bilingual and trilingual lists (English, French and Spanish), Tulving and Colotla (1970) found empirical support for Kolers'

1. cf. Figure 1: the two models match Weinreich's classification on Coordinated and Compound Bilinguals.

hypothesis. Lists of words were presented to each subject and after each list presentation, subjects had some time for recalling as many words as they could from the lists they had seen. The results showed that recall for bilingual and trilingual lists favors first language words. The amount of words recalled by subjects from the bilingual and trilingual lists was bigger than the amount recalled from the monolingual list, because more words from subject's first language were recalled. The authors interpreted this result as evidence for separate storage: if all the words of different languages were stored together, it should not be easier to recall words of one language rather than another.

The question that arose consequently was how these two linguistic systems are activated. MacNamara's research was devoted to that topic, and it will be reviewed in next section.

2.2. The Switch Model.

MacNamara (1967a/b; MacNamara & Kushnir, 1971) explored how the two systems described by Kolers interacted and maintained their independence. In his experiments subjects had to perform different tasks in monolingual or bilingual contexts. His results confirmed those of Kolers: he found that in a bilingual context the subjects needed more time to solve the task. To explain this phenomenon, McNamara developed the switch model.

According to the switch model, the two linguistic systems of a bilingual speaker are organized in a way that only one of them is accessible at a time. The language is selected according to a decision mechanism that MacNamara called a switch. There are two Switches for each linguistic system: the output switch, controlled by the speaker; and the input switch, controlled by the stimulus. The switch has two possible states: *on* and *off*, equivalent to the active or passive state of the language. When one language switch is *on*, the other language is *off*, both languages are never activated at the same time..

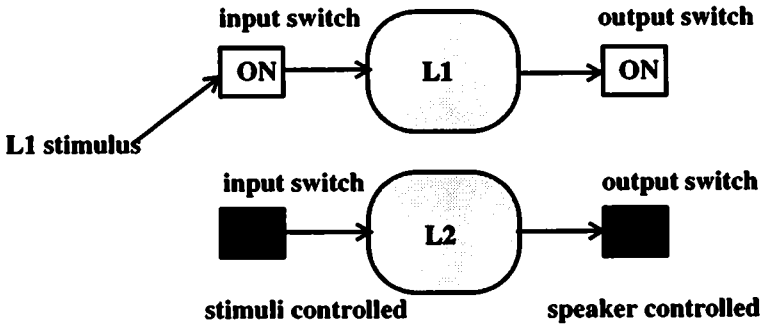

Figure 3. MacNamara's switch model. In the figure, the L1 stimulus turns ON the L1 switch, so L1 is the active language and L2 the passive language.

This model implies that the input mechanism must generate a preliminary categorization of the received signal and identify it as belonging to one or the other

language in order to process the proper language. This categorization takes some time: in this way MacNamara explained the reason why his subjects had longer reaction times when the task required the comprehension of more than one language. Subsequent research investigated the processing level at which the stimulus categorization is done.

MacNamara's interpretation of the empirical results has been questioned. Doctor and her collaborators (Doctor, E. A.; Ahmed, R.; Ainslee, V.; Cronje, T.; Klein, D.; Knight, S., 1987b) pointed out the time bilingual subjects spend on switching from one to the other language can be justified by the fact that languages differ orthographically, phonologically, syntactically, and semantically. The information about the languages has to be separated to avoid confusion but this does not imply that the languages have to be activated in an independent way.

2.3. The Dual Coding System.

The model Paivio & Desrochers (1980) developed for bilingualism takes a position between the Independence and Interdependence hypotheses. This model is based on the Dual Coding System model previously developed by Paivio (1971). The Dual Coding System gives a global framework for verbal and non-verbal processing. It is composed of two associative networks of logogen-type units (for a description of the Logogen Model, see Morton, 1969)).

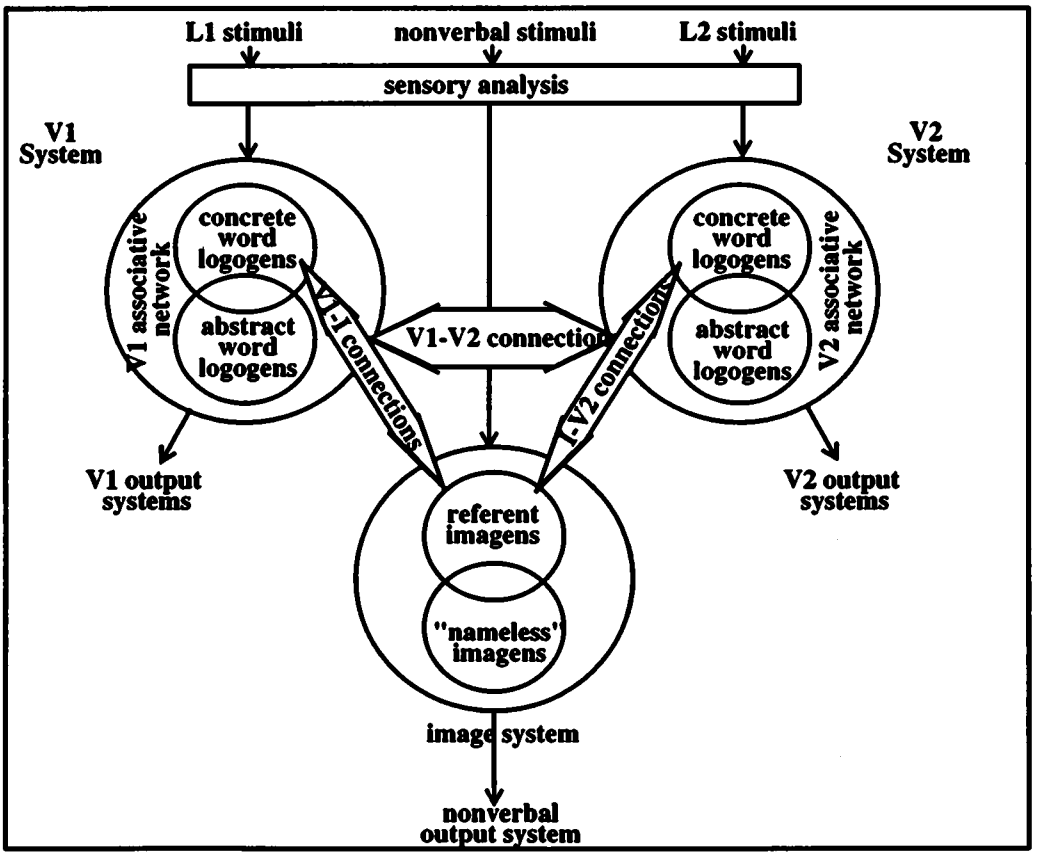

Figure 4. Paivio & Desrochers (1980) Dual Coding System Model.

The linguistic associative network is divided in two subsystems composed of concrete-word logogens and abstract-word logogens. This network, in turn, is connected to the image-system network, representing the knowledge of the world, and it is composed of two subsystems: referent *imagens* and nameless *imagens*. The *imagens* are units similar to *logogens*, but specific for image systems. Linguistic and image systems have different input-output mechanisms. In order to adapt this model to bilingual processing, the authors incorporated a new language system (i.e. a new associative network) corresponding to the second language. This network is connected to the original linguistic system and to the image-system as well, and input-output mechanisms are also independent.

Paivio & Desrochers' model is probably too general and it was not tested in subsequent research. The model has some weak points with respect to linguistic processing. Basically it neither explains what information is stored at semantic level nor some particular linguistic phenomena such as phonological representation. In general, the model does not solve the theoretical conflict between the independence and interdependence hypotheses.

Nevertheless, the dual coding system has proved to be useful in explaining phenomena described in the recent literature on bilingual lexical structure research. De Groot (1992) and Keatley *et al.* (1990) used this model because it can account for asymmetrical cross-language priming, showing an unbalanced relationship between the two languages of bilingual speakers. De Groot (1993) analyzed the abstract vs. concrete word effect in bilingual processing tasks and suggested that the internal representation for abstract and concrete words is different in the bilingual lexicon: while translations of concrete words have very similar meanings, translations of abstract words might have language-independent meanings. De Groot proposes that semantic representation might be distributed. Thus, translations of concrete words would share the same semantic nodes and translations of abstract words would not.

2.4. General considerations

A common feature of the models developed between the 60s and the 80s is their holistic point of view. The authors focused on language as a special memory system with some specific mechanisms, such as the switch suggested by McNamara. The holistic point of view is especially remarkable in the model of Paivio & Desrochers (1980) just described.

But as new effects were found empirically (especially concerning lexical access), researchers were forced to narrow their attention and devote themselves to more specific topics. Thus, research on bilingual lexical access appears to have been radically separate from research on monolingual lexical access in the years that followed. As will be seen, most of the research concerning visual word perception, for example the discussion on Dual/Single Route of Lexical Access, was completely ignored by researchers in bilingual lexical organization. The next section describes the models proposed in the 80s that are still supported nowadays. These models are essentially concerned with the relationship between the two lexical systems of the bilingual speaker.

3. Models proposing two lexical systems.

The two most important theories in the 80s on bilingual lexical system structure are the ones proposed by Kirsner, Smith, Lockart, King, & Jain (1984); and Potter, So, von Eckart, & Feldman (1984). Both papers reviewed previous literature and intended to summarize the results of different models.

The models have in common that two lexical systems are assumed, one for each language, and a common representational system where concepts are stored[1]. This idea had already been introduced by Caramazza & Brones (1979) and it is intrinsic to the Interdependence Hypothesis. The main difference between the two models is in the relation between the two lexical systems. Both models are described next.

3.1. The Hypotheses

3.1.1. Concept-Mediation Hypothesis

Potter *et al.* (1984) presented two hypotheses known as the Word Association Hypothesis and the Concept Mediation Hypothesis (see figure 5). According to the Word Association Hypothesis, lexicons are connected directly by means of word connections. According to the Concept Mediation Hypothesis model, the lexicons are related only via their connections with the conceptual information, which is common for both languages..

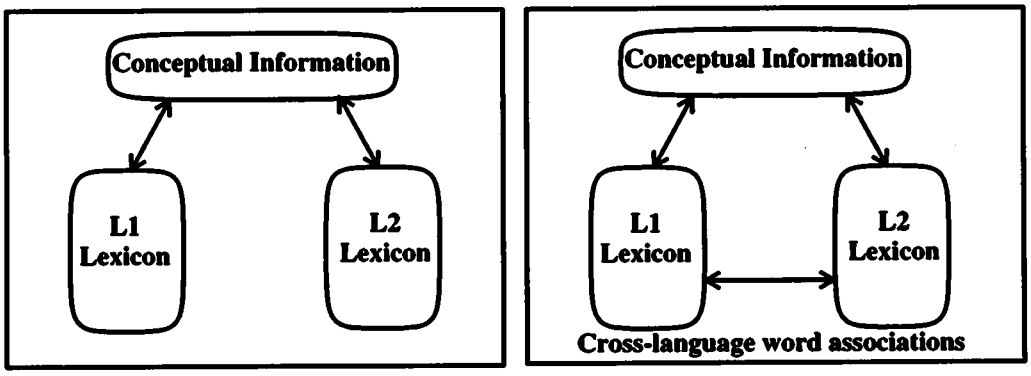

Figure 5. Left: Concept Mediation Model (Potter *et al.*, 1984); Right: Word Association Model (Kirsner *et al.*, 1984). The only difference between the models is the direct association of word entries at the lexical level.

In their research, Potter *et al.* (1984) used three different experimental tasks (reading words aloud, translation, and picture naming) for two subject groups with different levels of proficiency in their second language. They generated predictions that would support one or the other hypothesis, as summarized in the following table. In the table, the different steps needed for each task according to both hypotheses are described. The

1. It is important to know, as De Groot & Barry (1992) point out, that in the literature on bilingual lexicon the terms 'meaning', 'meaning representations', or 'concept representations' are used interchangeably.

more steps needed, the longer the Response Time (R.T.). Remark that for the Concept Mediation Hypotheses the steps are the same, so the R.T. should be identical.)

Word Association Model		Concept Mediation Model	
Picture-naming	Translating	Picture-naming	Translating
(1) Recognize Image	(1) Recognize L1 word	(1) Recognize Image	(1) Recognize L1 word
(2) Retrieve Concept		(2) Retrieve Concept	(2) Retrieve Concept
(3) Retrieve L1 word			
(4) Retrieve L2 word	(2) Retrieve L2 word	(3) Retrieve L2 word	(3) Retrieve L2 word
(5) Say L2 word	(3) Say L2 word	(4) Say L2 word	(4) Say L2 word

Table 1. Predictions according to Concept Mediation and Word Association Hypotheses for Picture-Naming and Translation tasks (Potter et al., 1984).

For both groups of subjects the results showed there was no time difference for the two tasks, suggesting that there is no direct word association between the two lexicons. Potter et al. (1984) concluded that words of different languages always relate through the conceptual level of representation

3.1.2. Word Association Hypothesis.

The experimental approach taken by Kirsner and his collaborators (1984) to support the word association hypothesis is different from Potter's. They used the priming paradigm in a lexical decision task to try to find repetition priming effects. The facilitation in the formal (or repetition) priming is an effect useful to check if two different forms of a stimulus have the same internal representation. For example, a word in uppercase is presented as a prime for the same word in lowercase. Kirsner *et al.* used this technique in order to find out if the translations of a word into the two languages of a bilingual subject facilitated each other. If this facilitatory effect between words of two languages was found, then it could be concluded that their internal representations are strongly associated.

The authors carried out 5 different experiments using both formal and semantic priming. They found facilitatory effects between languages using semantic priming, confirming the existence of a common semantic level for both lexicons. They also found facilitatory effects of a very short duration using formal priming. Thus they concluded that words of the two languages might be associated but that the links between the two lexicons were weaker than links from lexical to semantic level.

Since Kirsner et al. (1984) used as translations words that were not cognates (that is, not similar in their phonology and/or orthography) they pointed out that maybe another type of organization could account for the organization of the cognate words. They did not explore this relationship further, but their remark is very important, as will be seen in the next pages.

Although the work of Kirsner et al. (1984) seems to treat the bilingual lexical organization from a wider point of view, taking into account the previous research on memory to draw conclusions, Potter *et al.*'s (1984) Concept Mediation model has received more empirical support. As important examples of some of this research focusing on the convergence of the two languages at the semantic level, we mention Schwanenflugel & Rey (1986), Frenck & Pynte (1987), and Chen and Ng (1989). The last two authors evaluated facilitatory effects between languages, and they found that these effects are larger when the prime is a translation from the other language that when it is a semantically related word of the same language. This result is predicted by the Concept Mediation Hypothesis, because when presenting a word and its translation only one conceptual node should be activated, while presenting two related words two conceptual nodes need to be activated. In a different experiment they found that facilitatory semantic effects are comparable to the priming effect found with picture primes. In their conclusions they claimed that the mental processes implied in the priming paradigm are universal and independent of the differences between languages.

In next pages the language-specific factors in bilingual language processing will be reviewed. Next, some of the research devoted to learning as a factor in bilingual lexical organization will be summarized as well.

3.2. Factors in Bilingual Lexical Organization and Access.

3.2.1. Language-Specific Factors.

Some important research has focused on language-specific factors in order to find out if linguistic differences in a bilingual's languages would imply language processing differences. Obviously, the existence of language-specific factors concerns the internal organization of bilingual languages and the bilingual lexicon. As Aaronson and Ferres (1986) pointed out, when language-specific differences imply differences in cognitive linguistic information processing, it is necessary to find where they are in order to know specifically in which level of processing they can produce their effects.

In this section only the factors that concern the lexical level of processing, namely orthography and speech segmentation, will be presented.

A typical focus of research has been orthography. Katz & Feldman (1983) developed the orthography depth hypothesis, claiming that in languages with deep orthography (like English) written language is processed analogically, while in languages with shallow orthography (like Spanish or Serbocroatian) the readers use articulatory coding to access the lexicon. Other experiments supported this hypothesis (Bentin, Bargai, & Katz, 1984; Bentin & Frost, 1987; Chen & Juola, 1982; Chitiri, Sun, Willows, & Taylor, 1992); but there is research showing that shallow-orthography readers not only use articulatory decoding specifically for reading, but also read in an analogical way (see Sebastian-Galles, 1991, for Spanish). On the contrary, Chinese readers seem to use articulatory codes as well as analogical codes to decode their logographs (Seidenberg, 1985). Overall the evidence suggests that there is an universal pattern for reading using

both ways of accessing the lexicon (visual and articulatory), independently of orthography depth (Besner, 1987). Thus, it can be assumed that different orthographies should not affect the way words are represented in bilingual lexicon.

Recently, speech segmentation has attracted much research interest. As speech is a continuous process, it is assumed that the generation of an internal representation of auditory input is serial. Speech segmentation is then needed in order to organize this input into meaningful units. Although for years this process was supposed to be universal and so all hearer/speakers would do it in the same way, Cutler, Mehler, Norris & Segui (1986; 1989; 1992) showed that different languages settle different boundaries for their phonological processing. Their main finding is that French listeners use syllabic segmentation, while English listeners rely on other speech features such as stress, using strong syllables as a cue. In their experiments with bilinguals (Cutler *et al.*, 1992) the authors found that bilingual hearers/speakers rely on their first language for further segmentation. Even balanced bilinguals very proficient in their two languages use one of the two systems for speech segmentation. Similar research has been carried out for Spanish and Catalan listeners (Sebastian,N.; Dupoux, E.; Segui, J. & Mehler, 1992), for Japanese (Otake, Hatano, Cutler & Mehler, 1993), and Dutch (Van Zon & De Gelder, 1993), showing different types of segmentation according to the language. This implies that bilingual phonological processing of speech is actually monolingual. Speech segmentation is a language-specific factor and has to be taken into account when modelling lexical access in bilinguals.

It is interesting to bring these two findings together: Phonological segmentation appears to be a language-specific process, whereas there is evidence for orthographical decoding as an universal process. The different acquisition of both representations might play an important role.

3.2.2. The learning factor.

This aspect has been studied by Chen and his collaborators (Chen & Leung, 1989; Chen, 1990; Chen, 1992). Chen proposed different models of lexical organization for different learning stages during the acquisition of a second language and for the different developmental stages of the subject when learning the second language. In Chen & Leung (1989) evidence is provided by some experiments comparing the performance of beginner adults, beginner children, and those proficient in both languages. The authors propose that in the first stages of learning a new language this new language is accessed through formerly built up cognitive systems. Thus, an adult will use the first language to acquire the new one, and the language organization in memory can be described by the Word Association Hypothesis[1]. Children instead will use a prototypical-image system as the mediating system, since their first language system is not developed enough to support another language. Their internal organization then can be described according to the Concept Mediation Hypothesis.

Other authors, like Favreau & Segalowitz (1982) and Frenck & Pynte (1987) corroborated Chen's conclusions, finding differences between proficient and beginner

1. Note the similarity of this proposal to Weinreich's description of the *Subordinate Bilingual.*

subjects. Abunuwara's work (1992) on trilingual subjects' internal organization gave support to the hypothesis of different lexical organization according to the stages of learning. This author showed that the languages of a trilingual speaker are related to each other in different ways. His subjects were speakers of Arabic, Hebrew and English, and he found out that while Arabic and Hebrew (L1 and L2) were strongly related at the lexical level, as the Word Association model would predict, English and Hebrew (L3 and L2) seemed not to be connected at all, as suggested by the Concept Mediation Hypothesis.

Recently Kroll and her colleagues (see Dufour & Kroll, 1995, for a review of her different works) supported Chen's model by describing a different effect called Translation Asymmetry[1]. According to Kroll, translation from L1 to L2 takes more time than translation form L2 to L1 in the early stages of second language learning. This difference decreases as proficiency in second language is achieved. The proposed model explains translation asymmetry: translation from L1 to L2 requires conceptual access, whereas translation from L2 to L1 can be accomplished directly by the links between words in the two languages at the lexical level.

In spite of the different learning strategies, Chen pointed out that the newly acquired language gradually develops an independent status, and the fluent bilingual lexicon is organized according to the Concept Mediation Hypothesis. Overall the results point out the importance of learning stages in bilingual lexical organization.

3.3. Discussion.

As De Groot (1992) pointed out, the models for bilingual lexical organization are usually extremely simple and sometimes these models fail to account for the complexity of reality. As has been seen in the previous sections, the authors within the bilingual research field distinguish two representational levels for bilingual memory organization: the lexical and the conceptual level. A description of the organization for each level is as follows:

1. At the lexical level, each entry is represented by a single node. The information this node accounts for is normally not specified. It can be assumed that the node represents all the information about the word except for the meaning, the latter being represented at the conceptual level. Usually the modality of the representation is not specified in bilingual models. That means these models do not specify if the representation at the lexical level refers to the orthographic representation of the word, the phonological representation, or both of them.[2] Hence much research being devoted to the automatic vs. strategic activation of phonological representations of words during visual word perception (Coltheart, 1978; Seidenberg *et al.*, 1984; Seidenberg, 1985; Seidenberg, 1987; Tannenhaus, Flanigan, & Seidenberg, 1980; Van Orden, 1991, among others) seems to be ignored by researchers working on the bilingual lexicon. Another aspect that is never described, not even in the research on the learning factors just introduced,

1. Keatley, Spinks & De Gelder (1994) reported the same effect.
2. See Doctor & Klein (1992) for an exception: the authors describe a model partially based on the Double Route model and they specify Phonological and Orthographical Lexicons.

is how the new nodes for L2 representations are created.

2. The meanings of the words are stored at the conceptual level. How this meaning is represented is generally not specified. In general, the conceptual level is supposed to be a semantic network where the related meanings are linked together. These links explain the Associative Priming Effect within and between languages. As this project is concerned with the lexical level, the conceptual level will not be further discussed.

A major weakness of current models is that they are concerned with the relationship between the two lexicons but they do not suggest any description of the internal organizations of the lexicons themselves. Maybe some of the effects the authors found could be explained in a different way by means of a different organization for the representations.

A good example of this is that word representations are supposed to be language-specific. This statement implies that the relationship between the two languages has to be explained in terms of links between lexicons. But recent research, using different experimental paradigms, has shown that not all representations seem to be language-specific, or at least that some words belonging to the two languages might be stored together. In that case the relationship between the words of two languages might not be a question of how are they linked, but how are they represented.

This new research will be reviewed in section 7. The next section describes the connectionist proposal of Grainger & Dijkstra (1992) for bilingual lexical organization.

4. Parallel Access to Bilingual Lexicon.

Grainger & Dijkstra (1992) took a different point of view to describe the internal organization of the bilingual lexicon. Grainger and Dijkstra consider that there is a language network for each of the bilingual's languages, formed by local nodes representing the words. The authors propose a theoretical framework to explain bilingual lexical access, named Bilingual Interactive Activation, based on the Interactive Activation Model proposed by McClelland & Rumelhart (1981).

This theoretical framework (the authors insist on the fact that it is not a model, only a framework to set further research) describes a three level network like McClelland & Rumelhart use. The first level is composed of nodes identifying letters, the second of nodes identifying words and last one contains language-specific nodes. Grainger & Dijkstra's proposal tries to explain why lexical access is not language-selective: language is not identified before the words have been accessed. Thus, word-nodes would be connected with the proper language-node with a one-way connection; and this would explain why lexical access is not controlled by superior processing.

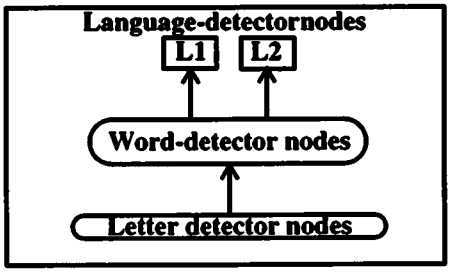

Figure 6. Bilingual Interactive Activation Model (Grainger and Dijkstra, 1992)

In a subsequent article, Grainger & O'Regan (1992) suggest that a feedback connection should exist between language-nodes and word-nodes. They describe an activating connection from language-node and the correspondent word-nodes, and an inhibitory connection from language-nodes to the opposite language word-nodes.

Grainger & Dijkstra (1992) introduced the use of connectionist framework to explain the specific phenomenon of language identification in lexical access in bilinguals, but as they used local representations, their point of view is not far from the lexical-instance models that have been reviewed in previous sections. Perhaps their most interesting suggestion is that language information is accessed post-lexically. Some of Grainger's previous works had shown empirically that language identification occurs after word identification (Grainger & Beauvillain, 1987; 1988;Beauvillain & Grainger, 1987). This implies that language specification might not be important at the lexical level, thus questioning the need for language-specific representations. The next section concerns this point.

5. The overlapping bilingual lexicon.

5.1. Accessing a Common Lexicon.

A group of researchers (Beauvillain, 1989; 1992; Cristoffanini *et al.*, 1986; Sanchez-Casas *et al.*, 1992) considers that lexical representation to be independent of bilingual experience, and so lexical access, either within as between languages, is governed by orthographic or associative principles. These authors suggest that although mental representations of lexical forms are necessarily language-specific, lexical organization is not governed by language (Beauvillain, 1992).

The first work suggesting this kind of bilingual lexicon organization was Cristoffanini, Kirsner & Milech (1986). Cristoffanini *et al.* reviewed contradictory results showing lack of facilitation when the translation of the target word was used as a prime for lexical decision task (Kirsner *et al.*, 1984; Chen & Ng, 1989). This result can be explained assuming the complete independence of the lexicons, as some authors did; but can also be explained by a different lexicon structure, based on the common morphology of words. Facilitation then takes place when the translations share orthographical features. Thus the authors concluded that morphology rather than language identity controls lexical functioning.

The experiment carried out by Beauvillain (1989) tried to show that lexical access in bilingual subjects is governed by the same principles as monolingual lexical access: basically, the frequency of morphological form, as Forster (1976) described. Beauvillain carefully choose five-character English and French stimulus-words, considering too the frequencies of the bigrams and trigrams that formed them. The combinations of letters that occur most frequently in one or the other language were considered language-specific, while the words with combinations equally frequent in both languages were considered non language-specific. The subjects, with equal proficiency for English and French, needed more time to recognize non-language specific words, independently of the language to which they belonged. Instead, when the task was performed by monolingual subjects in both languages, the reaction time was the same for specific and non-language specific words. These results show the sensitivity of lexical access to the orthographic features of the words.

Beauvillain concluded that there is a strong superposition of both language lexicons in bilingual subjects (see figure 7.), and that the superposition is achieved by storing together words that share the same morphology (i.e. non-language-specific). Language does not govern lexical access in bilinguals, although this does not imply that language information is not represented in the lexicon

Recently, the masked priming paradigm has been used to test between-languages facilitatory effects at the lexical level, bringing up some more evidence for a common lexicon. These empirical contributions are reviewed in the next section.

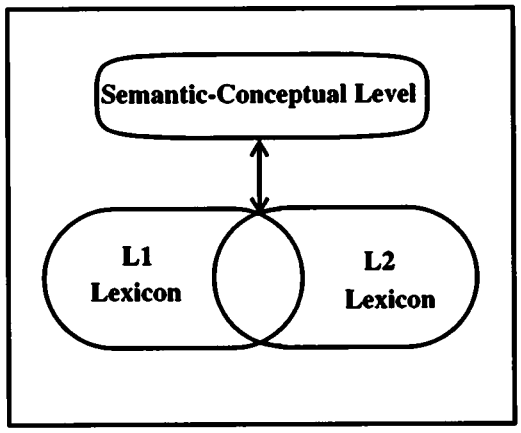

Figure 7. Beauvillain (1992) partially overlapping specific lexicons.

5.2. Form Priming Paradigm

5.2.1. The paradigm

Form Priming has been little used in bilingual research compared to semantic (or associative) priming. Segui and Grainger (1990) pointed out that in word recognition very little research has been carried out at the level of formal representations of words in memory, compared to the amount of research devoted to semantic and conceptual organization. For bilingual word recognition, form priming effect has attracted more attention during the last three years.

Moreover, the studies reporting form priming effects presented contradictory data. Form priming has been considered useful for exploring the organization of lexical information, not for making implications about the conceptual or semantic levels, since the priming effect is due to the similarity of the form and not to a semantic association.

Nevertheless, Forster studies on Monolingual Form-Priming (Forster & Davis, 1984; Forster, 1987) found that the facilitation obtained with form-priming could be due to subject's expectancies and meaning integration, specially at long SOAs[1]. When the SOA is long, the subjects have time enough to retrieve semantic information, thus the effect is due to semantic facilitation and not to the relation of forms at the lexical level. In other studies the form priming effect was not found (see Forster & Davis, 1991, for a review) and this could be due to the inhibitory effects generated as well at the semantic level.

To eliminate this interference from the semantic level, Forster & Davis (1984) used the masked priming technique, described by Evett & Humphreys (1981) for tachistoscopic identification. In this technique the prime is masked, and is presented in such a way that the subject is unaware of its presence. Forster & Davis (1984) suggest that in that way

1. Stimulus Onset Asynchrony.

episodic traces are relatively inaccessible, thus emphasizing the lexical component in lexical access. In further experiments (Forster, 1987), the author found strong form-priming effects that were insensitive to the lexical status of the word, thus confirming the absence of conceptual effects.

The masked priming technique involves a three part display. First, a presentation of hatch marks (##########) appears for 500ms and acts as a backward mask for the second item, the prime, presented in lowercase for a very short duration (typically, 30 to 60 ms, but it can also be shorter). The third item, presented in uppercase, is the target which is to be classified by the subject[1]. The target acts as well as a forward mask for the prime.

5.2.2. Factors under masked priming paradigm.

Under masked priming paradigm, Forster (1987) found some factors affecting reaction times in a Lexical Decision Task. Target-word length seemed to be an important factor, since the author could not find any facilitatory effect for short words, except when prime and target were identical (repetition priming). The author pointed out that the real intervening factor could be the neighborhood density for these words. Further experiments lead the author to the claim that when the target is from a high-density neighborhood inhibitory effects are obtained, but the neighborhood density effect is not the same for different tasks.

Segui and Grainger (1990) devoted a series of experiments to this effect, but they underlined the effect of frequency rather than neighborhood density. They found strong inhibitory effects for four-letter words when the masked prime was higher in frequency than the target. They claimed that when masked primes are higher frequency neighbors of the target they inhibit target processing, whereas primes that are lower frequency neighbors facilitate target processing. Thus, they claimed that frequency of the prime is not the intervening factor, but rather the relative frequency of the target-prime.

Sanchez Casas (personal communication) has been working with short words in Spanish and could not find any neighborhood effect. Instead she finds a very robust priming effect for four-letter words, regardless of the size of their neighborhood.

The results obtained by Sanchez-Casas might indicate language-specific differences, but unfortunately there has not been enough research on the neighborhood effect. Discounting the effect of frequency of the words and favoring the effect of the neighborhood seems to imply that the frequency-ordered organization of the lexicon is questionable. Moreover, overall results seem to stress the importance of the form. This point will be discussed later.

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1. The target has to be classified by the subject when the task to perform is Lexical Decision, but masked priming can also be applied to translation, naming, or picture naming.

5.2.3. Masked paradigm in cross-language experiments

Masked Form Priming has been used lately to study bilingual lexical organization. The specific advantage of masked priming in bilingual studies is that since the primes are not detected by the subjects, they perceive the experiment to be in the language of the targets (Alpitsis, 1990).

Garcia Albea, Bradley, Sanchez Casas and Forster (1985) compared the facilitatory effect obtained by repetition priming (the same word presented as a prime), cognate priming (the translation of the target as a prime, with similar form) and non-cognate priming (the translation as a prime, not having a similar form). In their results they could not find any difference between the magnitude of repetition priming and cognate priming. This effect, called the Cognate Effect, was explained in terms of internal representation of the cognate words. As in the model of Beauvillain described on p. 15, the authors claim that cognate words share the same representation in a common part of the bilingual lexicon.

De Groot and Nas (1991, experiment 4) did not find associative priming effects for noncognate translations, but they found strong effects under masked priming conditions for cognate translations. Sanchez-Casas, Davis & Garcia-Albea (1992) also reported strong priming effects for cognate translations in a cued translation task.

Overall this evidence shows that the Cognate Effect under Masked Priming is very robust between languages, but accounting for the factors that generate it is a completely different question. As Alpitsis (1990) said, the obvious difference between cognates and non-cognates is the form factor: cognates share a similar form while non-cognates do not. Nevertheless the authors are reluctant to admit that a form effect is all that is responsible for the facilitation in the Cognate Effect. Garcia Albea et al. (1985) suggested that the effect is produced by the summation of meaning and form effects. That would lead to the conclusion that morphology at the lexical level is the main factor that produces that effect. According to Beauvillain's (1992) model, morphologically similar pairs of words should share a common representation at the lexical level, and this is the reason why the priming effect found for cognate words has the same magnitude as the repetition effect.

The experiments presented so far were done with languages using the same alphabetic system (French and English, English and Spanish). For this reason, Alpitsis (1990) wanted to use languages with different alphabets. She worked with Greek/English pairs of words, thus allowing the virtual elimination of the visual form component shared by cognates. The question was whether the Cognate Effect would be observed across languages where visual forms are dissimilar. She obtained a very large Cognate Effect in spite of dissimilarity of form, thus confirming that orthographical similarity is not the main factor in this effect. Other results confirming this claim were obtained by Garcia Albea et al. (1985). They used Spanish cognate translations as primes with monolingual speakers of English. The Spanish words were nonwords for these subjects. The cognate words did not have any facilitatory effect on the response times. The results indicate that orthographic similarity is not the only factor responsible for this effect.

5.3. Discussion

There are some weak points in the theoretical point of view that has been presented so far. The first and most important point is that although the meaning of Cognate Translation seems to be clear for all researchers, a very specific definition of this term does not exist. Cognate translations are commonly assumed to be translations that share a similarity of form. The question arises as to what 'form' means. In Alpitsis' (1990) study it is clear that is it not only similar orthography that makes words cognate, because she used Greek words with different orthography and they produced the same facilitatory effect to English words as did cognates from languages using the same alphabets.

Further analysis could be done on other languages. Taking some cognate translations in Dutch and English as an example, it becomes clear that three different types of cognates can be found. The words in the pair *Fruit/Fruit* have identical orthographic form, but they are pronounced in different ways. The words in *Voed/Foot* have a different orthography but their pronunciation is very similar. Finally, members of a pair like *Hel/ Hell* are very similar both phonologically and orthographically.

Recent research has tested orthographic similarity as the main factor in the cognate effect. Finding evidence against it led to the conclusion that similarity of form is not what causes the cognate effect. On the other hand, phonological similarity has never been tested as a factor in the cognate effect. It is possible that similar phonology generates the priming. This hypothesis is difficult to test because of the difficulties involved in cross-modal experimentation.

A third possibility is that the interaction between orthography and phonology is the actual cause of the effect. This interaction could explain why the effect is found for all three types of Cognate translations described above. The suggestion implies that orthographic and phonological representations of words are activated simultaneously during visual word recognition, as has been proposed already by different authors (Seidenberg *et al.*, 1984; Seidenberg, 1985; Seidenberg, 1987; Tannenhaus, Flanigan, & Seidenberg, 1980; Van Orden, 1991). The research of Marcus Taft (Taft, 1985; 1986;1995) seems as well to point to visual word perception being based on speech segmentation. More empirical research is needed to test if similarity of form, understood in the terms just suggested, is the cause of the cognate effect.

A second point that deserves some discussion is the proposed model of overlapping lexicons. It is not very clear how the words in the overlapping part of the lexicons would be represented and which should be the criteria to store some words there and some elsewhere. If the criterion is 'words with similar morphology have the same representation' it should apply within-language as well. Then, words with similar morphology within languages would share one representation. According to this line of thinking, in the case of a bilingual speaker, words with similar morphology both within and between languages would share the same representation. It does not seem very efficient regarding lexical access.

Another set of words presenting problems are Inter-Language Homographs (words with exactly the same orthographical form but completely different meanings). With respect to the conceptual level, these words are language-specific, but with respect to their form they are not. Since they share the same form they should be stored in the overlapping part of the lexicons within one representation. But they are language-specific in the sense that they represent completely different meanings.

Last but not least, there is another important omission with respect to factors such as frequency and neighborhood size. How this language-specific information would be stored in case of a common representation is not described.

All these matters seem to lead to the conclusion that the usual description of the lexicon is not useful to explain cross-language phenomena such as the Cognate Effect. To account for these phenomena it is necessary to propose a different model that stresses word similarity as a factor in lexical organization. This point is going to be further discussed in next section, the General Discussion.

6. General Discussion

As particular points have already been discussed in previous sections, we will now try to summarize different trends in the literature and propose a new point of view from which to study bilingual lexical organization.

It is not difficult to see that existing models on bilingual lexical organization tend to merge the lexicons. From the first proposals of Kolers, suggesting a complete different linguistic system for each language, up to the last ones suggesting an overlapping lexicon, language specificity loses its place as the most important organizational factor for internal lexical representations.

An important body of evidence, coming from a different area of research, concerns the interaction of orthography and phonology during visual word perception. This evidence seems to indicate that the activation of both codes occurs simultaneously during word perception. A new line of research centers now on the study of perceptual units smaller than words, as for example the syllable (Alvarez, 1995; Dominguez y Cuetos, 1995) or parts of the syllable (Taft, 1995). This evidence supports the activation of phonology during reading, but also indicates that sublexical units play an important role in visual perception of the word.

Using the masked priming paradigm, two findings are especially remarkable: the importance of the neighborhood on priming effects (Segui and Grainger, 1990), and the cognate effect observed across languages (Garcia Albea *et al.*, 1985; Alpitsis, 1990). Both findings refer to the similarity of form (either orthographical or phonologic) as a decisive factor in lexical organization and bilingual lexical organization.

Overall the existing evidence cannot be explained by the models reviewed. These models lack a proper description of the interaction of orthography and phonology, and they cannot account for the Cognate Effect, as discussed in the previous section. As evidence seems to support a representation of lexical entries smaller than the words, maybe a different theoretical framework should be adopted to describe bilingual lexical organization.

Seidenberg & McClelland (1989) suggested a new theoretical framework with a different internal lexical representation. They proposed a distributed representation for lexical entries. According to the model, each lexical entry is not represented by a single node but by a pattern of activation through a number of nodes. In their model there is no lexicon as had been previously described. The lexical level is formed by a set of hidden units that are connected to two sets of input and output units. One of these two sets acts as encoder/decoder of the phonologic information of the words and the other as the encoder/decoder of the orthographical information of the words. These two sets are connected to the hidden units that represent the lexical level. The activation of the hidden units is a product of both phonologic and orthographical information, thus the pattern of activation obtained across the hidden units is a bimodal representation of each word.

The application of this kind of representation for a bilingual model could account for all the points mentioned above. Using local representations, learning words of a second language implies the creation of new word-nodes in a new lexicon. A distributed representation implies that for every language there is no need to add more representational nodes, because an infinite number of representations can be held by a pattern of activation across a limited number of nodes. Thus, language specificity as an organizational factor for lexical entries disappears and becomes a by-process, since the internal representations will be more alike when words are similar, independently of the language they belong to. This accounts as well for the Cognate Effect since Cognate representations will be very similar. The priming effect is easily explained by the similarity of activation between prime and target words.

As connectionist models are easy to simulate, a bilingual lexical model with the described features can be programmed. This characteristic represents another advantage over the classical models described in previous pages because it allows the model to be actually tested. The distributed representations seem to be a promising field to explore modelling bilingual lexical access representations.

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