# An investigation of the relationship between the development of bilingual semantic organisation and interactive connectivity across languages

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# Declaration

I hereby declare that this thesis, submitted in candidature for the degree of Doctor of Philosophy at Trinity College Dublin, is entirely my own work and has not been previously submitted for a degree at this or any other university. I agree that the Library may lend or copy the thesis upon request.

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Tomoko Ueno, 24th March, 2009

# Summary

This thesis explores the correlation between second language (L2) semantic development and interactive semantic connectivity across languages. Given that bilinguals' lexical access is language-non-selective at the initial stage of processing, the following two questions are investigated. If L2 acquisition is at an early stage and L2 semantics is dependent on first language (L1) semantics, is the bilingual semantic link from L2 to L1 very tight? On the other hand, as L2 ability develops and L2 semantics becomes independent of L1 semantics, does this weaken the bilingual semantic link from L2 to L1? Answers to these questions are attempted on the basis of the results of empirical study.

Relevant theories are reviewed in Part One with regard to lexical organisation and processing (Chapter 1), structure and processing in the bilingual mental lexicon (Chapter 2) and the development of bilingual semantic organisation and processing (Chapter 3). On foot of such theoretical discussions, in Part Two three experimental studies are reported which investigate L2 development (Chapters 5 and 6) and the magnitude of interlingual semantic connectivity in relation to developmental stages (Chapter 7). These three experimental studies adopted an on-line paradigm. In the experimental studies in Chapter 5 and 6, a picture-naming task and a translation task were employed with Japanese-English bilinguals at four levels of L2 acquisition (Chapter 5) and at three levels of L2 acquisition (Chapter 6). In the experiment in Chapter 7, a lexical decision task was used in a semantic priming paradigm in order to investigate the associative aspect of semantic organisation and processing. Assuming that lexical combinations in collocations reflect semantic relations which are specific to the language in question, the experiment explored how knowledge of L1 collocational associations might influence L2 semantic processing. Three groups of Japanese-English bilinguals at various L2 acquisition levels and native speakers of English supplied data for this experiment.

The data obtained were statistically analysed. The results supported the view that bilinguals' lexical access is non-selective at the initial stage of processing. However, the results also offered evidence that the two propositions implicit in the questions raised in the opening paragraph above are dubious. The results showed a larger degree of influence of L1 collocational knowledge on L2 processing for proficient bilinguals than for less proficient L2 learners. In other words, the cross-language semantic link in proficient bilinguals seemed, in fact, to be stronger than that in less proficient learners. This finding seems to indicate that, as L2 semantic acquisition progresses, the interactive connectivity between languages becomes more efficient. Interconnectivity within the bilingual semantic network in proficient bilinguals seems, indeed, to differ qualitatively from the parasitic connection between L2 semantics and L1 semantics which appears to characterise less proficient bilinguals. Suggestions are offered with regard to how this line of research might be further developed.

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# Introduction

The aim of this thesis is to explore the development of the organisation and processing of bilingual semantics. This exploration is based on my investigation into why proficient bilinguals are able to appropriately retrieve and convey meanings in the second language (L2), while less proficient L2 users often fail to do so. Such failure on the part of less proficient learners to retrieve and convey messages is assumed to be due to their less developed L2 abilities being strongly influenced by the first language (L1). If this is the case, how may their bilingual semantic system be different in terms of its make-up from that of more proficient bilinguals? Is the L2 semantics of these learners strongly connected to L1 semantics? On the other hand, does the L2 semantics of proficient bilinguals tend to be separated from L1 semantics, as L2-specific semantics is established?

When we learn an L2, we reach a point where we realise that words in the L1 and L2 which are regarded as having equivalent meanings, so-called 'translation equivalents,' are not, in fact, characterised by totally identical meanings. Semantic differences appear to be particularly marked in the case of languages which have had little language contact in terms of social and cultural background such as Japanese and English. Acquiring a mastery of subtle differences of meanings between languages is undoubtedly one of the major factors in the attainment of a high level of bilingual proficiency. The question which then arises is how the meaning systems of two languages with slightly different components are stored in a proficient bilingual's mind, and how the organisation of the two lexicons may differ in the case of less proficient L2 learners: how are the two meaning systems associated with each other, and does the L2 system become separated from the L1 system as specific-L2 meanings are acquired? Furthermore, on the basis of these questions, further questions emerge. If the L2 meaning system is not yet fully developed, is L1 meaning information readily accessible when the learners are communicating in L2? On the other hand, if L2-specific meanings have been acquired, is L1 information less likely to be prompted in the process of communicating in L2, so that proficient bilinguals can straightforwardly understand and produce L2-specific meanings? In order to answer these questions, in this thesis I investigate the organisation of bilingual semantics and the magnitude of semantic influence from L1 in L2 processing with reference to bilinguals' level of proficiency in L2.

Some studies have attempted to reveal the developmental organisation of bilingual semantics. They seem, in general, to support the following view. In the early phase of L2 acquisition, the meaning of an L2 word is retrieved by accessing the L1 semantics. However, as L2 acquisition proceeds, L2 word recognition becomes possible without recourse to L1 semantics, thanks to development in the realm of L2 semantics (Potter, et al., 1984; Kroll, 1993; Jiang, 2000). My questions relating to the foregoing can be summed up as follows. Does the above-sketched transition from one stage to another really occur in the case of Japanese-English bilinguals? If it does, approximately when does this transition occur for these bilinguals?

With regard to the bilingual processing of lexis, some researchers argue that when one language is processed, the other language is also activated at the initial stage of processing (Green, 1986; Grosjean, 1997). One may speculate that such parallel activation also occurs in the case of semantic processing. When the semantics of one language is accessed, this may prompt the semantic activation of the other language. In the light of this possibility, my objective is to investigate how semantic connectivity between languages may be correlated to semantic development, as noted above. When the L2 learner is at the stage where L2 semantics is dependent on L1 semantics, is the semantic link from L2 to L1 particularly strong? On the other hand, when L2 semantics develops to the point at which L2 semantics is independent of L1 semantics, is L2 semantic processing less likely to be influenced by knowledge of L1 semantics?

In order to begin to answer the questions outlined above, my research review (Part One) proceeds in the following manner. It begins by reviewing general theories with respect to lexical organisation and lexical processing (Chapter 1). The discussion then moves to the issue of the L2 lexicon and focuses on the structure and processing of the bilingual mental lexicon (Chapter 2). Subsequently, semantic aspects are brought into consideration, and issues relating to the development of semantic organisation and processing become the central theme (Chapter 3). In the empirical study (Part Two), three experimental studies investigate the development of the bilingual lexicon (Chapters 5 and 6) and investigate the semantic connectivity between L1 and L2 in semantic processing (Chapter 7).

Brief summaries of these chapters are set out below.

*Part One (Chapters 1-3)*

In Chapter 1, several lexical access models are examined in an exploration of how words may be represented in the memory system and processed in communication (1.1). The validity of these models is assessed from the standpoint of whether word properties (i.e. phonology, orthography, semantics and syntax) are stored at one level or two levels; hence, whether lexical access is direct or indirect. The related question is also discussed of whether representations of different properties are processed autonomously or simultaneously within the lexicon. The focal interest in this chapter is to investigate how different lexical properties are integrated in a single word. The complex mechanism of the lexical processing is explored with an account of McClelland and Rumelhart's interactive-activation model, which posits direct access and parallel processing (1.2). Investigation of the lexical system also includes Levelt's notion of lemma and lexeme, which is particularly useful in understanding the lexical mechanisms in the context of the bilingual lexicon (1.3).

Chapter 2 addresses the bilingual mental lexicon. It begins by looking at how the L2 lexicon may be acquired in relation to the L1 lexicon. The developmental system of L2 lexical knowledge is discussed in terms of four levels of lexical representations noted above (2.1), and is also considered from the viewpoint of communicative lexical use in L2, which is typically assessed in terms of 'breadth and depth' dimensions (2.2). The discussion then broaches the question of how the two lexicons are related to each other (2.3). This question in turn leads us to a more detailed inquiry as to whether two lexicons are stored in the memory system separately or in an integrated fashion, and whether each lexicon is processed autonomously or in parallel with the other. The discussion picks up on certain issues examined in Chapter 1 and considers them further. The treatment of the bilingual lexicon refers to three major models. These models deal with different aspects of lexical representation; that is, orthography recognition (Van Heuven, et al., 1998), the relationship between lexical and conceptual representation (Potter, et al., 1984; Kroll and Stewart, 1994) and semantic representation (De Groot, 1993). The standpoint of each model is scrutinized in the light of the evidence from the relevant experimental studies with particular regard to the issues of the integration or separation of bilingual memory and the autonomous or parallel processing of the bilingual lexicon. The chapter also includes attention to the orthographic issues relating to bilingual lexical processing (2.4).

Chapter 3 focuses on the semantic dimensions of bilingual organisation and processing. L1 semantic studies are first reviewed in order to investigate how semantics is understood to be constructed in the memory system (3.1). The review of L1 semantic theories covers the structuralist approach, the componential analysis, prototype theory and the network model. The discussion demonstrates how semantic relations are depicted according to the different perspectives and also how these models seem to have developed to a certain degree in isolation. The conclusion drawn from this survey is that the network model has the most to offer, and the mechanisms of the spreading activation model are probed further in the light of Collins and Loftus's (1975) study. The network model is then used as the basis for an exploration of the semantic structure and processing mechanisms of the bilingual lexicon (3.2). The focus of this discussion is on how semantics may be associated within and between languages and how bilingual semantics may be represented, taking account of cases where the semantics may differ across languages (De Groot, 1993). An attempt is made to depict semantic connectivity between translation equivalents in a Japanese-English bilingual via an exploration of collocational associations. At the end of this chapter, a hypothesis is formulated with regard to the relationship between the organisation of bilingual semantics and the manner of bilingual semantic processing depending on the L2 developmental stage.

*Part Two (Chapters 4 – 8)*

In Chapter 4, three experiments are introduced. An explanation is offered as to how the empirical study is seen as related to the theoretical issues discussed in Chapter 1 – 3. The three experiments are reported in Chapters 5, 6 and 7 respectively, and a brief introduction to each chapter is provided. In relation to these experiments, the background of the participants is outlined as well as the methodologies used for data analysis.

Chapter 5 reports on the testing of two L2 developmental models – the Hierarchical Model (Potter et al., 1984) and the Revised Hierarchical model (Kroll and Stewart, 1994) – by the use of a picture-naming task and a translation task. The first part of this chapter explores whether or not Potter et al.'s (*ibid.*) proposal is true for Japanese-English bilinguals. Potter et al. (*ibid.*) suggest that L2 acquisition moves from a stage where L2 recognition occurs via the L1 lexicon, to a stage where L2 recognition mediates concepts without accessing the L1 lexicon. The second part of the chapter is concerned with Kroll and Stewart's (1994) model, which focuses on the degree of concept mediation in bidirectional translation performances. Kroll and Stewart (*ibid.*) claim that L2 learners tend to translate an L1 word into L2 more slowly than they translate an L2 word into L1, which, for them, reflects the fact that an L1 word is more closely linked with the concepts than an L2 word. They also suggest that translation asymmetry increases as the L2 proficiency level decreases. The experiment examines the predictions of this model with the Japanese-English bilinguals by means of the conventional experimental design—that is, the comparison of the bidirectional translation performances.

Chapter 6 re-examines Kroll and Stewart's (1994) predictions via observation of the size of the concreteness effects. The experiment is designed on the basis of De Groot and Poot's (1994) postulation that the size of concreteness effects reflects the degree of conceptual involvement. According to De Groot and Poot (ibid.), concrete words tend to share conceptual memory between translation equivalents compared with abstract words; therefore, the concreteness effects derive from the larger degree of conceptual involvement in the translation process for concrete words than for abstract words. Observation of the concreteness effects also examines De Groot's (1993) earlier-noted claim with respect to semantic differences between translation equivalents depending on the level of the concreteness of a word.

The experiment reported in Chapter 7 uses a semantic priming paradigm to investigate how the L2 semantic processing of Japanese-English bilinguals might be influenced by their L2 semantic developmental stage. First, assuming that lexical access is language-non-selective at the initial stage (e.g. Green, 1986; Grosjean, 1997), the question arises whether or not this view can apply to the case of semantic processing - in other words, whether or not L2 semantic access activates related L1 semantics at the initial stage of processing. Such an eventuality raises the question of whether semantic interactive connectivity across languages is particularly strong when L2 semantics is underdeveloped, and thus dependent on L1 semantics? When L2 semantics develops and L2-specific semantics is more likely to be established independently of L1 semantics, does the interactive connectivity of bilingual semantics become weaker? These questions are answered on the basis of the results of the experiment. According to the discussion developed in Chapter 3 in respect of the 'associative' aspect of semantic processing, bilingual connectivity is examined in terms of collocational associations. These collocational associations are selected taking account of the semantic differences between the languages (De Groot, 1993).

Chapter 8 concludes the empirical study. In this chapter, I summarise the main findings of the three experiments discussed in Chapters 5 – 7. As has already been indicated, the main objective of this thesis is to shed light on the development of L2 semantics and the interactive connectivity across languages which might affect the bilingual's semantic processing. Therefore, the summary of each experiment relates mainly to these issues. The experimental methodologies deployed are also evaluated in terms of their advantages and disadvantages.

In the Conclusion, the attempt is made to bring the whole discussion together and to rethink the theoretical discussion with respect to bilingual semantics (Part One) by reflecting on the findings of the experiments reported in the empirical study (Part Two). Here, the initial question which was posed in my introduction is answered. Suggestions are also advanced with respect to the question of how this line of research might be further developed.

I would argue that the uniqueness of this thesis relates to my approach to the bilingual lexicon from an inter-lexical perspective. Bilingual experimental studies have conventionally dealt with individual words such as translation equivalents. These methodologies are adopted in the experiments reported in Chapter 5 and 6 relating to the investigation of L2 semantic development. However, the inter-lexical approach has been traditionally used in L1 semantic studies. If the aim is to investigate the associative nature of semantic organisation and processing, the inter-lexical approach seems to be also relevant to bilingual semantic studies. As Heredia and Brown (2004) show, approaches which deal with more than the single word level are necessary in bilingual studies in order to relate such studies to the communicative use of language.

The element of developmental process appears not yet to be fully investigated in the studies of the bilingual lexicon (Francis, 2005). In particular, to my knowledge, the issue with regard to the relationship between the L2 semantic development and the manner of interconnectivity relative to bilingual semantics has not yet been investigated. It is assumed that the exploration of these issues would contribute to our knowledge of this significant aspect of the bilingual mental lexicon.

# Part one: Theoretical Review

# Chapter 1 Lexical processing in L1

## Introduction

This chapter explores particular aspects of lexical representation and processing mechanisms in word recognition, on the basis of examination of some oft-cited pertinent models. Given the wide acceptance of the notion that the lexicon operates on units of phonology, orthography, semantics and syntax, the question is how these four properties can function in an integrated manner, while each of them has its own unique role. A further question is whether the lexicon is represented at two levels of storage. The two-level-storage perspective predicts that at one level, each of the four properties is individually stored, while at the other level, the entirety of information relating to all properties is stored, thus enabling the lexicon to function as an integrated system. According to this standpoint, lexical information of words is accessed through these two levels of storage. However, some argue that the lexicon may consist of only one level of storage, where the four types of lexical properties can be directly accessed. These two viewpoints lead us to another question, namely whether lexical properties are processed autonomously or simultaneously; for example, does information from semantics affect orthographic recognition?

These issues are discussed by assessing some lexical access models (1.1). The general assessment of models is followed by the examination of the actual mechanisms that one of the most influential direct access / parallel processing models, McClelland and Rumelhart's interactive-activation model, posit with respect to the lexical system (1.2). The interactive-activation model's account of the lexical system is important in that it offers a good explanation of how the efficient lexical access and processing is possible in word recognition. The discussion is further extended to include the case of speech production (Levelt, 1989, Levelt, et al., 1999), which re-examines the lexical system in relation to the conceptual memory (1.3).

## 1.1 L1 Lexical access

This section deals with the issues of whether the lexical storage system is direct (i.e. one-stage) or indirect (i.e. two-stage), and of whether the lexical processing is serial and parallel. Forster's (1976, 1979) search model sees that the lexical access is indirect, and predicts serial processing. On the other hand, Morton's (1969, 1979, 1980) Logogen model and McClelland and Rumelhart's (1981) interactive-activation model claim that the lexical access is direct, and posit parallel processing. The discussion of the issues in question takes account of the case of processing a non-word. We will examine which view better explains the case where it takes more time to recognise a word-like non-word *obttle*, than to recognise an orthographically similar actual word *bottle*. The discussion further considers whether direct/indirect access and serial/parallel processing occur in natural or strategic processing. Lastly, this section deals with hybrid models which combine both elements.

### 1.1.1 Direct and indirect access

Garman (1990, p.271) characterises the indirect models as representing *diversity of access* with a variety of properties in lexical representations, but as functioning in terms of *unity* because of the integrating operation of the different properties of the lexicon. Forster's search model predicts that at one level called the *access files*, each of the four properties (orthographic, phonological and semantic/syntactic) is individually stored. At the other level named the *master file*, the entirety of information relating to all properties is stored, thus enabling the lexicon to function as an integrated system. According to this standpoint, lexical information of words is accessed through these two levels of storage.

However, some weaknesses of Forster's model are noted concerning ambiguity with regard to actual functions of the access files and the master file. Singleton (1999, pp.101-106) points out that, whereas the model implies that phonological and orthographical access files are completely separate, the research evidence indicates that one can read non-words aloud and somehow spell non-words that one hears, which indicates that there is some kind of connection between them.

Forster's model is not satisfactory to explain such grapheme-phoneme connectivity. Garman (1990) also raises some questions about Forster's account of cross-referencing operations regarding semantically related words. For Forster, in each access file, words are normally sorted according to their frequency. However, once a word is processed, the entry located for the currently processed word makes the entry for some other semantically close words in the master file immediately available without the necessity of going back to any access file. This cross-reference function is to explain the finding of Meyer and Schvaneveldt (1971) that less time is required for a lexical decision task when a target word is preceded by a semantically close priming word (*e.g.* the word *cow* is recognised faster when it is preceded by *pig*). The questions are how semantics functions in the semantic access file when cross-reference is supposed to occur in the master-file, and whether or not there are cross-references in the phonological access file. Garman (1990, pp.270-271) queries the function of the master file as follows:

> At the bottom of this uncertainty is a question concerning the nature of the cross-references in the master file: do they effectively provide a separate search mechanism, and, if so, does this wastefully duplicate the function of the semantic access file? If there is no duplication, then what are the conditions under which one or the other search will be carried out? Are there sound-structure cross references in the master file, and how far might these duplicate the operation of the phonological access file?

By raising these issues, Garman questions whether such a two stage-model (i.e. the system of master file and the peripheral access files) is the only way to represent *diversity of access* accompanied by the function of storage as *unity*. Garman suggests that a single-stage (or direct) model may better represent the complex but efficient mechanism of lexical access in terms of the connectivity between different lexical properties (e.g. grapheme-phoneme connectivity) and the activation of semantically/phonologically/orthographically related words.

In Garman's (*ibid.*) account of direct models, he uses the analogy of a word-processing package

> ...in which we may have certain items stored by name, so that, on typing in the letters of the name (perhaps only the first few letters, sufficient to identify the item in question), the item can be accessed (p.260).

The idea is that each phoneme in the input would affect "one further step in the overall process, up to the point at which no further input was available, or was needed to identify the stored form" (Garman, *ibid.* p.276). In short, the direct model emphasises the efficiency of lexical access.

**1.1.2 Serial and parallel processing**

In this section, the discussion centred on the issues concerning lexical processing. Lexical processing is also described in two ways - i.e. in terms of serial (or autonomous) processing (the search model), and parallel processing (Logogen model; interactive-activation model). Forster proposes a strict autonomy principle in relation to lexical processing, claiming "that the process involved in locating the lexical entry of a word cannot be modified by processing at either the syntactic or at the message level" (Forster, 1979, p.56). Lexical access always proceeds from the lexical level to the message level via the syntactic level. These have access to the lexicon but no access at all to general conceptual knowledge, which does not allow top-down processing of non-lexical knowledge to be involved (Harley, 2001). For Forster, the word is continuously searched for in the memory files until the exact match to the stimulus is found.

On the other hand, parallel processing models such as the Logogen model and the interactive-activation model posit the view of interactive information processing between lower- (bottom-up) and higher- (top-down) information resources. The information that is found in the lower-level resources via visual word recognition is synthesised with the information found in the higher-level resources. Thus, the word is recognised in an economical manner; that is, full and precise information is not really necessary for word recognition. The logogen model predicts that the relevant visual information in respect of *table*, for example, is evidence such as <five-letter word>, <initial ascending letter>, <central pair of ascenders>, <final *e*>, etc. Such evidence triggers accumulating excitation in the input system called the *input logogen*, and when the evidence causes the excitation to exceed the threshold level, the output system called the *output logogen* fires. At the same time, the evidence that is derived from the lower-level resources also activates some other words which are close in the network of the cognitive system. However, this activation is inhibited when the response which matches appropriately with the evidence reaches the threshold level and it is sent to the response device. This model emphasises that the most appropriate candidate can be still chosen for a response, even though the cognitive system allows semantic and phonological activation to occur.

The interactive-activation model also proposes interaction between lower- and higher-level resources. Rumelhart and McClelland (1982) suggest that each letter in the word *table* is processed simultaneously at a visual feature level, a letter level and a word level. Through the visual input, relevant features, letters and words are activated whereby the activation further spreads to the neighbouring nodes. However, once the mismatches are identified between candidate and stimulus items, these features, letters and words are eliminated by the inhibition operation.

### 1.1.3 Processing of a non-word

The serial and parallel standpoints also offer different approaches to understanding the mechanism for determining a particular stimulus item as a non-word. Forster suggests that one has to carry out an exhaustive search for this, on the basis of there being no entry for it in the master file. This is what this model proposes to account for evidence that it takes more time to recognise a non-word than an actual word (Rubenstein, Garfield and Millikan, 1970; Forster and Chambers, 1973). In relation to this, Forster proposes a *post-access check* to explain the fact that a non-word which is similar to an actual word takes longer to identify as a non-word in a lexical decision task, than a non-word which is dissimilar to an actual word. For example, a visual presentation of a non-word *obttle*, which is similar to *bottle*, takes more time to reject than to reject a non-word *ridap*, which is less likely to be an English word. He offers the following explanation for this phenomenon:

> This is presumably due to the fact that the search stops at an incorrect entry, and time is lost during the entry to the master file and the performance of the post-access check, the search in the original access file then recommencing.
>
> (Forster 1976, p.269)

On the other hand, the interactive-activation model predicts that the perception of letters in a non-word which is similar to a real word (e.g. *obttle*) temporally activates the real words which consist of the same letters (e.g. *bottle*). These inappropriate candidates are, however, inhibited by each letter's information being fed back.

These differences between serial processing and parallel processing imply that the search model's processing is inherently slower and more effort -demanding. Taft (1991, p.26) argues that "lexical access would be a slow and cumbersome process if the entire lexicon were searched for every word encountered in a sentence." This is in conflict with the claim that lexical processing is essentially rapid and automatic (LaBerge and Samuels, 1974; West and Stanovich, 1978; Stanovich, 1981; Posner and Snyder, 1975). LaBerge and Samuels (1974) discuss the automaticity with regard to the word recognition process, while Stanovich and his colleague (Stanovich, 1980, 1981; West and Stanovich, 1978; Stanovich and West, 1979) and Posner and Snyder (1975) argue this point in relation to semantic processing. For this reason, Forster (1989) later proposed parallel searching, which postulates that all the locations where words are stored in the access file are searched simultaneously.

However, post-access checking is argued to be useful as an optional stage. For example, Chambers (1979) finds that the response to a letter substituted non-word (*traim* in contrast with *train*) is longer than the response to letter transposed non-word (*trian* in contrast with *train*). Furthermore, O'Connor and Forster (1981) find that the response to the former is long but almost always accurate whereas the response to the latter is often very inaccurate. Taft (1991, p.18) argues that the interactive-activation model is not clear enough to predict such a complex outcome. Thus, in such a case, additional post-access checking may be required, so that the most activated word is compared with the stimulus word and the more plausible response is produced. Moreover, Taft (1991, *ibid.*) states that this *strategy* is often used, not only in the artificial experiments, but also for proofreading, where orthographically incorrect but likely words are found and also corrected to the appropriate orthography.

### 1.1.4 Natural and strategic processing

This serial and parallel controversy in terms of recognition of non-words is summarised by Harley (2001, pp.167-168) that "most researchers agree that the initial stages of lexical access involve parallel direct access, although serial processes might subsequently be involved in checking prepared responses." It may be possible that the parallel processing represents automatic nature of lexical processing, while serial processing represents the strategic conscious processing.

Similarly, concerning the direct (single-stage)/indirect (two-stage) lexical access issue, two-stage access might sometimes be required in particular cases, although it has been argued that the direct model is economical and efficient.

Garman (1990, pp.280-281) comments as follows:

> ...it mirrors our query above about the soundness of the distinction between the stages in Forster's two-stage model. It may be that language processing in this area is not very comfortably described in terms of either clear-cut single-stage or two-stage models... It may be that a resolution of

> this issue lies in the direction of distinguishing between what we 'normally' do (which may involve single-stage processing) and what we resort to in more artificial situations (of which the lexical decision task is arguably an example), where some back-up stage of processing may be necessary.

Harley's (2001) understanding that the difference between parallel and serial processing is the natural *versus* strategic processing seems to be also agreed with by Garman (1990) with regard to the difference between direct and indirect access.

**1.1.5 Hybrid models**

There are hybrid models which claim that lexical processing combines parallel and serial processing. Hybrid models include the verification model (Becker, 1976, 1979, 1980), and the activation-verification model (Paap, Newsome, McDonald, and Schvaneveldt, 1982; Paap, McDonald, and Schvaneveldt, and Noel, 1987). These models postulate that encoding is processed in a parallel manner, involving unconscious activation. This process is followed by a verification stage where some candidates, selected as a result of encoding, are verified via a serial comparison, which comprises conscious processing of top-down analysis. However, as Taft (1991) argues, this conscious verification seems to be used as a strategy in the artificial experiments and the proof-reading activities rather than used in a natural processing.

**1.2 Direct access/parallel processing models as natural lexical processing**

Except for some cases, direct parallel model seems to account for the natural manner of lexical processing. It may be plausible to examine the detail mechanism of direct access and parallel lexical processing. Two direct parallel models have been discussed so far. It has to be noted that the logogen model has some limitations. With regard to the issue of non-word recognition which was discussed earlier, this model is often criticised that the logogen system cannot explain the mechanism in question. The logogen system is an evidence-collecting device only for *real words* but not for non-words. Hence, the non-word stimulus may excite some logogens but not to threshold level, with the consequence that the relevant logogens do not fire; that is to say, the logogen system cannot *determine* that a given stimulus is a non-word. Coltheart et al. (1977, p.546) consider the possibility that the threshold may have a deadline for the "no" response. For example, if no logogen reaches threshold level by *t* msec after stimulus onset, the logogen system may decide that none is going to, and respond 'no.' However, they reject this hypothesis because it cannot explain the evidence indicating that a 'no' response for a more plausible non-word (e.g. *obttle*) takes longer than that for a less plausible non-word (e.g. *ridap*) (Stanners and Forbach, 1973).

Garman (1990) also points out the ambiguity of this model in that the logogen system has different thresholds for words according to their frequency level. Morton (1969) suggests that a word with a high-frequency level is recognised faster than a word with a low-frequency level, because for such a word, less evidence is necessary for the logogen to be excited beyond the threshold level. Garman (*ibid.*, p.280) argues that there is considerable opaqueness in respect of the operational meaning of these concepts:

> All we can say is that, to square with observation, the logogen system must operate with 'appropriately set' thresholds, in relation to the physical properties of the stimuli: but this is not testable.

The logogen system seems to offer a metaphorical understanding of lexical access with emphasis on automaticity in relation to the competition of candidate words.

On the other hand, the interactive-activation model provides convincing explanation for the complex mechanism of lexical processing, whose validity is verified using computer simulation. Next section addresses how this model actually works.

**The interactive-activation model**

This model (McClelland and Rumelhart, 1981; Rumelhart and McClelland, 1981; Rumelhart and McClelland, 1982; McClelland, 1987) is derived from Rumelhart's (1977) interactive model combined with the flow-of-activation assumption of McClelland's (1979) cascade model. McClelland's (1979) cascade model was designed to present an alternative view to the discrete stage model (Sternberg, 1969). According to the cascade model, each subprocess is continuously active and influences the following subprocess, which enables "all processes except response execution (to be) at work all of the time" (McClelland, 1979, p.291). This contrasts with the discrete stage model, which allows only one process to work at a time. This view of *continuous* but *linear* processing is combined with another view, the interactive model of information processing (Rumelhart's, 1977), which allows for several information resources to be interacting at a given time. This model fundamentally addresses the issue of how knowledge from higher-level resources interacts with input at lower levels and, furthermore, how such interaction facilitates perception (McClelland and Rumelhart 1981, p.375).

According to McClelland and Rumelhart (1981), this model identifies three characteristics of lexical processing. First, lexical processing is seen as having several levels; for example, regarding visual word perception, it posits a visual feature level, a letter level and a word level, which is assumed to be responsible for all levels below it. It also posits higher levels of processing such as syntactic and semantic levels, which make *top-down* resources available for word recognition (see Figure 1 below).

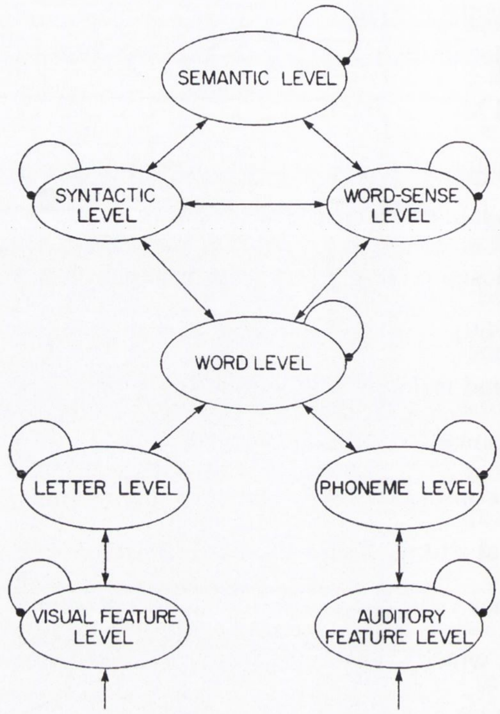


**Figure 1** A set of possible processing levels and connections among these levels. (Rumelhart and McClelland, 1982)

The second proposed characteristic is that lexical processing involves parallel processing. For instance, each letter in a four-letter word is claimed to be processed simultaneously and also at several levels. Third, such processing is envisaged as operating interactively, so that top-down processing occurs simultaneously with bottom-up processing in a spreading activation manner.

During such interactive activation, the activation of features, letters, and words is spread to the neighbouring nodes mutually among the several levels via excitatory and inhibitory mechanisms. For example, the letter *t* activates several neighbour line features, several neighbour letters such as *a, n, t, g, s,* and several neighbour words such as *table, trap, trip, take, time* and *cart* (excitatory processing). On the other hand, activation is decreased in the process of competition between features, letters and words as soon as mismatches are detected (inhibitory processing).

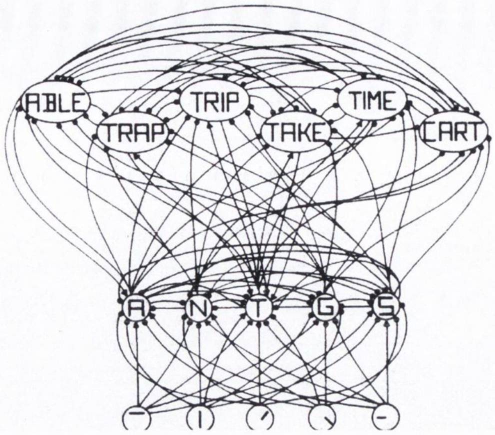


**Figure 2** A few of the neighbours of the letter *t*, in the first position in a word, and some of their interconnections. Excitatory connections are represented by arrows ending with points, and inhibitor connections are represented by arrows ending with dots. (Rumelhart and McClelland, 1981)

Rumelhart and McClelland (1982) illustrate this mechanism as follows. The presentation of context letters for a four-letter word (e.g. 'hip' in *ship*) activates the letter nodes that the context includes (i.e. *h, i, p*). These letter nodes activate the word nodes which contain the context letters and which include the expected target letter (*ship*, *whip*, etc.). Such activation of word nodes strengthens the connection between the context letters and letters which are candidates to complete the relevant words. Once the target letter is arrived at, the strength of this letter becomes immediately dominant, while the strength of the other candidate letters becomes immediately inhibited.

This model claims, in common with the logogen model, that lexical access occurs owing to the activation of complete lexical entries on the basis of stimulation from input information. It is noteworthy that in this model, word level encompasses both visual and auditory properties (see Figure 1), while the logogen model proposes that visual and auditory input logogens are independent from each other. This is seen as facilitating grapheme-phoneme connectivity and as ensuring that both visual and auditory entries lead to higher levels of lexical information: i.e. semantic and syntactic information. Another point is the detailed indication of feature level, letter level, word level, and furthermore semantic and syntactic attributes; in the logogen model the latter are contained in the cognitive system. The account of these various levels provides a detailed representation of what the mental lexicon consists of and how the relevant elements are processed. Moreover, the strong connection between letter and word levels can explain how words and non-words are recognised, without the need for recourse to arguments from frequency effects for words as a whole. A third important characteristic of the model is its inhibition function, which sheds light on how the appropriate word might be selected and the non-word rejected. We move now to a closer look at how word-letter connection works in relation to the facilitation-inhibition mechanism.

Rumelhart and McClelland (1981) argue that letter perception and word perception are mutually facilitated. They base their claim on a word-to-letter facilitation study (Reicher, 1969) and a letter-to-word facilitation study (McClelland, 1976). Reicher found that letter perception is facilitated in a word context. For example, the choice between *D* and *K* was easier for the subjects when the word *WORD* was presented than when a non-word such as *ORWD* was presented. On the other hand, McClelland found that in a recognition test, word recognition was not influenced by a mixture of visual forms such as upper- and lower- case types, whereas the recognition of isolated letters was influenced by inconsistent visual forms. The inference is that connection between letter nodes and word nodes facilitates recognition:

> The basic idea is that the presentation of a string of letters begins the process of activating detectors for letters that are consistent with the visual input. As these activations grow stronger, they begin to activate detectors for words that are consistent with the letters, if there are any. The active word detectors then produce feedback, which reinforces the activations of the detectors for the letters in the word. Letters in words are more perceptible, because they receive more activation than representations of either single letters or letters in an unrelated context.
>
> (McClelland and Rumelhart, 1981, p.376)

Such strength of connection between letters and words which bring about activation is based on one's experience with words (Andrews 1989); therefore, high-frequency words tend to be activated rapidly.

On the other hand, regarding the recognition of non-words, Rumelhart and McClelland (1981) found that pronounceable non-words are easier to recognise than phonologically non-related letter strings, and that real words are easier to recognise than pronounceable non-words. For them, the pronounceable non-word MAVE activates several words which share same letter strings with this target non-word. For example, nine words share its last three letters (HAVE, SAVE, CAVE etc.), one word shares the first and the last two letters (MOVE), and eight words share the first two letters and the last letter (MAZE, MADE, MALE etc.); all these words are activated partially when MAVE is presented, which feeds back each letter's information, enforcing their activation. Therefore, a pronounceable non-word is recognised more easily than isolated letters from the word or phonologically non-related letter strings (Rumelhart and McClelland 1981, pp.52-3).

Related to this issue, there is a good deal of evidence concerning neighbourhood size effect (i.e. the number of words that can be created by replacing one letter with another from a target word without changing letter positions). Neighbourhood size influences non-word recognition; the bigger the neighbourhood size is, the later or the less accurate the decision for the non-words becomes in the lexical decision task (Coltheart et al., 1977; Andrews, 1989; Forster and Shen, 1996). This inhibitory effect is because letter strings in a non-word with a larger neighbourhood size activate more actual words which are neighbours, owing to the spreading activation mechanism explained above. Therefore, it takes more time for competition to inhibit inappropriate candidate words.

As far as real words are concerned, Andrews (1989; 1992) found the facilitation effect in neighbourhood size only for low-frequency words in both her lexical decision task and her naming task. She assumes that this effect is due to the strength of connection between the letter level and the word level, as was previously mentioned. Forster and Shen (1996) summarise this mechanism as follows:

> This facilitatory effect derives from top-down feedback from the word level to the letter level, which reinforces the activation at the letter level, which leads to stronger activation at the word level. The more units at the word level that are activated by the stimulus, the greater will be the strength of this feedback. Therefore, words with many neighbours should be perceived faster than words with few neighbours (p.697).

The effects of this operation tend to be more distinctive for lower frequency words than for high-frequency words, and this finding seems to support the interactive -activation model.

These phenomena illustrated above are ascribed to an activation-inhibition mechanism of parallel processing and cannot be explained by a serial search model, owing to the fact that this model does not have a letter-word connection system. It is also problematic that, in the search model, neighbours only have an inhibitory effect in word recognition and cannot account for the findings of Andrews (1989; 1992) in respect of the facilitation effect of neighbourhood size for low-frequency words. The interactive-activation model elegantly illustrates various patterns of lexical processing which are proved on the basis of the findings in experiments.

### 1.3 Rethinking of the lexicon

On the basis of the discussion so far, Levelt' model (1989; 1993, Levelt et al.,1999) is dealt with in this section. Levelt's model represents the mechanism of the mental lexicon in terms of its function as a single memory system but operating as four (or, in larger categories, two) properties.

**Levelt's model**

Levelt's model aims to explain the information processing which takes place in fluent speech production. The principal benefits of presenting this model are that this model accounts for the relation between the lexicon and concepts. Levelt proposes that at the higher level there is a Conceptualizer which controls all mental activities involving the intentions underlying informational messages. This Conceptualizer is then connected with the Formulator which converts a conceptual information structure to a linguistic information structure. The Formulator receives the message generated in the Conceptualizer as characteristic input and produces a *phonetic* or *articulatory plan* as output via grammatical and phonological encoding. In order to do this, the Formulator has to consult the lexicon, which consists of lemmas and forms (or lexemes) in Levelt's model (see Figure 3 below).

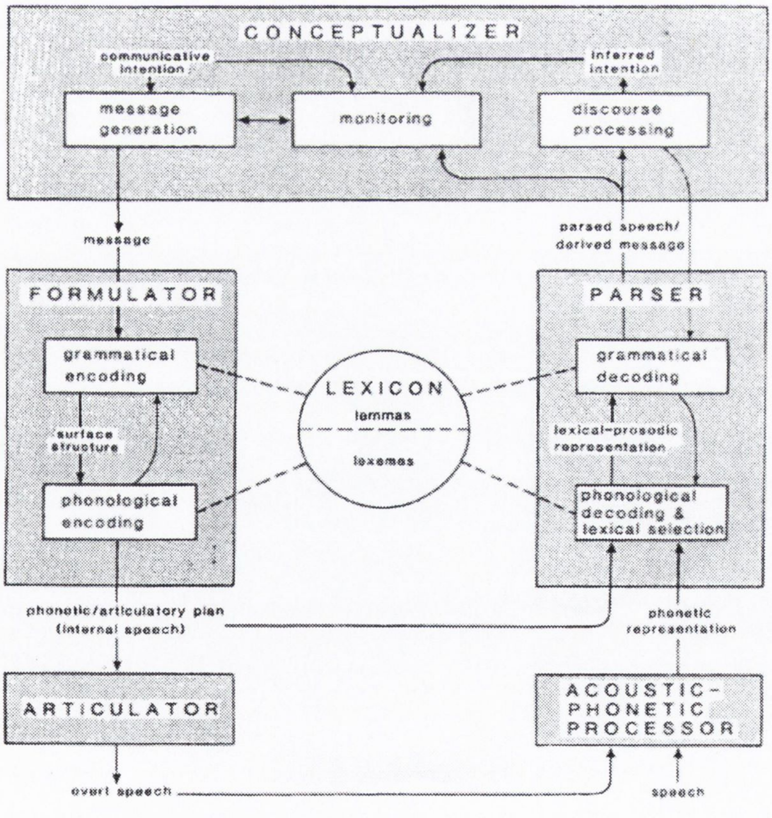


**Figure 3** Schematic representation of the processing components involved in spoken language use (Levelt, 1993)

Lemma information includes the *meaning* or *sense* (the semantico-grammatical component) of the word. For example, the word *give* represents "some actor X causing some possession Y to go from actor X to recipient Z" (Levelt, 1989, p.11). From the syntactic perspective, the word *give* is a verb (V) "which can take a subject expressing the actor X, a direct object expressing the possession Y, and indirect object expressing the recipient Z (as in *John gave Mary the book*)" (Levelt, *ibid.*). Furthermore, lemma information also includes the address of the equivalent morpho-phonological information among the word forms. The lexical pointer specifies where to refer to in order to get to the corresponding form.

Finally, lemma information indicates some diacritic parameters such as tense, mood, person, etc. Levelt (1989) claims that such syntactic properties of lemma information enable grammatical encoding.

On the other hand, the lexical forms are responsible for the lexical information concerning morphology and phonology. For instance, form information for the word *dangerous* includes a root (*danger*) and a suffix (*ous*), three syllables with the accent on the first one, and the sound /d/ at the beginning. Such form information is involved in phonological encoding.

This proposal regarding the constitution of the lexicon seems to be quite persuasive when we recall the characteristics of the lexicon which consists of *diversity* of properties but functions as *unity* (Garman 1990, p.271). In particular, the distribution of lexical properties between lemmas and forms seems to be plausible. De Bot, Paribakht, and Wesche (1997) argue that studies on naturally occurring and elicited speech errors, aphasia and tip-of-the-tongue (TOT) phenomena prove the imperfect correspondence between lemmas and forms. Radford, et al. (1999) illustrates speech errors such as *blends*, *substitutions*, and *word exchanges* as follows:

(1) At the end of today's *lection* (← *lecture* and *lesson*) ---**blend**

(2) Don't burn your *toes* (← *fingers*) --- **substitution**

(3) You can't cut *rain* in the *trees* (*rain* ←→ *trees*) --- **word exchange**

They are explained in more detail below. (1) shows that approximately equivalent lemmas, *lecture* and *lesson*, are simultaneously activated and this results in the production of this kind of blend error. Radford et al. (*ibid.*) explains that blends occur mostly within the same categories but hardly ever between antonyms (such as *harsy* from easy and hard) or superordinates (such as *dealsman* from dealer and salesman). (2) is an example of a substitution error. The substitution error in question, *toes,* is brought about by the activation of word which is semantically related to the target. According to Radford, et al., the activation of antonyms is often found in these kind of errors, and high-frequency words are more likely to be substituted for low-frequency words. In the case of (3), the error involves syntactic relations rather than semantic relations. When one produces this phrase, both *rain* and *trees* are activated at the same time and exchange slots for some reason. Such evidence seems to imply that the available lemma information does not activate full formal information (De Bot, Paribakht, and Wesche, 1997). According to Meyer and Bock (1992), the partial activation of corresponding formal information also brings about such phenomena as tip-of-the-tongue. Hence, the distinction between lemmas and forms can be regarded as relevant for studies of the internal structure of mental lexicon. In particular, the distinction between the lexical properties of lemmas and forms seems to be quite useful when it comes to investigating the lexical processing of bilinguals, where, for example, different form information may represent the same lemma information in L1 and L2.

As far as the connection between the lemma level and form level is concerned, Levelt (1989) conceives the relationship between these representations in terms of a spreading activation mechanism. The figure below represents the relationship between lemma level and form level in the case of two words *construct* and *constrain* (see Figure 4 below).

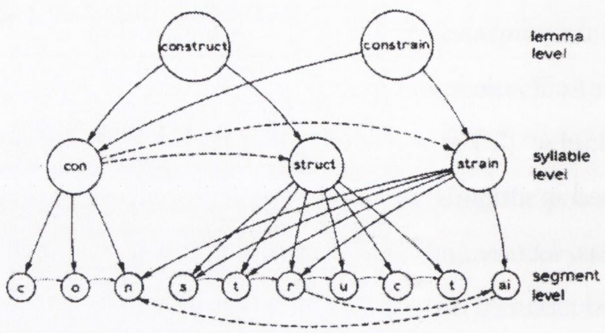


**Figure 4** Example of an activation-spreading network (Levelt, 1989)

Each node at the lemma level is divided into nodes at the syllable level (*con*, *struct*, *strain*). Each syllable set, furthermore, is connected to each morpho-phonological form such as *c*, *o*, *n* at the segment level. When the lemma *construct* is activated, its node for the appropriate lemma "fires" and activates immediately the two syllable nodes in forms, *con* and *struct*. Such activated nodes at the syllable level in turn activate relevant nodes such as *c*, *o*, and *n*. There is also a directed inhibitory connection (indicated by dotted lines) between *con* and *struct* at the syllable level, so that the combination of the syllable sets is made in the right order; i.e. *construct* instead of *structcon*.

Levelt (1989) claims the lexicon plays the central role among all the components in lexical processing. In a speech production process, according to him, the lexicon is "an essential mediator between conceptualization and grammatical and phonological encoding" (p. 181) (see Figure 3 above). He calls this the *lexical hypothesis*, and characterises it as follows:

> The lexical hypothesis entails, in particular, that nothing in the speaker's message will *by itself* trigger a particular syntactic form, such as a passive or a dative construction. There must always be mediating lexical items, triggered by the message, which by their grammatical properties and their order of activation cause the Grammatical Encoder to generate a particular syntactic structure. (Levelt, 1989, p.181)

On the basis of this notion, a theory of lexical access in speech production was developed by Levelt, Roelofs and Meyer (1999), presenting a computational model called 'Weaver++.' The theory suggests that processing of speech production occurs at three levels –conceptual, lemma and form levels. The speech production process starts with conceptual preparation, followed by lexical selection by retrieving lemma, in this case, syntactic information. The next step is morpho-phonogical encoding and syllabification, which occur now in the form level. For example, the lemma information, *escort*, diacritically marked for progressive aspect, activates morphemes <escort> and <ing>, which makes available the information of phonological syllables, *e* and *scor* and *ting,* with word accent on *scor*. This information allows phonetic encoding, which eventually enables articulation of speech. According to Levelt et al. (1999), all of this process, from conceptual level to form level via lemma level, occurs in a spreading activation manner.

Levelt's model also incorporates the receptive processing of speech (i.e. listening), in which the decoding (grammatical and discourse decoding) process is outlined (see Figure 3) (Levelt, 1993, 1999). According to this model, an aural stimulus is sent firstly to a parser, via an acoustic-phonetic processor. Here phonological decoding, lexical access and grammatical decoding (including syntactic/semantic processing) are carried out. Information emerged from this process is finally sent to the Conceptualizer for discourse processing.

Levelt's model was originally proposed for the process of speech production and comprehension. However, his view of lexical organization with lemmas and forms, and its central role of lexical processing, seems to be applicable to other modalities of lexical processing such as reading and writing. De Bot, Paribakht, and Wesche (1997) support this standpoint on the basis of its principle that the lexicon functions mainly as lemmas and forms and that the lexical processing operates both at the higher and lower levels via the lexicon (Bradley and Forster, 1987; Zwitserlood, 1994).

De Bot, Paribakht, and Wesche (1997) outline Levelt's account of receptive and productive lexical processing as shown below (see Figure 5).

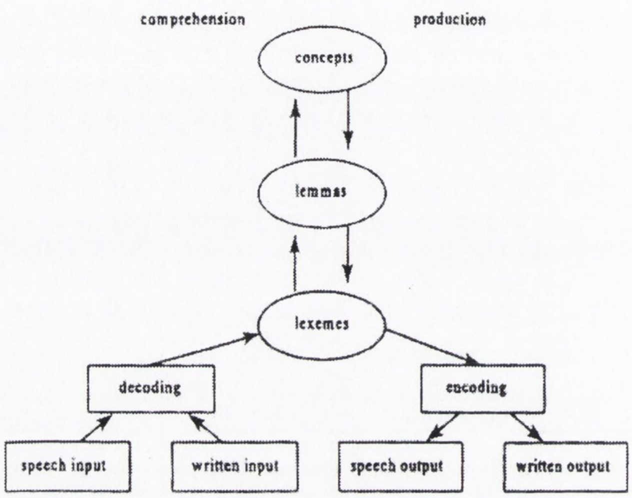


**Figure 5** Lexical comprehension/production model for oral and written modalities

Receptive and productive information is processed via shared concepts at the higher level but is processed via different processes at the lower level; i.e. using decoding and encoding processes with speech/written forms.

Levelt's notion of lemma - forms distinction is also useful if we consider the complex mechanism of the bilingual lexicon. The two languages of L2 users tend to be unbalanced, when they started to learn their L2 after they had acquired their L1. It often happens in the early stages of L2 acquisition that while form information is registered to the L2 lexicon, lemma information remains incomplete. De Bot, Paribakht, and Wesche (1997) comment as follows:

> Semantic information in a lemma can only come from existing concepts in the learner's conceptual system: The lemma does not develop a conceptual specification on the basis of form characteristics. The process of learning the meaning of a lexical item must, then, involve the copying of semantic information from the conceptual system to the lemma. Once a lexical item has been added to the lexicon in a more or less primitive form (and

> sometimes containing inadequate or misleading semantic and/or syntactic specifications vis-à-vis the target language form), its continued use will gradually specify additional information (p.317).

This seems to occur particularly in the following cases. In one language, a form may connect to one lemma, while in another language covering two lemmas (e.g. the homonymous word *bank* in English corresponds to two forms in Japanese). In one language, a lemma may connect to one form, while, in another language, linking to two forms (e.g. the meanings of *force* and *power* in English are covered by a single form in Japanese).

Such divergences across languages often influence L2 lexical acquisition. Thus, we cannot discuss the L2 lexicon without considering the influence it undergoes from the L1 lexicon. This obviously implies that the bilingual lexicon has complexities that the monolingual lexicon does not. Closer attention is paid to L2 vocabulary acquisition and the nature of the L2 mental lexicon in Chapter 2.

**Conclusion**

The main purpose of this chapter was to investigate the questions of whether lexical access is direct or indirect, and whether lexical processing is serial or parallel. From an examination of these perspectives, it was concluded that only the direct and parallel model accounts for the rapid and automatic nature of lexical processing. In particular, it emerged that the interactive-activation model (Rumelhart and McClelland, 1981, 1982), with its postulation of a facilitation-inhibition system, elegantly elucidated the mechanisms behind the frequency effect, the neighbourhood size effect and non-word recognition. Rumelhart and McClelland's positing of dynamic interactive operations between bottom-up and top-down processing very plausibly explains how the different levels of lexical information (i.e. phonology, orthography, semantics and syntax) actually communicate with each other when language is being processed.

Levelt's (1989, 1993, Levelt et al., 1999) view of information processing in speech production was also discussed. Its position with regard to the activation-inhibition mechanism is in essence similar to that of the interactive-activation model (Rumelhart and McClelland, 1981, 1982). The importance of this model further resides in its claim, on the basis of speech error studies, that a distinction needs to be drawn between lemmas and forms, semantics and syntax being categorised under the *lemma* heading, while phonology and orthography are categorized under the *form* heading. It was noted that this distinction is useful when we consider how bilinguals deal with cases of cross-language incongruencies in relation to the configuration of lexical forms and meanings.

The general notion of language organisation and processing constitutes an important basis for the investigation of the complex mechanisms that operate in the bilingual system. The next chapter is concerned with the issue of the bilingual lexicon. We will explore how the L2 lexicon may be organised and processed in relation to the L1 lexicon at different L2 developmental stages.

# Chapter 2 L2 lexical knowledge and the bilingual mental lexicon

## Introduction

In Chapter 1, discussion centred on the typical system and processing mechanisms of the lexicon as these appear to be revealed by L1 lexical studies. Taking into account the findings reviewed in the previous chapter, this chapter considers organisation and processing in the bilingual lexicon.

The chapter begins with a review of one general theory with regard to L2 acquisition (2.1). Taking as its starting point the view that the L2 lexicon is, in the most cases, incomplete (as compared with the L1 lexicon of most mature native speakers), the discussion includes assessment of vocabulary size from the perspectives of breadth and depth (2.2). The focus of discussion then moves on to the psychological perspectives of bilingual studies (2.3). Here, three major bilingual models are considered in order to investigate how lemmas and forms may be associated across languages - i.e. to address the question of to what degree the bilingual lexicon is integrated or separated at the lexical (form) and lemma levels? Understanding of the bilingual organisational system ought to reveal also what is occurring in the bilingual's lexical processing. It was concluded in Chapter 1 that the various aspects of the lexicon may be accessed in parallel. In the case of bilingual lexical processing, does this parallel processing occur within or between languages? In other words, is there language selection or not when the bilingual lexicon is accessed? This issue will be discussed in relation to the question of how bilinguals can manipulate language modes in contexts where both languages are available in their system. In the end, this chapter also deals with the matter of writing systems involved in bilingual lexical processing (2.4), which may be pertinent to the discussion relative to bilinguals' visual word recognition.

## 2.1 Lexical acquisition in L2

The L2 mental lexicon is different to the L1 mental lexicon in terms of the acquisition process. Jiang (2000) suggests three stages in L2 lexical development: i.e. the formal stage, the L1 lemma mediation stage and the L2 integration stage. On this view, L2 forms are acquired earlier than L2 lemmas, because L1 lemmas are often associated with L2 forms at the early stage. In the formal stage, where the receptive and productive processing of the L2 word is always mediated by the L1 translation, a learner only has L2 phonology and orthography in respect of the L2 lexical entry. Thus, the use of L2 words depends on the link to L1 morphology, semantics and syntax, so that an L2 word form connects with a concept only through the L1 lemma (see Figure 6 below).

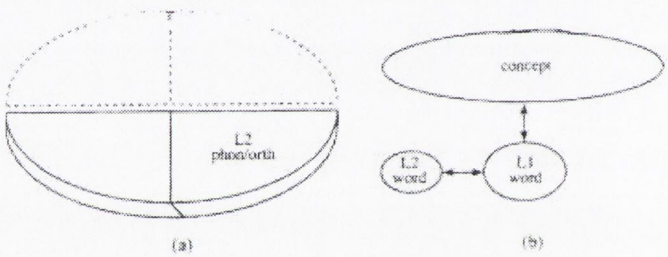


**Figure 6** Lexical representation (a) and processing (b) at the initial stage of lexical development in L2 (Jiang, 2000)

At the second stage, the L1 lemma mediation stage, L2 phonological and orthographic representations come to have a weak link to the learner's conceptual representations, while the L2 word form remains strongly connected with the lemma of the L1 equivalent (see Figure 7 below).

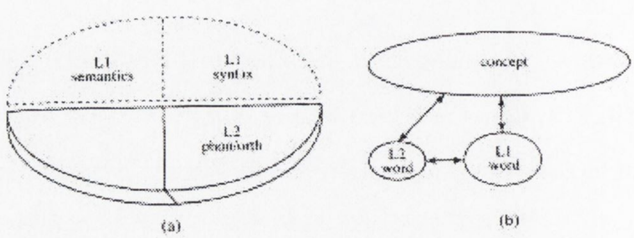


**Figure 7** Lexical representation (a) and processing (b) in L2 at the second stage (Jiang, 2000)

Jiang also suggests that in this stage, morphological information is not included in the L2 lexicon, owing to the uniqueness of its characteristics in each language. For example, in the case of plurality in English and Chinese, although the English word, *table*, requires –s in the end, the Chinese equivalent word *zhnozi* remains in the same form. According to Jiang, because of such language-specific nature of morphology, the L1 morphological information is less likely to apply to the use of L2 morphology (p.52).

Jiang (*ibid.*) suggests that only the most proficient L2 learners reach the L2 integration stage, where phonological/orthographic, morphological, semantic and syntactic representations are all integrated in L2 lexical memory and where the L2 lexical representation is directly connected to the concept (see Figure 8 below).

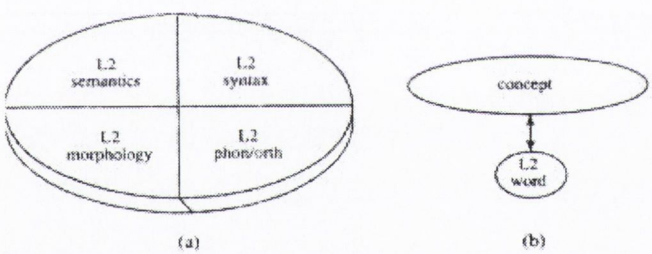


**Figure 8** Lexical representation (a) and processing (b) in L2 at the third stage (Jiang 2000)

This stage enables a lexical entry in the L2 to "be very similar to a lexical entry in (the) L1 in terms of both representation and processing" (p.53). This implies that native-like organisation of the L2 mental lexicon is acquired at this stage, although no clear indication of the relationship between L1 and L2 semantic representations can be found in Jiang's account. Jiang's view of lexical development provides detailed insights in respect of the organisation of L2 lexical representations and processing at each learning stage, which appear to be similar to the views of the Hierarchical model (Potter et al., 1984) and Revised Hierarchical model (Kroll and Stewart, 1994) (see discussion below in 2.3.1). However, there is still a necessity to provide a more adequate explanation concerning the relationship between L1 and L2 semantics in the bilingual mental lexicon. This issue will be focused on in Chapter 3, 3.2.

The constituent of the L2 lexicon seems to differ depending on the acquisition level. The next section discusses how the size of L2 lexical knowledge is generally assessed in a framework of L2 acquisition studies.

**2.2 Lexical knowledge**

Several researchers have attempted to answer the question of what lexical knowledge comprises. Research in this area dates back to the 1940s; Cronbach (1942), for example, proposed five components of lexical knowledge (see Table 1 below). These components include the extensive dimensions of lexical knowledge required for deployment in actual language use. Chodkiewicz (2000, p.36) notes that these components are basically envisaged as guidelines for direct vocabulary teaching, and suggests that their principal contribution was to trigger further study, which focuses on the taxonomising of lexical knowledge. Another version of the composition of lexical knowledge, proposed by Richards (1976), offers more detailed aspects of lexical knowledge, covering phonological/orthographic, syntactic, semantic, and paradigmatic aspects (see Table 1 below). A more recent version of categorization of components of lexical knowledge is put forward by Nation (1990) (see Table 1 below). It broadly contains four aspects (phonological/orthographic, syntactic, semantic, and paradigmatic) but also refers to another classification of lexical knowledge—i.e. receptive and productive dimensions—between which, it is widely agreed, there is a considerable gap in an individual's lexical competence (Henriksen, 1999).

The detailed components suggested by each of the above-mentioned researchers are summarised as follows:

**Table 1** The components of word knowledge (based on Chodkiewicz, 2000, p.37)

| Cronbach (1942) | Richards (1976) | Nation (1990) |
|---|---|---|
| 1. Generalization –the ability to define a word.<br>2. Application –the ability to select and recognize situations appropriate to the word.<br>3. Breadth –knowledge of multiple meanings.<br>4. Precision –knowledge to apply the word appropriately.<br>5. Availability –the actual use of a word in thinking and discourse. | 1. Probability of occurrence.<br>2. Register limitations.<br>3. Appropriate syntactic behaviour.<br>4. Underlying form and derivation.<br>5. Network of associations.<br>6. Semantic features.<br>7. Extended and metaphorical meaning. | 1. Form (spoken and written).<br>2. Position (grammatical pattern and collocations).<br>3. Function (frequency and appropriateness).<br>4. Meaning (concept and associations). |

The components of lexical knowledge are generally measured along two parameters: that of breadth of lexical knowledge and that of depth of lexical knowledge. Assessment of breadth of lexical knowledge has been a feature of lexical research from the early period. Investigation of the depth of lexical knowledge has also now come to be seen as an important element in such research.

Breadth of lexical knowledge means the quantity (or size) of such knowledge; in other words, how many words one knows. A set of results estimates the annual growth of vocabulary size during the school years, and suggests that school children absorb vocabulary at an approximate rate of 3,000 words per year (Nagy and Herman, 1987). Recently, vocabulary size has frequently been measured by means of the Vocabulary Levels Test (Nation, 2001). This test consists of five frequency levels; the 2,000 most frequent words level, then the 3,000 and 5,000 most frequent words levels , the University word level (beyond 5,000 words), and the 10,000 most frequent words level (Thorndike and Lorge, 1944; West, 1953; Kucera and Francis, 1967). This test requires a learner to read sentences and to decide whether the statements are true or not, to match a word with an appropriate definition, or to produce a word in sentential contexts.

Another means of assessing vocabulary size is the Eurocentres Vocabulary Size Test developed by Meara and his colleagues (Meara and Buxton, 1987; Meara and Jones, 1988). It requires a learner to decide whether s/he knows the word or not in a vocabulary list, which includes a number of non-word distractors.

Depth of word knowledge, on the other hand, refers to the quality (or degree) of word knowledge; that is, how well one knows specific words. Anderson and Freebody's (1981) discussion of the depth of word knowledge suggests that as lexical acquisition proceeds, vocabulary knowledge deepens and the learner comes to understand "nuances and subtle distinctions conveyed by words" (p. 94). Wolter (2001) also offers the view that depth of vocabulary knowledge "conditions the connections made between [a] particular word and the other words in the mental lexicon" (p.47). The distinctions and connections between words in the lexical network are seen as multidimensional in nature. Vermeer (2001, p.218) illustrates the various dimensions that may be good indicators relative to the measurement of depth of vocabulary knowledge; they are: thematic (*e.g. table-chair-couch*), phonological (*e.g. table-fable-label*), morphological (*e.g. similitude-gratitude-altitude*), conceptual (*e.g. cup-glass-mug*), and sociolinguistic (*e.g. piss off-bollocks-fucking*). Growth of knowledge in such aspects, furthermore, is viewed as facilitative of "pronunciation, spelling, grammatical and stylistic possibilities, collocations and frequency" (*ibid.*). According to Wolter (2001), 'how well the specific words are known' has a gradation from "slightly known" to "well known" (p.48), and he claims that generally words in the "well known" category have stronger connections in paradigmatic dimensions (including synonymy, antonymy, and hyponymy; cf. Chodkiewicz, 2000, p.26) than in syntagmatic or phonological dimensions. That is to say, as vocabulary knowledge deepens, the paradigmatic connections with other words in the lexical network become stronger. With regard to children's vocabulary acquisition, Chodkiewicz (2000, p.36) indicates that vocabulary in the native language grows along with several factors such as cognitive development and the progress of general language abilities. Nagy and Herman (1987, p.24) claim that sufficient exposure to (especially oral) context plays an important role for such vocabulary growth. Nagy and Herman (*ibid.*) explain that oral context includes many extralinguistic elements such as intonation, gesture, and other indicators of speakers and that these compensate for the listener's lack of knowledge. They claim that exposure to appropriate and adequate context helps children create semantic and syntactic information concerning the new vocabulary, which eventually has an impact on the quality of vocabulary knowledge. Also in L2 vocabulary acquisition studies, the importance of exposure to sufficient and appropriate context in vocabulary learning has received attention. There are numerous studies focused on the learning of words from context (Huckin and Block, 1993; Nagy, 1997; Coady, 1997; Chodkiewicz, 2000), on the implicit learning of vocabulary (Ellis, 1994), and on incidental vocabulary learning (Hulstijn, 1992; Schouten-van Parreren, 1992; Stoller and Grabe, 1993; Huckin and Coady, 1999; Paribakht and Wesche, 1997; Wesche and Paribakht, 1999; Schmidt, 1993; Schmitt, 2000). However, it is often argued that, particularly for less experienced L2 learners, learning words through context might be less efficient than explicit learning via definitions or L1 translation equivalents (Nagy, 1997; Nation, 1993). This is because inference of an unknown word's meaning requires a learner to know approximately 90-98% of other words in the context (Liu Na and Nation, 1985; Laufer, 1989; Coady, Magoto, Hubbard, Graney, and Mkhtari, 1993; Hirsh and Nation, 1992; Nation and Waring, 1997). Schmitt (2000) also suggests that an effective use of both methods (explicit and implicit learning) is beneficial for the L2 learners.

Dolch and Leeds (1953) pointed out that the conventional vocabulary size test may not be quite appropriate for gauging in-depth aspects of lexical knowledge, and, accordingly, alternative types of assessment have been explored for such aspects. Thus, interviews have commonly been used to measure the depth of vocabulary knowledge, where interviewees are asked to provide "definitions, functional characteristics and relations, essential features…etc" (Vermeer, 2001, p.221). Word association tasks have also been employed in both L1 (Deese, 1965; Clark, 1970) and L2 (Meara, 1980), and these have in the course of time suggested ways of developing a format for a depth of vocabulary knowledge test. With regard to the word association task, it has been pointed out that it is not really appropriate for L2 learners whose semantic network has not yet been fully established. This is because such immature networks tend to yield instability of response, which makes it difficult to judge depth of lexical knowledge precisely (Read, 1993). It was, therefore, deemed necessary to develop better formats for probing depth of lexical knowledge. In particular, two formats have been proposed by Read (1993) and Paribakht and Wesche (1996, 1997). First, the Word Associates Test developed by Read (1993) gives a target word and two groups of words, and a learner is asked to choose four words which would go with the target word from the word group. This test measures the paradigmatic, syntagmatic, and analytic aspects of the learner's knowledge of each target word (Read, 2000, p.181). The Vocabulary Knowledge Scale (Paribakht and Wesche, 1997) elicits a self-report of how well a learner knows each word. The testee is required to produce a synonym or translation, and to create a sentence using the word. The self-report includes five categories which range from 'no entry of the specific word in a learner's lexicon' to 'the degree of learner's knowledge about the word.' Although it is admitted that it is more difficult to measure depth of lexical knowledge than breadth of lexical knowledge (Quian, 1999), the crucial nature of depth of vocabulary knowledge has been pointed out in relation to the lexical processing; especially in relation to reading (Anderson and Freebody, 1981; Beck, Perifetti and McKeown, 1982; Mezynski, 1983).

The breadth and depth perspectives on vocabulary knowledge explained above are not a dichotomy; rather, they are connected with each other (Vermeer 2001, p.222). Both components of word knowledge can grow simultaneously in the lexical network; in other words, such a lexical network is, as it were, a lexical ground with a possibility of horizontal and vertical growth on the breadth and depth axes. Therefore, both breadth and depth of vocabulary knowledge reflect the ongoing development of vocabulary knowledge in the mental lexicon. The more words one knows, the deeper one's knowledge becomes about relationships between words in the lexical network, which are so important for categorization and classification purposes. Collins and his colleagues (Collins and Quillian, 1969; Collins and Loftus, 1975) suggest that word knowledge is not stored randomly, but it is sorted and organised finely in memory in the form of a network structure. While there are slight differences among researchers on this topic, the lexical network is generally regarded as organised according to paradigmatic, syntagmatic, and phonological properties. Moreover, the nodes of the network of such property fields are interconnected with each other and the strength of the connections varies in terms of individuals' familiarity with the words in question (Aitchson, 1994). Aitchson claims that such property fields are connected with general cognitive abilities, and that L1 learners have to develop their general cognitive and conceptual abilities alongside lexical knowledge. Jiang (2000) argues that L2 learners also have to register L2-specific semantico-syntactic information in the L2 lexicon, in order for L2 words to be deployed and understood in a semantically and pragmatically appropriate manner. It is assumed that new concepts also have to be added according to the registration of such L2-specific information.

Wolter (2001) points to similarities in L1 and L2 lexical development, and proposes that paradigmatic and syntagmatic aspects of vocabulary knowledge are more dominant in the organisation of both L1 and L2 lexical networks than phonological aspects, as one's knowledge of words becomes deeper, with greater frequency of input. At the same time, Wolter (*ibid.*, p.66) also claims that there are organisational differences between the L1 and L2 mental lexicons. It seems relevant at this point to focus on the organization of the L2 mental lexicon in the acquisition process in relation to the L1 mental lexicon, since it is obvious that the L1 mental lexicon has some kind of influence upon the organisation of the L2 mental lexicon, especially for L2 learners in the FL (foreign language) environment who begin to learn their L2 after they have already acquired their L1 and have less L2 input in their everyday lives. Furthermore, it is also necessary to consider whether the differences of organization between the L1 and L2 mental lexicons mentioned by Wolter (*ibid.*), if any, are simply due to differences between the respective acquisition levels or due to other factors; i.e. inherent differences between L1 and L2 lexicons.

## 2.3 Bilingual mental lexicon

The previous section was concerned with the general question of what constitutes vocabulary knowledge. It also discussed the fact that vocabulary knowledge is assessed from both a breadth and a depth perspective. This section focuses on the depth perspective of vocabulary knowledge in bilinguals, attempting to reveal how the bilinguals' mental lexicon is organised and processed between two languages.

### 2.3.1 Lexical and semantic representations and processing in the bilingual mental lexicon

Levelt (1989, 1993, Levelt et al., 1999) suggests that the mental lexicon consists of lemmas and forms, as was described in 1.3. The validity of this categorisation appears to be confirmed by a series of speech error studies (see discussion in 1.3). It has also been suggested that, particularly in the context of the bilingual mental lexicon, the distinction between lemmas and forms is quite useful to account for the mechanism by which a single memory storage system controls two kinds of information (i.e. forms and meanings). However, some decades of study regarding the mechanism of the bilingual mental lexicon has not yet reached a clear consensus in terms of how the lemmas and forms of one language are related to those of the other language in the bilingual mental lexicon (Kroll and Sunderman, 2003). There are three views on this issue:

1. Formal (or lexical) representations are stored separately, while semantic (conceptual in their term) representations are shared between the two languages (Potter, So, Von Eckardt, and Feldman, 1984; Kroll, 1993; Kroll and Stewart, 1994).
2. Lexical representations are integrated between languages which share the same kind of writing system (Van Heuven, Dijkstra, and Grainger, 1998; Dijkstra and Van Heuven, 2002).
3. Semantic representations may be separated in contexts where inherent

concepts between translation-equivalent words are not exactly the same (De Groot, 1993).

Let us begin our discussion by focusing on the second claim proposed by Van Heuven, Dijkstra, and Grainger (1998) that lexical representations are integrated. Their Bilingual Interactive Activation Model describes the interaction of lexical representations across two languages in visual word recognition.

**The Bilingual Interactive Activation Model**

Van Heuven, Dijkstra, and Grainger (1998) present the Bilingual Interactive Activation model as being based on the Interactive Activation model (McClelland and Rumelhart, 1981, etc.; see discussion in 1.2). Van Heuven et al. (1998) support a parallel processing view of the Interactive Activation model insofar as visual word recognition is seen as being influenced by the neighbourhood size. (Neighbour words are those differing from the stimulus word by only one letter/sound in the same position; thus, the English stimulus *game* has 11 neighbour words in English - *CAME, DAME, FAME,* etc.) Under this assumption, they attempted to demonstrate the interlingual neighbourhood effect on visual word recognition. The interlingual neighbourhood effect refers to a phenomenon whereby word recognition in one language is influenced by the neighbourhood size of a word in the non-target language (e.g. the English stimulus *word* has 3 Dutch competitors: *BORD, WOND, WORP*). The theoretical position underlying this model is that of non-selective access to an integrated lexicon.

Van Heuven et al. (1998) give an account of two main views: i.e. language-selective access in independent lexicons and non-selective access to an integrated lexicon. According to van Heuven et al. (1998), the first view, language-selective access in independent lexicons, represents a model found in the early study of the bilingual mental lexicon. This view suggests that the code of language is initially selected by a bilingual speaker when input is given in a monolingual environment. However, if the input lexical representation does not match any relevant candidate in the consulted code of language, selection is shifted to the other code of language. In contrast, van Heuven et al. (1998) explain that the non-selective access to an integrated lexicon view is characterised in terms of two aspects –the manner of the search and that of inhibition. Firstly, a simultaneous search in both languages is possible, and the order of search is determined according to relative frequency. Secondly, according to the Interactive Activation model (McClelland and Rumelhart, 1981), this view allows inhibitory activity in parallel across languages.

Van Heuven et al. (1998) examine these views on the basis of results provided by several experimental studies. They argue (*ibid.* p.459-460) that earlier research on the selective access model was concerned with comparing monolingual and code-switched bilingual sentence comprehension (Macnamara and Kushnir, 1971; Soares and Grosjean, 1984; Scarborough, et al., 1984; Gerard and Scarborough, 1989). In contrast, experimental studies on the non-selective access model have focused on interference activity (Dijkstra, van Jaarsveld, and ten Brinke, 1998; Grainger and Beauvillain, 1987; Hermans, Bongaerts, de Bot and Schreuder, 1998).

Gerard and Scarborough's (1989) lexical decision study with Spanish-English bilinguals provided evidence for the selective model. Their experiment included cognates (translation equivalents in the two languages which were orthographically identical – e.g. *actual*), non-cognates (translation equivalents which were orthographically different, e.g. *dog* and *perro*), and homographic non-cognates (words which were orthographically identical but semantically different, e.g. *red*). Spanish-English bilinguals recognised cognates and homographic non-cognates in either target language without any influence seeming to derive from their knowledge of words in the non-target languages. That is, the bilinguals' latencies and errors for these words were found to be similar to those of monolinguals in that latencies and errors were affected by the frequency of usage in the target language, not by knowledge of the words in the non-target language. Hence, Gerard and Scarborough concluded that bilinguals recognise words as monolinguals do, as the language-selective access, separate lexicon view predicts.

On the other hand, there is some evidence to support a non-selective, integrated view of lexical processing (Dijkstra, et al., 1998; Grainger and Beauvillain, 1987; Hermans, et al., 1998). Dijkstra, et al. (1998) replicated a part of Gerard and Scarborough (1989)'s study. They asked Dutch-English bilinguals to perform English lexical decision tasks including cognates and homographs. Experiment 1 yielded a similar outcome to the Gerard and Scarborough (1989) study in that no significant difference in latencies was found between English-Dutch homographs, cognates, and non-words derived from existing English words (control words), although the latencies for the cognates were significantly faster (facilitation effects) than those of monolingual control words. In Experiment 2, Dutch filler words were included in an English lexical decision task and for these Dutch filler words, bilinguals were asked to respond "no." Results of this experiment demonstrated that recognition latencies were significantly longer (inhibitory effects) for English-Dutch homographs than for English control words, and that the latency patterns were affected by the frequency of usage in the non-target (Dutch) language. Dijkstra et al. (1998) claim that this inhibitory effect results from non-selective access. They confirmed this view when strong facilitation effects were obtained for Dutch-English homographs in relation to English control words in Experiment 3, where bilinguals were instructed to respond "yes" for both English and Dutch words. Regarding the difference in findings from Gerard and Scarborough's (1989) study, Dijkstra et al. (ibid.) propose that it may be related to task sensitivity; in other words, they suggest that the task context (i.e. whether non-target language distracters were used or not) is likely to affect responses.

Dijkstra and van Heuven (1998) criticise earlier experimental designs in relation to the selective-non-selective controversy as follows:

> ... (the) reason that the selective-nonselective access issue has been around for some time is researchers' relative neglect of the question of the potential context dependence of cross-language effects. From this viewpoint, the two hypotheses are not symmetrical. We must reject the language-selective access hypothesis as soon as reliable evidence for online cross-language effects is available, evidence that cannot be explained away by pointing at weak stimulus materials or flaws in experimental design.
>
> (Dijkstra and van Heuven, 1998, p.191)

According to Dijkstra and van Heuven (1998), the design of earlier experiments has not been appropriate to determine whether access of the bilingual lexicon is language-selective or language-non-selective.

In order to investigate the validity of selective vs. non-selective views, the focus has shifted from interlingual homographs (Gerard and Scarborough, 1989; Dijkstra et al., 1998) to interlingual orthographic neighbours (Grainger and Dijkstra, 1992; Beauvillain, 1992; van Heuven et al., 1998). On the one hand, interlingual homograph tasks investigate the effects of word forms extracted from the non-target language on the recognition of the word in the target language (e.g. *red* as an English word may activate a word with the same form in Spanish language). On the other hand, interlingual neighbourhood tasks attempt to investigate the effects of neighbour words from both target and non-target languages on the recognition of the target word (e.g. the English target word *word* may activate *LORD*, *WOOD*, and *WORK* as well as *BORD*, *WOND*, and *WORP* in Dutch). While interlingual homographs offer evidence with regard to only one form, interlingual neighbourhood tasks allow one to see how the entirety of orthographic contexts (neighbours) across languages affects the recognition of words in the target language. Thus, interlingual neighbourhood tasks were assumed to be able to provide broader insights than interlingual homograph tasks relative to the complex mechanism of lexical access in the bilingual lexicon. Neighbourhood tasks, based on monolingual neighbourhood tasks (Coltheart, et al., 1977), have been often seen as supplying evidence in favour of the non-selective model.

Van Heuven et al. (1998) used the cross-language neighbourhood tasks in a word identification task and a lexical decision task with Dutch-English bilinguals and English monolinguals. Stimulus words were manipulated in terms of the number of neighbours (N) in the target and the non-target languages: i.e. English words with either small or large N in English (target language) and Dutch (non-target language), and Dutch words with small or large N in Dutch (target language) and English (non-target language). The result of all these experiments demonstrated strong inhibitory effects of non-target language neighbourhood density in both languages, while no such effect was obtained for monolingual participants. In other words, the RTs were longer for the target words with increasing number of neighbours in the non-target language. On the other hand, a facilitatory effect of English (L2) neighbourhood density was observed for the English target words. Furthermore, the lexical decision tasks showed the interlingual neighbourhood effects for non-word stimuli only when the language of the stimuli's non-target neighbours was the bilinguals' dominant language (Dutch). For van Heuven et al. (1998) these results confirmed the validity of their support for the language-non-selective, integrationist model.

Van Heuven et al. (1998) claim that this result can only be explained by the model of non-selective access to an integrated lexicon. This is because, according to the model of language-selective access to independent lexicon, non-target language neighbourhood should have no effect for bilingual participants on lexical access in the target language. Van Heuven et al. (1998, p.461) argue as follows:

> …in a selective access model, only words from the target language are activated (or considered) on a given trial…. the selective access model predicts that recognition of a target word is determined by the neighbourhood characteristics of the target language only. In a non-selective access model, on the other hand, sensory input activates words from both languages simultaneously, and it therefore predicts neighbourhood

> effects of both languages during the word recognition process.... According to an integrated lexicon hypothesis, recognition of a target word will be affected by the presence of both target and non-target language neighbours in situations where both languages are active. According to an independent lexicon hypothesis, recognition of the target word should not be affected by interlexical neighbourhood density [i.e. the number of neighbours], since there are no direct interaction effects between the two lexica.

According to van Heuven et al. (1998), cross-language neighbourhood tasks seem to be the best way to determine which view (selective access in independent lexicons or non-selective access to integrated lexicon) would better account for the complex mechanisms of word recognition in bilinguals.

On foot of such evidence, van Heuven et al. (1998) propose the Bilingual Interactive Activation (BIA) model. (See Figure 9 below.) As was noted earlier, this model is based on the Interactive-Activation Model (e.g. McClelland and Rumelhart, 1981) expanded to the bilingual lexicon context. The additional elements to the IA model are as follows; (a) This model addresses the case of a lexicon integrated across two languages, and (b) an extra layer is added as a language level which includes two language nodes, these nodes being connected to each word node from both languages. Thus, when visual input is provided, through recognition of relevant features, several letters are excited, and this, furthermore, stimulates excitation of candidate words, which include several letters in the appropriate position from both available languages. Eventually, the word is recognised as a result of competition between these candidate words by which irrelevant candidates are suppressed and the most appropriate word reaches the threshold level. At the word level, competition is carried out via vertical and horizontal inhibition activity; that is, candidate words from the two languages are inhibited by the top-down feedback from the language node.

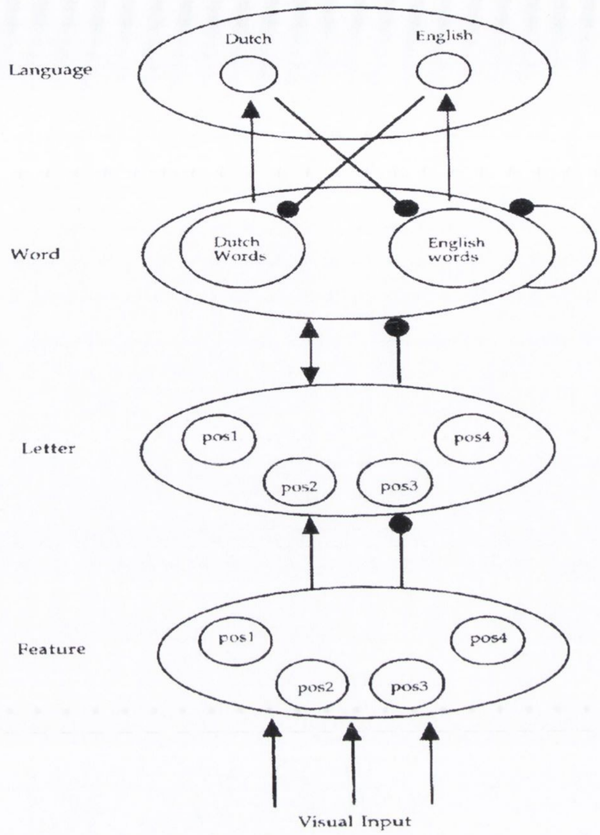


**Figure 9** The Bilingual Interactive Activation (BIA) model (van Heuven et al., 1998 p.475). Arrowheads indicate excitatory connections; black filled circles indicate inhibitory connections. Though only four positions for features and letters are represented, the model is not limited to the recognition of four-letter words.

Dijkstra and van Heuven (1998) argue that these functions in the BIA model, taking over the original concepts from the IA model, can account for complex mechanisms of bilingual word recognition processing that the experimental studies seem to reveal.

> In the BIA model, both mechanisms [lateral inhibition and top-down feedback] exert their influence at the word level. Inhibitory top-down and cross-language feedback from the language node level operates as a kind of language filter (not an all-or-none switch) that modulates lexical activity, dependent on the relative activity of the language nodes. At the same time, lateral inhibition suppresses other items than the target from the same or

> other language and speeds up the recognition process. The two mechanisms in combination might account for the complex experimental results for interlingual homographs and neighbours earlier reviewed.
>
> (Dijkstra and van Heuven, 1998, p.201)

For Dijkstra and van Heuven (1998), these functions (i.e. lateral inhibition and top-down feedback) are the essence of bilingual lexical access processing.

Consistent results relating to interlingual orthographic effects are obtained from several studies with stimuli controlled by the target/non-target neighbourhood density (Grainger and Dijkstra, 1992; Beauvillain, 1992; van Heuven et al., 1998). This outcome seems to offer persuasive evidence in favour of the BIA model, which has greater explanatory power than the selective access, separated lexica model.

Some studies further investigated the phonological and semantic interaction between two languages (Brysbaert, Van Dyck, and Van de Poel, 1999; Dijkstra, Grainger, and Van Heuven, 1999; Gollan, Forster, and Frost, 1997; Jared and Kroll, 2001; Lemhöfer and Dijkstra, 2004, Talamas, Kroll, and Dufour, 1999). For instance, Dijkstra, et al. (1999) offered evidence of interlanguage grapheme-to-phoneme correspondences. In this study, they used an English word identification task and English lexical decision tasks with Dutch-English bilinguals and English monolinguals. Both tasks included the same English stimuli which were orthographically, phonologically, or semantically similar to Dutch words. For example, they were homophonic cognates with identical orthographies such as HOTEL-HOTEL and non-homographic homophonic false friends such as COW-KOU, the latter of which means COLD in Dutch, etc. A series of experiments in two different paradigms demonstrated very similar results. Bilinguals exhibited a facilitation effect for orthographic and semantic similarity across languages (i.e. cognates, homographs) but an inhibitory effect for phonological similarity across languages (i.e. homophones), while no difference in reactions was found between stimulus conditions for monolingual participants.

Talamas, et al. (1999) examined the non-selectivity of lexical as well as semantic processing in terms of bilinguals' L2 proficiency levels. In this study, English-Spanish bilinguals were asked to decide whether cross-language pairs were translation equivalents or not. For example, in the case of the target word *man*, the prime word was either correct translation equivalents (e.g. *hombre*), form related distracters (e.g. *hambre*, meaning 'hunger' in English), or meaning related distracters (e.g. *mujer*, meaning 'woman' in English). Talamas, et al. obtained the results that less proficient bilinguals had more interference for form similarity than for semantic similarity across languages. Furthermore, they observed the opposite effects for more proficient bilinguals; i.e. more proficient bilinguals demonstrated more interference for semantic similarity than for form similarity between languages.

Despite the fact that the BIA model is generally successful and brought a great impact to the bilingual research, the outcome of empirical studies also revealed limitations of this model. Dijkstra and Van Heuven (2002) argue limitations, which may be summarised into the following three points. First, the BIA model does not include phonological and semantic representations; therefore, it cannot explain the phonological and semantic interactions across languages in visual word recognition of homographs and cognates (e.g. Dijkstra et al., 1999; Lemhöfer and Dijkstra, 2004). Second, the actual mechanism of language nodes is opaque –representational and functional roles seem to be confounded. To illustrate, if the language nodes have inhibitory function for the non-target language with the top-down feedback, it is unable to explain a phenomenon whereby bilinguals cannot inhibit L1 words in an L2 lexical decision task (see Experiment 2 in Dijkstra et al, 1998). Third, the model is not flexible in terms of the task demand; that is, the relationship between word identification and task demands is not clear.

Therefore, Dijkstra and Van Heuven (2002) proposed a revised model, the BIA+ model, in which the limitations described above are reflected (see Figure 10 below).

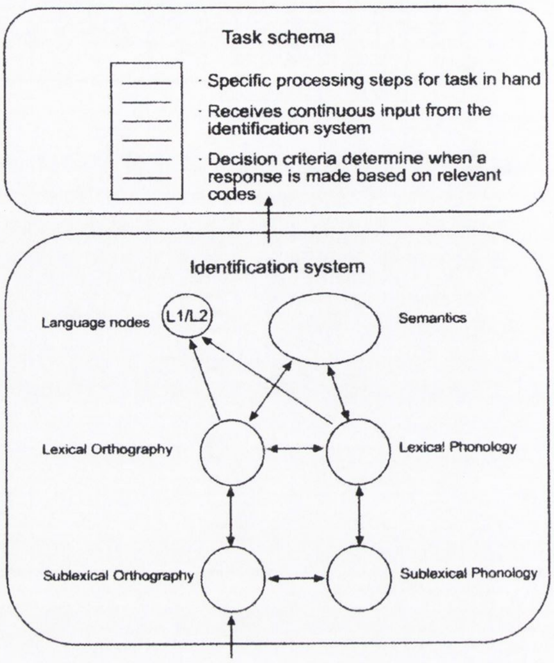


**Figure 10** The BIA+ model for bilingual word recognition (Dijkstra and van Heuven, 2002)

The BIA+ model suggests a distinction between a word identification system and a task / decision system. The word identification system includes not only orthographic but also phonological and semantic representations. It also comprises lexical and sublexical connections between orthographic and phonological representations. In visual word recognition, input through sublexical and lexical orthography activates corresponding sublexical and lexical phonology and also corresponding semantics. The identification system posits non-selective access to an integrated lexicon, and it predicts interconnection between orthography and phonology across languages. This enables the model to account for phenomena with respect to effects of cross-linguistic correspondence on phonological and semantic levels such as interlingual homograph and cognate effects (e.g. Dijkstra, et al., 1999; Lemhöfer and Dijkstra, 2004).

Unlike the earlier version model, the language nodes only have a representational role; they operate as language-tags (Green, 1998). They are useful in identifying which language each word belongs to, but no longer have an effect on activation of words in the other language. For example, in order to make a decision of whether or not the stimulus item is a word in the target language, the task / decision system has to retrieve information regarding language membership through lexeme or lemma in the identification system.

Output produced in the identification system is continuously sent to the task / decision system. This system adopts the notion of Green's (1998) 'task schemas' in his Inhibitory Control (IC) model (see 2.3.2 Control for a detailed explanation). The task schema identifies the procedures of how the task in question should be dealt with for a response. On the basis of the task schema specific to the task in question, the decision mechanism produces a response by employing activation thresholds appropriate to individual word candidates.

Basically, the decision is made based on the output information activated in the identification system; however, the decision system sometimes does not wait for the information from the identification system to produce a response, in cases such as in a lexical decision task. Conversely, it is also possible that a target word is recognised before the decision system makes a response. Dijkstra and van Heuven (2002) suggest that this occurs because of the partially independent nature of the identification and the task / decision systems. According to Dijkstra and van Heuven (ibid.), the significant difference between the two systems is that the former can be affected by linguistic context such as sentence context, while the latter is affected by non-linguistic context such as instruction, task demands and the participant's expectations.

The BIA+ model, which is a theoretical framework of bilingual word recognition, can be implemented in the Semantic, Orthographic and Phonological Interactive Activation (SOPHIA) model (van Heuven, 2005). As the name of the model indicates, it incorporates orthography, phonology and semantics. Orthography and phonology have letter and phoneme levels and the word levels, which are connected to language nodes. According to van Heuven (2005), the SOPHIA model is able to simulate the frequency-dependent inhibition effects with interlingual homographs shown in the results of Dijkstra et al.'s (1998) second experiment. As was observed in Dijkstra et al.'s (1998) study described earlier, in the simulation of the SOPHIA model it took longer to recognise homographs than English control words and also it took longer to recognise homographs with high-frequency reading in Dutch than those with low-frequency reading in Dutch.

The BIA+ model and its simulation model, namely, the SOPHIA model, seem to have achieved a step forward in the study of bilingual lexical processing. The revised model is able to account for some phenomena that experimental studies elicited. However, the model's theoretical and practical development is still required. For example, there is no detailed account of the context effect mechanisms concerning semantics and syntax (Dijkstra, 2005). Also, in implementation of theoretical framework, actual involvements of the semantic system in word recognition are not yet transparent (Brysbaert and Dijkstra, 2006). Dijkstra and van Heuven (2002) explain about the lemma issue in their model as follows:

> For the sake of simplicity, the model currently does not incorporate lemma representations, implying that the language nodes are directly connected to lexical form representations. (Dijkstra and van Heuven, 2002, p.186)

This indicates that this model does not take account of the cases of semantic difference for translation equivalent pairs between languages (De Groot, 1993). Furthermore, the conceptual level of the lexicon is not included in the discussion; thus, it is opaque with regard to how concepts may be involved in the word recognition system and the task / decision system in this model.

Furthermore, the BIA+ model does not include clear indication regarding interlingual phonological and semantic interaction between two languages which do not share orthography. Gollan, Forster, and Frost (1997) provide evidence concerning the simultaneous activation of phonological semantic information in cognates across two languages via visual stimuli, in spite of the divergence of orthographic forms between them. Dijkstra and van Heuven (2002) acknowledge the possibility of phonological interaction, but no indication with regard to semantic interaction.

> Note that it follows logically that no "orthographically similar" word candidates can be activated across language pairs that do not share orthography at all (e.g., Chinese and English), even though effects of phonological similarity might still occur for such language pairs.
>
> (Dijkstra and van Heuven, 2002, p.183)

Indeed, what the BIA/BIA+ model revealed relative to integration of lexicon is only concerned with the limited language families (mainly those which share the same language origins; thus sharing common orthography and phonology). The issues regarding the bilingual semantic interaction will be investigated with the languages which do not share orthography in one of the empirical studies (Chapter 7).

The next two models are concerned with the issue of how concepts and semantics might relate to lexical representations in the bilingual lexicon. The following model (the revised hierarchical model) attempts to provide an account of the connection between lexical representations and conceptual representations across languages as well as the connection between L1 and L2 lexical representations in the development of the L2 lexicon. This model is based on the assumption that in general lexical representations are separated but that concepts are integrated across languages.

**The Revised Hierarchical model**

A model of the organisation of the bilingual lexicon in relation to lexical and conceptual representations was first offered by Potter, So, von Eckardt, and Feldman (1984). Potter et al. (*ibid.*) suggest that the bilingual lexicon is organised on two levels: lexical and conceptual levels. Lexical representation is independent for each language while conceptual representation is shared between languages. Furthermore, they claim that the manner of connection between these two levels is different in the bilingual lexicon according to the bilinguals' acquisition levels, proposing two models of connectivity in this context: the word association model and the concept mediation model (see Figure 11 below.)

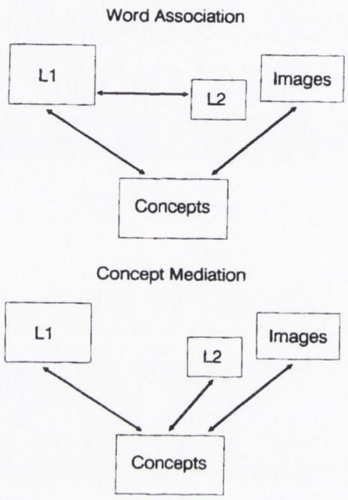


**Figure 11** Two models of cross-language connection in which second language (L2) words are associated with first language (L1) words (Word Association) or directly linked to concepts (Concept Mediation) Adapted from Potter et al. (1984) (Kroll, 1993, p.66).

Kroll (1993) suggests that learners at the early stages of L2 acquisition access the L1 lexicon in order to recognise L2 words (word association), but that as acquisition progresses, they construct a direct link between L2 lexical representations and concepts, thus understanding the meaning of L2 words without accessing the L1 lexicon (concept mediation). This approach is consistent with the conception of lexical development in L2 (Jiang, 2000; Wolter, 2001; see earlier discussion in 2.1 and 2.2), according to which learners acquire L2 morphology and phonology/orthography earlier and L2 syntax and semantics later.

The evidence for this model comes from a considerable number of studies involving picture naming and translation tasks (Potter et al., 1984; Kroll and Curley, 1988; Chen and Ho, 1986; Chen and Leung, 1989, Chen and Ng, 1989; Chen, 1990). The general principle underlying these empirical studies is as follows. The word association model predicts that subjects at this stage will translate one language (L1) to another (L2) faster than they name pictures in their L2, because there is a connecting path between L1 and L2 lexical representations, and access to L2 lexical representation from concepts (represented by images in the experiments) is always completed via the L1 lexical representation. On the other hand, the concept mediation model hypothesises that subjects at this stage name pictures and translate one language (L1) to another (L2) at approximately the same speed, because an independent route between L2 lexical representation and concepts has been established by this stage (see Figure 11 above).

On the basis of this hypothesis, Potter et al.(1984) administered picture-naming and translation tasks to fluent Chinese-English bilinguals (university students) and less fluent English-French bilinguals (secondary school students) and compared their reaction times (RTs) for each task. They found that the fluent bilinguals performed the two tasks at approximately the same speed. Therefore, they claimed that these bilinguals had already reached the concept mediation stage. However, regarding the less fluent bilinguals, they unexpectedly found that these subjects also performed the two tasks at approximately the same speed. They concluded that these bilinguals had also reached the concept mediation stage.

On the other hand, Kroll and Curley (1988) replicated Potter et al.'s (1984) study with English-German bilinguals in order to re-examine this hypothesis. They compared the RTs for picture naming and translation tasks between subjects with L2 learning experience of more than 30 months (more fluent bilinguals) and less than 30 months (less fluent bilinguals). The analysis of the RTs showed that the two groups showed different patterns of reactions for the two tasks. The less fluent bilingual group required significantly less time for translating from L1 (English) to L2 (German) than for naming pictures in the L2 (German), whereas the more fluent bilingual group required approximately the same or not less time for translating from L1 to L2 as/than for naming pictures in L2. Chen and Leung (1989) obtained a similar result with proficient Chinese-English bilinguals who had learned their L2 for more than 12 years and beginner-level Chinese-French bilinguals who had learned their L2 for approximately 2 years. Again, the beginner-level bilinguals translated L1 into L2 faster than they named pictures, while proficient bilinguals named pictures as fast as they translated L1 into L2. To sum up, both Kroll and Curley (1988) and Chen and Leung (1989) elicited evidence favouring the lexical association model and the concept mediation model. Their results indicate that lexical association was characteristic of bilinguals whose L2 learning experience was approximately less than two years duration. According to this view, the L2 proficiency of subjects in the Potter et al. (1984)'s study was too high to provide the evidence for the word association model.

Further investigation of lexical and conceptual development in bilinguals prompted a revision of the word association and the concept mediation model. Kroll (1993) reviews a series of unpublished studies (Kroll and Stewart, 1989, 1990, 1992; Roufca, 1992; Keatley, Spinks, and de Gelder, 1992; San-Chez-Casas, Davis and Garcia-Albea, 1992; cited in Kroll 1993, pp. 68-69) and claims that several studies examining two directions of translation (i.e. from L1 to L2 and from L2 to L1) have revealed asymmetry of translation patterns. According to Kroll (1993), all the studies referred to above showed a similar pattern, i.e. that translation from L2 to L1 was faster than translation from L1 to L2. Possible reasons suggested for this consistent outcome are: i) for most bilinguals, the L1 lexicon is larger than the L2 lexicon, and the L1 has a stronger link with concepts than the L2 does, and, therefore, ii) translation in the L2→L1 direction tends to be accomplished only at the lexical level, whereas translation in the L1→L2 direction involved a conceptual dimension (Kroll and Sholl, 1992; Kroll, 1993). The figure below (Figure 12) illustrates the link between L1 and L2 in relation to concepts.

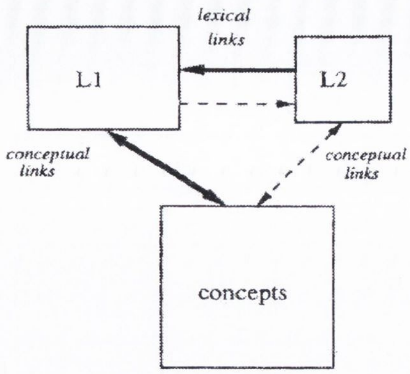


**Figure 12** A revised model of lexical and conceptual representation in bilingual memory (Kroll, 1993, p.69)

Kroll suggests that L2 students are likely to learn their L2 by relating L2 words to L1 words but seldom learn it by relating L1 words to L2 words. Kroll and Stewart (1994) comment on the first reason given above that the L1 lexicon is somewhat larger than the L2 lexicon even for the bilinguals whose L2 is relatively fluent, citing the fact that it takes more time for them to name in L2 than in L1. Kroll and Stewart's (1994) study using translation experiments in semantically categorised and randomized contexts, provided evidence of the stronger connection between L1 and concepts than the connection between L2 and concepts. Their study showed that translation from L1 to L2 required more time in the categorised context than the randomised context but the RTs relative to translation from L2 to L1 were the same for both contexts. In other words, there was semantic interference in the translation from L1 to L2, while there was no effect of semantic interference in the L2→L1 direction. Sholl, Sankaranarayanan, and Kroll (1995) also obtained evidence supporting the concept mediation hypothesis only for L1→L2 translation. They examined differences in responses between the two translation directions, L1→L2 and L2→L1, under the conditions that in each direction the translation task was or was not preceded by picture-naming tasks. They found that only translation from L1 to L2 benefited from the preceding picture-naming task; that is to say, only L1→L2 translation seemed to involve the mediation of concepts.

One question that arises from the foregoing is the following. If the L1→L2 route mediates concepts, how is L1→L2 translation accomplished by learners at the beginner's level who have no or an extremely weak link between concepts and L2? This task should be much more difficult and take considerably longer for beginner's level learners than for fluent learners to process (Kroll, 1993, p.72). In fact, a series of studies indeed showed that L1→L2 translation also required more time for bilinguals at the beginner's level than L2→L1 translation and, in addition, that the asymmetry of reactions in these two-way translation tasks was larger for subjects at the beginner's level than for subjects at the advanced level (Kroll and Stewart, 1989; Roufca, 1992; Kroll and Curley, 1988; Kroll and Sholl, 1991; all cited in Kroll, 1993, p.73). This larger asymmetry for beginner's level subjects is explained by postulating that their L1→L2 translation is also somewhat lexically based, because, even though concepts are activated via L1 word presentation there is no link or only a very weak link between concepts and L2 lexical representation (Kroll, 1993, p.74). Thus, the argument runs as follows: L1→L2 translation is extremely slow for these novice learners owing to i) the fact that the lexical link from L1 to L2 is weaker than the L2→L1 link and ii) presentation of L1 words automatically activates concepts, which, however, does not directly lead to L2 lexical representation. As a result, this concept activation just delays the required processing.

To summarise, this revised model offers a more detailed explanation than the earlier one concerning the link between L1 and L2 in relation to access to concepts in the course of the development of L2 acquisition. Kroll and Sunderman (2003) summarise the difference between the earlier model and the revised model as follows:

> This model includes the direct lexical connections of the word association model in addition to the word-to-concept connections of the concept mediation model. However, unlike the earlier model, the RHM (Revised Hierarchical Model) proposes differential weighting of the strength of the word-to-word and word-to-concept connections for L1 and L2 (p.114).

As the earlier model suggested, this revised version also predicts a development from the word association stage to the concept mediation stage. That is, the early stage of acquisition is seen as allowing the L2 to be associated with concepts via a lexical link to the L1, and as acquisition proceeds, a direct link is established from the L2 to concepts. In addition, the revised version proposes that the lexical link from L2 to L1 remains strong even after the establishment of a direct link between L2 lexical representations and concepts – so that the asymmetry of translation between L1→L2 and L2→L1 directions is also found for proficient bilinguals.

Priming studies also offer evidence which supports the RHM's claim that L1 is stronger in lexical memory than L2, and that L1 lexical representation has a stronger link with concepts than L2 lexical representation, even for proficient bilinguals. Between-language priming studies pointed to asymmetry of priming effects across languages. Evidence from a broad range of languages indicates that there are stronger semantic priming effects in lexical decision tasks when the prime is provided in L1 than when it is provided in L2 (Chinese-English: Chen and Ng, 1989; Korean-English: Jin, 1990; English-Spanish: Altarriba, 1992; Chinese-English in Experiment 1, Dutch-French in Experiment 2 and 3: Keatley, Spinks, and de Gelder, 1994; Hebrew-English: Gollan, Forster, and Frost, 1997).

Additional evidence is given by Fox (1996). Experiment 1 in Fox's (ibid.) study demonstrated larger negative priming effects when the initially presented words were in L1 than in L2. This experiment included prime and probe displays. In the prime display, where target numbers were presented in the centre and 'flankers' were presented above and below the target numbers, English-French and French-English bilinguals were asked to decide whether the target numbers were odd or even. After the prime task, probe letter strings were presented to bilinguals who were asked to decide whether the letter strings were words or non-words. Negative priming effects refer to the phenomenon whereby in the lexical decision task the probe target words (e.g. *hate* in English) are automatically affected by semantically associated flankers (*amour* in French), although it could be processed more efficiently if these flankers were ignored in the completion of the task. Fox (1996) reaches the conclusion that this asymmetry of priming effects in two directions comes from the different manner of processing in terms of cross-language lexical representations and concepts. Fox (*ibid.*, p.357) argues that translation from an L1 word into an L2 word involves conceptual link, whereas translation from an L2 word into an L1 word involves lexical link. This is supposed to be because the L1 primes are more likely to associate with concepts than L2 primes, while L2 primes are more likely to associate with L1 lexical representations.

These findings favour the claims of the RHM; however, these kinds of priming experiments have also attracted criticism. Kroll and De Groot (1997) argue that the difference in size in lexical memory between L1 and L2 may bring about the asymmetry of priming effects in both directions. They discuss this matter as follows:

> … for bilinguals who are dominant in L1 (which is most of the bilingual population), there will be more information available from a L1 prime than from a L2 prime. Taken together with the fact that, on average, a L1 target will also be recognized more rapidly than a L2 target, it makes sense to expect that L1 will be more effective as a prime but less influenced as a target. (Kroll and de Groot, 1997, p.181)

This discussion illustrates the sensitivity of experiments to particulars of experimental designs, which may have a bearing on their degree of relevance to specific theoretical models.

There are some empirical findings which have yielded patterns running counter to the RHM (e.g. La Heij, Hooglander, Kerling, and Van der Velden, 1996; Altarriba and Mathis, 1997; De Groot, Dannenburg, and Van Hell, 1994; De Groot and Poot, 1997). La Heij et al. (1996) examined the asymmetry of L1→L2 translation with undergraduate-level Dutch-English bilinguals who were relatively fluent in their L2. In La Heij et al.'s (*ibid.*) study, a series of reverse Stroop tasks were administered, in which subjects were required to translate words (colour names or non-cognate words) from one language to another which were written in the colour word related/unrelated ink, or were accompanied by word-congruent or semantically related/unrelated pictures. Throughout this variety of tasks, the outcome was consistent in showing that L2→L1 (backward) translation was interfered with by congruent/semantically related colours/pictures to almost the same extent as L1→L2 (forward) translation was. In other words, the study seemed to indicate that both forward and backward translations were equally conceptually mediated for these Dutch-English bilinguals, which is not in line with the claim of the RHM (Kroll and Stewart, 1994).

The above finding seems to be problematic for the RHM because both La Heij et al. (1996) and Kroll and Stewart (1994) deployed similar subject and language conditions (i.e. subjects were relatively proficient Dutch-English bilinguals); therefore, this different outcome cannot be due to the proficiency of participants or the nature of the two chosen languages (Kroll and Sunderman, 2003, p.115). However, Kroll and De Groot (1997) argue that this unexpected outcome for the RHM might be due to the different experimental designs focusing on different perspectives. To illustrate, the La Heij et al.'s (1996) focus is on whether there is semantic mediation in L2→L1 translation or not, and they examine the translation task by providing semantic context. On the other hand, the RHM's focus is on the entirety of the bilingual lexicon mechanism. Kroll and De Groot (1997) point out that context such as colours and pictures which are supposedly related to target words indeed affects the processing of the target words not only in L1 but also in L2. Kroll and De Groot (1997) imply that a more semantically oriented design than Kroll and Stewart's (1994) and Sholl et al.'s (1995) creates additional conditions in respect of what the RHM postulates, which is unlikely to produce what the RHM predicts.

The following studies, without providing semantic context, also showed unexpected patterns of asymmetry. De Groot et al. (1994) examined asymmetry with relatively fluent Dutch-English bilinguals, by comparing their backward translation data with De Groot's (1992) forward translation data. They took some predictor variables into consideration such as cognates/non-cognates, concreteness, context availability, definition accuracy, and familiarity. For cognates and concrete words, they observed equal reaction times in the two directions (Experiment 1) and faster reaction times for forward translation than backward translation (Experiment 2). This unexpected outcome for the RHM was explained by De Groot et al. (1994) as follows. For cognate words such as *huis* and *house*, a direct link between lexical representations across languages tends to remain after learners have passed the initial stage of acquisition in L2, and even L1 lexical representation can directly access L2 lexical representation without mediating concepts.

Another problematic finding for the RHM, provided by De Groot and Poot (1997), indicates a similar pattern as in La Heij et al.'s (1996) findings. De Groot and Poot's (ibid.) study showed no statistically significant asymmetry between forward and backward translation for Dutch-English bilinguals who were approximately equally proficient as those in La Heij et al.'s study (undergraduate level), despite the fact that this study did not provide any semantic context.

Kroll and De Groot (1997) discuss that these inconsistent outcomes are problematic because the same conditions are shared among these studies of Kroll and Stewart (1994), De Groot et al. (1994), La Heij et al.'s (1996), and De Groot and Poot (1997), in that the discussed languages are Dutch (L1) and English (L2) and subjects are at university undergraduate level with relatively high levels of L2 proficiency. Kroll and De Groot (1997) argue that further investigation of the relations between these variables is required.

De Groot and Poot (1997) further examined concept mediation in forward/backward translation by observing the size of concreteness effect for each translation direction. The design of this study included three variances: imageability (concreteness), frequency, and cognate status. There is considerable evidence that concrete words are processed faster than abstract words (e.g. De Groot, 1992, De Groot et al., 1994). De Groot and her colleagues argue that this occurs because concepts of concrete words are more likely to be shared between languages than abstract words (see the next section, the distributed feature model, for detailed explanation). On the basis of this view, De Groot and Poot (ibid.) postulated that concept should be more mediated when bilinguals process concrete words than abstract words. Thus, they set up the hypothesis that as the RHM predicts, if concept mediation occurs more in forward translation than in backward translation, more imageability (concreteness) effect is expected for forward translation than for backward translation. However, in their study, translation in both directions demonstrated considerable imageability (concreteness) effects for both cognates and non-cognates. De Groot and Poot (ibid.) claim that this result indicates that concepts are also mediated in backward translation.

On the basis of such a result, De Groot and Poot (1997) concluded that it is not a question of whether concepts are mediated or not in forward and backward translation, but rather which part of the process is difficult in each direction. De Groot and Poot (ibid.) suggest that both directions of the translation process mediate concepts, and the translation asymmetry is caused by the difficulty of either phase related to L2 processing. It is broadly accepted that it is in general more difficult to deal with L2 than L1 even for proficient bilinguals (Kroll, Michael, Tokowicz, and Dufour, 2002). Therefore, the central difficulty is likely to be concerned with L2 processing. Hence, in forward translation one may find difficulty in word retrieval: i.e. lexicalisation, selection of L2 words, and L2 word production (phonological articulation); whereas in backward translation one may find difficulty in concept activation via L2 visual presentation. The following figure illustrates this view.

**Forward translation**

L1 visual stimulus → concept activation → lexicalisation → selection of an L2 word → L2 word production (phonological articulation)

**Backward translation**:

L2 visual stimulus → concept activation → lexicalisation → selection of an L1 word → L1 word production

**Figure 13** The processes of forward and backward translation

Word retrieval problems in forward translation tend to create phonological errors or response failures. On the other hand, concept activation problems in backward translation tend to produce semantic errors (La Heij et al., 1996, p.662). In fact, this proposal is supported by De Groot and her colleagues' findings which identified more omissions in forward translation and more errors in backward translation (DeGroot et al., 1994; De Groot and Poot, 1997).

Therefore, if the RTs for forward translation are slower than for backward translation, it may mean that L2 word retrieval in forward translation is more problematic than concept activation with L2 stimuli in backward translation. Furthermore, De Groot and Poot's (1997) finding that proficient bilinguals performed both directions of the translation tasks with equal speed might reflect the fact that their L2 word retrieval was equally as difficult as concept activation in respect of L2 stimuli. On the other hand, the finding that less proficient bilinguals produced slower responses for backward translation might mean that concept activation via L2 presentation was more difficult than L2 word retrieval.

A more recent study provides additional evidence of conceptual mediation in both forward and backward translations even at the early stage of L2 acquisition (Duyck and Brysbaert, 2004). Duyck and Brysbaert (2004) administered number-word translation tasks with Dutch-French bilinguals in order to examine the RHM's hypothesis. The concept of a number refers to magnitude in a continuum orderly arranged from small to large. It is said that the magnitude information of smaller number words (e.g. two) is activated faster than that of larger number words (e.g. eight), which is called the magnitude effect. Duyck and Brysbaert (ibid.) claim that the magnitude effect indicates semantic involvement, since it is not likely that magnitude information is stored at the lexical level. Thus, they postulated that if the RHM is correct, magnitude effect should be observed in forward translation; that is, it should take more time for bilinguals to translate larger L1 number words (e.g. *acht* [eight]) into L2 (e.g. *huit*) than smaller L1 number words (e.g. *twee* [two]) into L2 (e.g. *deux*), but not in backward translation. Results of their study consistently demonstrated magnitude effects in both directions, even in different conditions (random / blocked language presentations) and for different proficiency levels (balanced / unbalanced bilinguals, and novice L2 learners). Such results seem to indicate that concept is mediated in both forward and backward translations, at least for number words, which cannot be accounted for by the RHM.

It appears that discussion still continues concerning the question of whether the backward translation process is conceptually mediated or not. Several experimental studies revealed the current limits in understanding in relation to translation tasks and factors related to the RHM which remain unclear. Heredia and his colleagues argue the limitations of the RHM, taking the case of the language translation reversal where the bilingual's L1 turns into the L2 (Heredia, 2008; Heredia and Brown, 2004). Heredia and Brown (2004, p.238) discuss as follows:

> At the present time, the RHM does not allow for the possibility that effects of translation direction and strength of word translations, and some extent priming, are not fixed characteristics in bilingualism. . . . [B]ilingual memory representation is not a static representational system but a dynamic system that can be influenced by language usage.

Duyck and Brysbaert (2004, p.902) also argue the inflexibleness of the RHM, suggesting different patterns of conceptual involvement in translation process depending on word types including number words, abstract words and syntactic function words.

In spite of such limitations, the RHM is important in that it prompted a number of researchers to investigate the structure and development of the bilingual memory system in relation to conceptual memory by means of translation tasks. This is how this model has a different approach to the bilingual lexicon studies from the previously introduced BIA model, which focuses on lexical processing in relation to bilingual lexical representations. Kroll and Dussias (2004) summarise these two models as follows:

> An alternative way to understand these different claims about lexical activation is to consider that the RHM may be more likely to capture the processes engaged in production tasks that require the top-down lexicalization of concepts to words, whereas the BIA model may better account for the bottom-up aspects of processing during the earliest stages of word recognition (p.178).

Finally, a query relative to the concepts-semantics distinction should be dealt with at the end of the discussion in this section. De Groot (2002, p.47) regards the RHM as a three-component model (i.e. two separated lexical representations but one shared concept for two languages), and points out that the notion of conceptual representation and semantic representation is confounded in this model, supporting Paradis (1995, 1997) and Pavlenko (1999). Paradis (1995, 1997) argues that concept should be distinguished from semantic representation. He illustrates the relationship between semantic and conceptual representations as follows:

> The three-store hypothesis (Paradis, 1978, 1980, 1985) considers word meanings as well as word form (phonological form and syntactic properties)

> to be part of the *lexical* representation, along with a third, conceptual level of representation, independent of language and, hence, of languages. Two lexicons are postulated, one for each language, as well as a single separate conceptual store, irrespective of the number of languages. (1997, p.335)

For Paradis, concepts may be shared for both or multiple lexicons and semantic representations from each lexicon refer to the relevant information in concepts. Therefore, semantic representations might be different for translation equivalents, depending on how much conceptual information they have in common.
Pavlenko (1999) also offers the definitions of semantic representation and conceptual representation. According to her, semantic representation refers to "explicitly available information which relates the word to other words, idioms and conventionalised expressions in the language" (Pavlenko, 1999, p.212). On the other hand, conceptual representation might be defined as "non-linguistic multimodal information, which includes imagery, schemas, motor programs, and auditory, tactile and somatosensory representations, based on experiential world knowledge" (Pavlenko, ibid., p.212). It appears that Pavlenko's view of conceptual and semantic representations agrees with Paradis' in that semantic representation is regarded as functioning within a language system, while conceptual representation functions apart from a language system. Both Paradis and Pavlenko cite aphasic cases which might prove their claim of concepts being different from semantic representation – that is, semantics (word meaning) is affected by aphasia but concepts are not. Aphasic patients can retain their conceptual processing ability even after their linguistic system has been severely impaired (Paradis, 1997, p.337). For Paradis, this provides evidence favouring his standpoint that concepts are independent of the lexicons (form and semantics). Pavlenko introduces some aphasic cases where aphasic patients can perform categorisation of word objects appropriately (e.g. being able to identify the difference between 'mug' and 'cup'), but are unable to process words (e.g. naming words) (Pavlenko, 1999, p.211).

Indeed, if one takes this point into consideration, the RHM's claim of the direct lexical link across languages in backward translation seems to be problematic. The 'direct lexical link' cannot explain the concreteness effects for non-cognate words in backward translation obtained in De Groot and Poot's (1997) study, when we assume that concrete non-cognates do not share common lexical *forms* (phonology or orthography) but may share similar *meanings*. As Green (1998, p.73) claims, a direct link between L1 and L2 is likely to involve a connection between L1 and L2 lemmas as well as a connection between L1 and L2 forms. Thus, the RHM's notion of 'independent lexical forms for each language and shared concepts between languages' may well be reconsidered as follows. Each lexicon includes lexical and semantic representations apart from concepts. The lexical and semantic representations might be independent for each language and concepts may be shared between languages.

This discussion here proceeds to focus more on the semantic aspects in lexical processing of bilinguals. In the earlier discussion, it was pointed out that word types such as cognates/non-cognates and concrete/abstract words *per se* affect the processing of conceptual mediation in relation to cross-language lexical representations. It was also found that this effect was influenced by proficiency levels. The focus of the discussion in the next section is concerned with semantic attributes in terms of the development of the L2 lexicon in the bilingual memory system.

**<u>The distributed feature model</u>**

It was mentioned earlier that the Hierarchical model is based on the assumption that the lexical representations of L1 and L2 are independent between languages but semantic representations are shared through common conceptual memory (Kroll, 1993, p.54). Such a view is also supported by neuropsychological research in that the same cortical regions are activated for semantic processing in L1 and L2, even when L2 learning starts after the age of 10 (Illes, et al., 1999). Such evidence of semantic integration across languages, however, is mostly limited to the case of picture objects and their names (Kroll and Sunderman, 2003; Kroll and Dussias, 2004). It appears that a study of this issue has to include other word types such as abstract words as well as concrete words in order to pursue a broad view of lexical and semantic representations between languages. In fact, the different manner of processing between concrete words and abstract words has long been a focus of discussion in within-language studies. Paivio (1971) offers a definition of concreteness in relation to the sensory system as follows:

> Concreteness is formally defined in terms of directness of sensory reference and, for present purposes, this can be taken to mean a dimension extending from highly abstract words (e.g., truth), to concrete words (e.g., house), to pictures and objects, in increasing order of concreteness.
>
> (Paivio, 1971, p.59)

Thus, the concreteness effects were initially considered to be involved in the access to an imaginal code (Paivio, 1971, 1986). The dual-coding model (Paivio, 1971, 1986) claims that while abstract words are only available in the verbal (linguistic) system for memory retention and processing, concrete words are available also in the imaginal system as well as the verbal system. Therefore, concrete words can be represented in pictures or objects as well as in languages, which, for Paivio, makes the concreteness effects possible. A number of studies using free recall tasks (Paivio and Csapo, 1973) as well as picture naming and word naming tasks (Potter et al, 1984; Kroll and Curley, 1988; Chen and Leung, 1989) suggest an advantage for picture processing in comparison with word processing. It may be that the availability of imaginal codes for concrete words eases processing, if there are indeed imaginal and verbal codes as Paivio claims.

In contrast, Schwanenflugel and Shoben (1983) suggested that the advantages presented by concrete words in processing are due to the availability of context rather than the availability of imaginal codes. Their study found that abstract words/sentences required longer RTs for processing than concrete words/sentences did; however, the concreteness effects were not observed under the condition where context was provided. This view assumes that such different results derive from the strength of association in the conceptual network and the magnitude of concept activation. Schwanenflugel and Shoben (ibid.) argue that abstract words tend to have weaker association with corresponding concepts than concrete words, and that this implies the necessity of a greater magnitude of concept activation in order for the necessary information to be retrieved, which consequently leads to slower RTs for processing. However, when context is provided, it may help abstract words to associate strongly with relevant concepts in a comparable manner to concrete words – with the result that accessing abstract words may become as fast as accessing concrete words. This would suggest that concept activation in respect of abstract words is sensitive to the context that is provided. Although what causes concreteness effects is not yet entirely clear, it is possible that lexical access with respect to abstract words involves different processing than lexical access in the case of concrete words.

Recent neuropsychological studies suggest that the conceptual representations of concrete and abstract words are structurally different (Crutch and Warrington, 2005, 2007). Crutch and Warrington (2005) conducted a spoken word-written word matching task with a patient with a refractory access disorder, A.Z. In this test, A.Z. was presented with sets of four semantically similar concrete/abstract words (e.g. concrete words: goose, pigeon, crow, sparrow; abstract words: deceit, trick, steal, cheat) and sets of four semantically associated concrete/abstract words (e.g. concrete words: farm, cow, tractor, barn; abstract words: exercise, healthy, fitness, jogging). Then, she was asked to point to the target written word identical to each spoken stimulus item. The result demonstrated that concrete words were more likely to be affected by semantic similarity (category) than abstract words, and abstract words tended to be more influenced by semantic association than concrete words. This result seems to indicate that conceptual representation of concrete words is likely to be organised on the basis of a categorical network, whereas that of abstract words tends to be organised on the basis of an associative network.

The notion of different mechanisms of processing for concrete words and abstract words also offers a suggestion with respect to cross-language lexical access relative to concrete and abstract words. That is, presentation of abstract words in one language would be less likely to activate the concept of corresponding words in another language available to a bilingual than concept activation of concrete words. This may be because the translation equivalents of abstract words are less likely to share the same concepts across languages than those of concrete words. A number of studies have attempted to investigate interlingual concreteness effects, using word association (Taylor, 1976; Opoku, 1985) and translation recognition and translation production (e.g. Jin, 1990; De Groot, 1992; De Groot, Dannenburg, and Van Hell, 1994; De Groot and Poot, 1997).

On the basis of the foregoing, De Groot and her colleagues (De Groot, 1992, 1993; De Groot et al., 1994) proposed the distributed feature model to describe the different features in bilinguals' distribution of conceptual representations depending on the word types. This suggests the possibility of incomplete integration of conceptual representations between two languages; that is, it implies that word type may determine to what degree the concepts between two languages are shared. This view originates from Weinreich's (1953) model of bilingualism, which proposes three systems of bilingual memory representation: i.e. subordinate, compound, and coordinate. The subordinate system corresponds to the *word association* model, whereas the compound system corresponds to the *concept mediation* model (Potter, et al., 1984; Kroll, 1993; refer to the RHM in the previous section for a detailed account). Thus, in the subordinate system, a direct connection between L1 and L2 lexical representations is posited whenever an L2 word is recognised and produced, since the L2 lexicon is seen as parasitic on L1 semantics. On the other hand, with regard to the compound system, it is proposed that a direct route from L2 lexical representations to conceptual representations becomes available as acquisition proceeds, and that in these circumstances an L2 word is recognised and produced without depending on L1 semantics. It has to be noted that the latter system is in conformity with the view of concept mediation insofar as L1 and L2 lexical representations are viewed as having access to the same concepts: i.e. the concepts are seen as shared between L1 and L2 lexicon. Concerning Weinreich's notion of the co-ordinate system, where separate sets of lexical representations and meanings are postulated for each language known, De Groot (1993) suggests that such a system can be found in bilinguals who have acquired lexis for each language in distinct environments and have specific concepts attached to each lexical representation. However, according to De Groot, compound and coordinate systems do not necessarily refer to independent acquisition levels where individual bilinguals are strictly identified as belonging to either compound or coordinate system. Rather, she sees these systems as being able to coexist in a single bilingual memory system. She admits the possibility of a "mixed structure" (p.46) ranging from "purely compound to purely coordinate" (ibid.). De Groot (2002, p.45) explains that "the different versions of the three-component model [the different versions of the hierarchical model: i.e. subordinate, compound, and co-ordinate systems] should not be viewed as qualitatively different from one another, but merely as functionally different." De Groot emphasises that the operative system is determined by the nature of the word in question. Thus, concrete words and cognates tend to share the concept between bilingual semantic representations and constitute a compound system, while abstract words and non-cognates are unlikely to share the concepts between languages and constitute a co-ordinate system. Cognates can be defined in terms of the sharing of orthography and phonology (DeGroot et al., 1994, p.606) or simply phonology (Gollan, Forster, and Frost, 1997) and in terms of sharing the same or similar concepts. As far as concrete words are concerned, concepts of concrete words are more likely to be shared between languages than those of abstract words. This may be because abstract concepts tend to be strongly involved in the individual languages' cultural background. The difference of conceptual distribution in bilingual memory between concrete and abstract words can be depicted as the following figure illustrates.

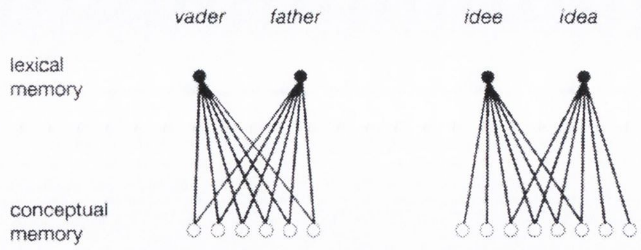


**Figure 14** Decompositional conceptual representations in bilingual memory (DeGroot, 1993)

The concrete translation equivalents such as *vader* (Dutch) and *father* (English) seem to represent similar concepts across languages, whereas abstract translation equivalents such as *idée* (Dutch) and *idea* (English) may share only some parts of conceptual representation mapping across languages. As was mentioned above, for such abstract concepts, one has to acquire the concepts which are unique to the L2 in order to arrive at a co-ordinate system. De Groot (1993) suggests that this is possible when the learners acquire their languages in language-specific contexts. To summarise, De Groot suggests that the subordinate, compound and co-ordinate systems represent three possibilities for lexical-semantic organisation and that the most proficient bilinguals may manipulate compound and coordinate systems depending on word-types.

The view of different conceptual distribution according to word type was initially examined in several classic studies of word association tasks, which, in general, showed that subjects produced more translation equivalent words for cognates and concrete words than for non-cognates and abstract words (Taylor, 1976; Opoku, 1985). More recent studies revealed effects for concrete and cognate words using on-line experiments such as translation and semantic priming tasks (Jin, 1990; De Groot, 1992; De Groot and Keijzer, 2000; De Groot and Nas, 1991; De Groot et al., 1994; De Groot and Poot, 1997; Gollan et al., 1997). In general, bilinguals exhibited faster RTs for cognates and concrete words than for non-cognates and abstract words.

For example, Jin (1990) used the between-/within-language priming paradigm with Korean-English bilinguals to examine the effect of concrete/abstract word types in processing. In the first experiment, participants performed a between-language lexical decision task, in which prime-target stimuli were manipulated in terms of translation equivalents, semantic association, and unrelated pairs. Results were as follows. For the concrete stimuli, significant priming effects were found for both translation equivalents and semantic association pairs (i.e. the RTs for these pairs were much faster than for unrelated stimuli), while for the abstract stimuli, priming was significant only for translation pairs. Comparison of the priming effects between concrete words and abstract words also yielded the result that the priming effects for both translation and semantic association pairs were significantly larger for concrete words than for abstract words. On the contrary, the results of the second experiment, which included a within-language (English) priming task, demonstrated that significant semantic priming effects were obtained for both concrete and abstract words. This different outcome between intralingual and interlingual conditions clearly implied that abstract translation equivalent pairs by nature may refer to different conceptual representations between languages, while concrete words tend to share the common concepts across languages. To summarise, Jin's (1990) finding is in line with the distributed feature model in that it supports the view that concepts are likely to be shared between languages for concrete words while concepts for abstract words may be language specific.

Interestingly, a study involving languages with different orthographic systems offers evidence of cognate effects (Gollan, Forster and Frost, 1997; Hoshino and Kroll, 2008). Gollan et al.'s (1997) translation priming study, involving Hebrew-English bilinguals, obtained more enhanced priming effects for cognates than for non-cognates when the prime was presented in L1 rather than in L2. Hoshino and Kroll (2008) also observed a facilitation effect for cognates as compared with non-cognates in their picture naming study with Japanese-English bilinguals. These studies shed light on the processing mechanism for cognates and non-cognates where orthographically different languages are in question.

The fundamental features of this model are in line with the generally accepted view of L2 lexical development, which posits that the link between the L2 and concepts is weak at the early stage of L2 acquisition, but that as acquisition progresses, stronger links between the L2 and concepts are gradually constructed (Jiang, 2000; Potter et al, 1984; Kroll and Stewart, 1994). This amounts to a claim that proficient bilinguals develop sensitivity to similarity/difference of conceptual mapping between languages, because these bilinguals no longer need to depend on their L1 semantics. Aitchison (1994) proposes an account of the concept building process in first language acquisition, suggesting that the process may include three stages-labelling, packaging and network building. Although this model is proposed to account for first language acquisition, the process in question might also occur in second language concept building. This may help us understand the development process of the three systems that the distributed feature model suggests.

Labelling seems to correspond to the subordinate system, where L2 words are recognised via L1 semantic representations. L2 adolescent or adult learners whose L1 concepts are already established may find it more efficient to access L1 semantics in order to identify an L2 word than to create a new concept for the new L2 word. Thus, in this stage, L2 words may function as merely labels. The next stage, packaging, may work similarly to the compound system. In this stage, learners' L2 semantics may be established but there is a tendency for L2 semantics to be assimilated to existing L1 semantics. Thus, the semantic representations of the bilingual lexicon may be shared in conceptual memory, and subtle semantic differences between non-cognates and abstract words may not be identified. This phenomenon may be regarded as 'overextension' as Aitchison (ibid., p.173) suggests: in this case, the overextension of L1 semantics to L2 semantics. Finally, the network-building stage may also occur in L2 lexical development. L2 unique concepts, as in non-cognates and abstract words, are installed into the L2 semantic network, separate from the almost 'equivalent' L1 semantic representations. In this way, an L2 semantic network may be elaborated, as envisaged in the co-ordinate system, while semantic representations corresponding to concepts which overlap across languages (as in the case of cognates and concrete words) may remain in the same semantic package as L1 representations. This L2 network building seems to involve a high degree of cognitive activity as FL (foreign language) learners often struggle to harmonize newly encountered meanings with their existing concepts, and the process may be influenced by the context in which exposure to the languages takes place. Kroll and Tokowicz (2001) point to the lexicalisation problem that the adult L2 learners are likely to face:

> An important feature of L2 vocabulary acquisition for adult learners is that new words must be linked to old concepts. If the skill of lexicalizing concepts to L1 words is highly practiced, as it surely is for adult L2 learners, then the problem of acquiring new L2 vocabulary is not simply a matter of adding new information to memory and linking it appropriately, but also a matter of negotiating the increased ambiguity and competition that the inclusion of the new L2 information represents. The problem is likely to be most acute for second language learners whose experience is limited to the classroom (p. 63).

Completion of the coordinate system in L2 lexical development may be affected by factors such as word type, cultural background, age of onset of exposure, language acquisition environment (classroom setting or context where the language in question is spoken), teaching methods, and duration of contact with the L2.

In sum, De Groot and her colleagues argue that, depending on word type, the degree of conceptual overlap may vary. They propose that concepts for cognates/concrete words may be highly overlapping, while concepts for non-cognates/abstract words may overlap to a much lesser extent. Thus, the focus of their discussion is not whether the components of the bilingual lexicon are completely integrated or separated. Kroll and Sunderman (2003, p.111) make the point as follows:

> Recent developments in the realm of conceptual modelling have enabled a view of semantic representation that is graded so that concepts are not simply the same or different but differentiated in the degree to which they share types of semantic features.

Cook (2002, p.12) also comments on this integration/separation matter:

> Clearly neither total separation nor total integration can be completely true. Total separation is belied by the use of the same mouth and ears for both languages; total integration is denied by the L2 user's ability to keep to one language at a time.

Cook talks about *interconnection*, a state somewhere between total separation and total integration, and notes that the relationship between lexical and semantic representations and the ways in which they are processed in the two languages seems to be complex and to vary from case to case. The claim is again that the most proficient bilinguals are able to differentiate and manipulate the language specific concepts of non-cognates, and abstract words, whose conceptual representations are less likely to overlap across two languages.

The distributed feature model is criticised for the fact that it still remains opaque with regard to how the degree of conceptual overlap between the components of the bilingual lexicon might be identified. In other words, it is not clear whether this is determined by the number of features which overlap, or whether it is determined by the overlap of particular features and, if so, what particular features may be considered to determine the criteria of overlap. Kroll and De Groot (1997) argue as follows:

> It is unclear as to whether the conceptual features represent units whose joint activation determines conceptual overlap in a purely quantitative sense or

> whether, within the conceptual representation, there are differences in the weights assigned to particular features and corresponding assumptions made about the degree of intercorrelation between features (p.189).

Kroll and Dussias (2004, p.175) also query the same points; however, this problem still seems to remain unresolved. The question may be related to the fundamental issue of how the overlap of conceptual features is to be defined – whether by the number of common definitions or the number of shared contexts.

Furthermore, Kroll and Dussias (2004) raise the question of whether ease of conceptual processing between languages is purely related to the *inter*language issue. They imply that better performance for concrete words than for abstract words in bilingual semantic priming tasks or translation production tasks may be connected with an inherent ease of processing associated with concrete words as compared with abstract words. Evidence for such a position comes from *intra*lingual studies yielding concreteness effects (Paivio, 1971, 1986; Schwanenflugel and Shoben, 1983). Kroll and Tokowicz (2001; Tokowicz and Kroll, 2007) support this position and argue as follows:

> That is, it may not be necessary to assume differential (conceptual) overlap among translation equivalents, because any factor that slows conceptual access in general will also slow bilingual translation to the extent that conceptual access is a component of the task.
>
> (Tokowicz and Kroll, 2007 p.730)

On the basis of the context availability view (e.g. Schwanenflugel and Shoben, 1983), Tokowicz and Kroll (2007) assume that concrete words are strongly associated to few nodes while abstract words are weakly associated to many nodes in the conceptual network. For them, this inherent difference in conceptual organisation between concrete and abstract words applies also in the bilingual context. They claim that abstract words are, by nature, more likely to correspond to multiple translation equivalents in other languages than concrete words.

Presentation of abstract stimuli in one language activates multiple translation equivalents in another language, and the competition of multiple translation equivalents inhibits inappropriate responses, which eventually leads to the production of the most appropriate response. For them, the tendency of abstract words to activate more candidates may delay processing, while the fewer number of candidates activated by concrete stimulus words may ease processing.

Based on this notion, Kroll and Tokowicz (ibid.) hypothesised that concreteness effects are due to the activation of multiple translation equivalents for the abstract word stimuli, rather than due to the accessibility of the different conceptual constitution for abstract words between languages (e.g. De Groot, 1992, 1993; De Groot et al. 1994). Tokowicz and Kroll (2007) examined this hypothesis by comparing concreteness effects for words with single/multiple translation equivalents in monolingual/bilingual contexts. The result of their translation production study with English-Spanish bilinguals in Experiment 1 yielded no concreteness effects for concrete/abstract words which had single translation equivalents. Experiment 2 compared the translation latencies of concrete/abstract words with single and multiple translation equivalents. The result showed significant interaction between concreteness and number of translations for RTs. Concrete words were not affected by number of translations whereas abstract words with single translations were translated significantly faster than those with multiple translations. Furthermore, the comparison of words with single translations exhibited reverse concreteness effect; that is, concrete words were translated more *slowly* than abstract words. In Experiment 3, a similar pattern of interaction was observed with English monolinguals in a lexical decision task. Such results led Tokowicz and Kroll to conclude that the concreteness effect is not a phenomenon specific to cross-linguistic processing, but that of general language processing; in other words, it is not attributed to greater conceptual overlap for concrete words between languages.

By providing evidence that number of translations affects translation performance relating to concreteness, Kroll and Tokowicz offer another interpretation of cross-language concreteness effects. It seems that this interpretation is not incompatible with conventional understanding of the concreteness effect. For concrete words, there is greater semantic overlap between translation equivalents and activation of the concepts of the words in question is likely to specify the particular semantics of translation equivalents. This may be how concrete words are likely to be strongly associated to few nodes of translation equivalents. In contrast, abstract words tend to have less degree of semantic overlap between translation equivalents, which may result in weaker association to multiple nodes of translation equivalents. Less number of translations would surely ease processing in comparison with the case of more number of translations. It appears that further investigation is required to understand the mechanism of between-language concreteness effects.

Although the basic claim regarding the distinction of compound and coordinate systems appears to be plausible, the distributed feature model has weakness relating to the unclear notion of conceptual overlap between components of the bilingual lexicon. However, Heredia and Brown (2004) discuss this problem as follows:

> In general, the distributed model does an excellent job of describing why certain concepts are similar or different across languages, though, as a general bilingual model, it is limited because it is unable to generate specific testable hypotheses. At least, it is not clear how we can objectively operationalize "degree of word overlap" (p. 241-2).

It may be more appropriate to assume that this model allows for varying degrees of overlap in conceptual memory across languages depending on word types involved, rather than that it envisages the universal model that may apply to all cases of bilingual memory. Thus, it seems that, in order to outline the bilingual systems with regard to the different degree of overlap, De Groot (1993) uses examples of general difference between concrete and abstract words, and between cognates and non-cognates. A similar pattern of the conceptual overlap across languages is reported relative to grammatical class by Van Hell and De Groot (1998). Their experiment using an on-line between-language association task elicited the results of more and faster translation responses for nouns than for verbs, which indicated that concepts of nouns may be more likely to overlap between languages than those of verbs.

As was mentioned earlier, this 'degree of overlap' issue appears to be involved in various elements such as word type, word origins, cultural distance between languages, age factor, exposure to the languages, and language acquisition environment, etc. Therefore, it may be possible to say that each case is different in terms of conceptual overlap between languages. The following example of concrete words concerns less conceptual overlap between languages, which may reflect the diversity of cultural backgrounds associated with languages. The English word *altar* is usually associated with Christianity. However, the Japanese translation equivalent words *saidan* and *butsudan* are, in general, associated respectively with a Shintoist altar and a Buddhist altar, rather than a Christian altar.

It appears that studies of semantic similarity and difference between languages have tended to focus on single words in two languages. It may be worth while investigating the semantic organisation of the bilingual lexicon in terms of the inter-lexical connections. Issues concerning inter-lexical connections will be discussed in Chapter 3.

Lastly, it has to be noted that for the amount of attention paid to the investigation of the bilingual system, very few experimental studies have dealt with bilinguals' languages in different writing systems (e.g. Gollan, Forster, and Frost, 1997; Hoshino and Kroll, 2008; Potter et al., 1984). Thus, the empirical studies in this thesis will deal with languages with different writing systems. Some complexities concerning the diversity of writing systems and its effects on bilinguals' lexical processing are discussed later in 2.4.

In the next section, representation and processing in the bilingual lexicon will be re-examined, taking all three models discussed so far into consideration.

**2.3.2 Is the bilingual lexicon integrated or separated, and is its access selective or non-selective?**

The previous section introduced three models concerned with representation and processing in the bilingual lexicon. It is often argued that the issue of lexical representation should not be confounded with that of lexical processing (Grosjean, 1998; Pavlenko, 1999). The BIA/BIA+ model (Van Heuven et al., 1998; Dijkstra and Van Heuven, 2002) was proposed in relation to receptive processing in the bilingual lexicon. Postulating that the lexical access of bilinguals may be non-selective, Van Heuven and colleagues observed the facilitation and inhibition mechanisms affecting interlingual homographs and interlingual neighbours in lexical decision tasks. On the other hand, the focus of discussion revolving around the RHM (Kroll and Stewart, 1994) and the distributed feature model (De Groot, 1993) is concerned with lexical and conceptual representation. The RHM postulates that the bilingual lexicon may be integrated at the conceptual level while being separated at the lexical level. In contrast, the distributed feature model suggests that the extent to which concepts are shared between two languages may vary depending on word type (e.g. in respect of such attributes as concreteness and cognate status). In this section, two issues regarding representation and processing in the bilingual lexicon will be considered in a more extensive manner.

**<u>Representation: the issue of integration and separation</u>**

There has been active discussion of integration and separation in the bilingual mental lexicon for five decades, since Weinreich (1953) presented his separation view (Pavlenko, 1999). The discussion frequently homes in on different levels of representations in relation to the bilingual lexicon – notably the lexical and semantic levels. Conceptual representation is here regarded as being outside the lexicon; therefore, in spite of Kroll and Stewart's (1994) claim with respect to the RHM, concepts are not taken into account in the present discussion of integration/separation in the bilingual lexicon (see the discussion of the RHM). The integration perspective includes a lexical dimension:

- Activation of non-target language due to the form similarity (Van Heuven, Dijkstra, and Grainger, 1998).

It also refers to the semantic level:

- Concreteness effects in lexical decision tasks (Jin, 1990) and in translation productions (De Groot, 1992; De Groot, et al., 1994; De Groot and Poot, 1997; De Groot and Keijzer, 2000);
- Activation of the same cortical regions for semantic processing across languages (Illes, et al., 1999).

It also takes account of evidence relating to both the semantic and the lexical level:

- Cognate effects in lexical decision tasks (De Groot and Nas, 1991) and in translation production (De Groot, 1992; De Groot, et al., 1994; De Groot and Poot, 1997; De Groot and Keijzer, 2000);
- Activation of the same areas in the cerebral cortex for lexical and semantic processing between languages (Franceschini, Zappatore, and Nitsch, 2003).

Cook (1992) cites a broad array of examples in favour of the notion of an integrated bi/multilingual lexicon in the context of making a case for a comprehensive linguistic mechanism which he labels "holistic multicompetence," and claims extremely strong connectivity between L1 and L2 lexicons. Yet, there is a range of evidence that supports the standpoint of separation. The separation view also refers to both the lexical and the semantic level.

At the lexical level one can cite:

- Slower RTs for non-cognates than for cognates in lexical decision (De Gr oot and Nas, 1991) and translation performance (De Groot, 1992; De Groot, et al., 1994; De Groot and Poot, 1997; De Groot and Keijzer, 2000);

At the semantic level:

- Slower RTs for abstract words than for concrete words in lexical decision (Jin, 1990) and translation performance (De Groot, 1992; De Groot, et al., 1994; De Groot and Poot, 1997; De Groot and Keijzer, 2000).

Evidence for separation at the lexical and semantic levels is also offered by an aphasic study.

- Paradis, Goldblum and Abidi (1982) offer evidence of language selectivity regarding an aphasic patient's case of alternate antagonism (i.e. one of the bilingual's languages is available one day for spontaneous speaking; however, on the next day the same language becomes unavailable and instead the other language is available for spontaneous production). An Arabic-French patient, A. D. became aphasic after she had a moped accident. A few weeks after the accident, she first recovered some Arabic words. Two weeks later, she was able to speak her L1, Arabic, fluently, but the following day her Arabic fluency regressed and instead she was able to speak her L2, French, fluently. She demonstrated further language selectivity in terms of her translation ability. She was able to translate into the language with which she had a problem in terms of spontaneous production, while she was unable to translate into the language which she could speak spontaneously.

Thus, the controversial issue of the bilingual lexicon has been discussed at both the lexical and the semantic level. However, discussion concerning this issue tends to neglect the syntactic level of integration/separation in the bilingual lexicon.

It is widely believed that the lexicon consists of lexemes and lemmas, the latter of which includes semantics and syntax (Levelt, 1989, 1993; Jiang, 2000; de Bot, Paribakht, and Wesche, 1997). Broad syntactic integration may be assumed from the Chomskyan viewpoint (Cook and Newson, 1996). On the other hand, syntactic separation may be argued for by those who claim that L2-specific syntactic information, as well as semantic information, has to be installed into the L2 lexicon distinct from L1 syntax, as Jiang (2000) suggests. The following two examples indicate a difference of grammatical functions between translation equivalents in English and Japanese. The English word *discuss* is a transitive verb; in contrast, the translation equivalent in Japanese *giron-suru* is an intransitive verb and requires a preposition *ni tsuite* when an object is indicated. The next example concerns relative pronouns. The English language sometimes takes relative pronouns such as *which*, *who*, and *that* in relative clauses, while the Japanese language does not have such pronouns. The examples below illustrate this.

This is the photo ***that*** *I took*.
Kore wa *watashi ga totta* shashin desu.
[This *I* *took* the photo is.]
*Relative clauses are indicated in *Italics*.

Evidence from neurobiological studies may also favour the separation view of syntactic representations across languages. According to Franceschini, Zappatore, and Nitsch (2003), different cortical areas are activated for processing which involves syntactic representations (e.g. sentence and story comprehension) in respect of languages whose acquisition levels are not equal. In summary, the issue of integration/separation also relates to the syntactic property of the bilingual lexicon.

This integration-separation dispute may also be related to language-non-selectivity and language-selectivity in the context of processing. For example, in general, it seems that bilinguals can usually control which language to use in communication, and this may be seen as evidence of separated lexicons. Singleton (2003a, p.168) notes an extreme case of this phenomenon as follows:

> …where the expectation is that language *x* is being spoken but where, in fact, it turns out that language *y* is being used, comprehension may actually be blocked, even where both languages are familiar to the individual in question…

With regard to speech errors, it may be argued that non-selectivity such as accidental production of words from the inappropriate language reflects integrated lexicons. However, the fact that occurrences of such cases are quite rare (Poulisse, 1999, p.171) may favour the separation view. The evidence of code-switching may also be seen as relating to the integration/separation issue. Some researchers may be inclined to assume that the simultaneous availability of two languages derives from the integration of the bilingual lexicons, while others may consider that the ability to select languages appropriately according to context reflects the separation of lexicons. In earlier times, code-switching was believed to result from a sort of on-off switch controlling language selection (Green, 1986; Poulisse, 1997). However, in recent years the mainstream idea has been that both languages are available but that a control mechanism inhibits the inappropriate lexicon (Green, 1986, 1993, 1998), or that the control mechanism orients the language user to a more bilingual or a more monolingual language mode depending on where the communication situation lies on the bilingual-monolingual continuum (Grosjean, 1997, 1998, 2001). In spite of differences between them, both models share the view that information from both lexicons is available but that such information is usually controllable. The issue of control will be considered later in more detail by looking at Green and Grosjean's models respectively.

Thus, after a period of integration-separation confusion, recent studies seem to settle on the view of 'interconnection,' which admits a high degree of connectivity between lexicons and also allows some extent of separation (Cook, 2002; Singleton, 2003b). Cook (2002) argues that the manner of integration/separation may vary in terms of the language areas (i.e. language properties such as semantics and syntax), language closeness/distance, the stage of development or of language attrition, and individual differences (i.e. in respect of cognitive abilities, social context vis-à-vis teaching methodology, and age factors) (p.12-13). Indeed, there seem to be a variety of factors bearing on the extent to which the bilingual lexicon is integrated/separated, and these factors may be related *inter alia* to the nature of the two languages in question (e.g. language properties and language distance) and the situation of individual bilinguals (e.g. acquisition levels and individual abilities).

**Processing: language selective and non-selective access**

Conflicting views concerning language-selective/non-selective access have been looked at in a previous section (see the discussion of the BIA model in 2.3.1). Some studies suggest that lexical access is language-selective, on the basis of findings from experiments including visual/auditory monolingual and code-switched sentences (Macnamara and Kushnir, 1971; Soares and Grosjean, 1984), translation equivalents (Scarborough et al., 1984) and interlingual homographs (Gerard and Scarborough, 1989). In contrast, a number of studies provide evidence of language-non-selective access, using language switch (Grainger and Beauvillain, 1987), interlingual homographs (Dijkstra *et al.*, 1998; Grainger and Dijkstra, 1992; Beauvillain, 1992) and interlingual neighbours (van Heuven *et al.*, 1998; Dijkstra *et al.*, 1998; Dijkstra et al., 2000; Brysbaert *et al.*, 1999; Dijkstra *et al.* 1999; Gollan *et al.*, 1997; Jared and Kroll, 2001). Much evidence of language-non-selectivity is offered also by speech production studies, using picture-naming with phonetic- and semantic-related distracters (Hermans *et al.*, 1998), and with cognates and non-cognates (Costa, Caramazza and Sebastián-Gallés, 2000), and using phoneme monitoring (Colomé, 2001).

As was discussed earlier, it appears that such inconsistent results obtained by language-selective studies are due to the following two reasons. One reason may be related to how the experiments are designed. For example, studies on interlingual homographs showed different results with and without non-target language distracters (Gerard and Scarborough, 1989; Dijkstra et al., 1998). When non-target distracters are not provided, it seems that the language control system is enhanced in a way which helps to produce the outcome favouring language-selective access. Code-switching studies also demonstrated that experiments with language-specific and language-non-specific orthographies are likely to elicit different results (Macnamara and Kushnir, 1971; Soares and Grosjean, 1984; Grainger and Beauvillain, 1987). The second reason may come from the nature of the bilingual's language system with respect to activation and inhibition. Grainger and his colleague argue that the negative effects of code-switching (i.e. longer RTs for code-switching contexts than for monolingual contexts) are compatible with the standpoint of initial language-non-selectivity. That is, language access of bilinguals is non-selective at the initial stage and the non-target language is soon inhibited due to the language control system (Grainger and Beauvillain, 1987; Grainger, 1993). Following the raising of the experimental design issues (Dijkstra and van Heuven, 1998), numerous more recent studies offer further evidence of non-selective access.

This line of discussion shows that the trend of the bilingual lexicon processing studies accepts the view that the bilingual lexicon processing is non-selective at the initial stage and that the control mechanism of non-target languages enables the correct output (Kroll and Tokowicz, 2001, p.64; De Groot, 2002, p.57). This manner of control also seems to vary depending on the degree of non-target language activeness. In the next section, two standpoints regarding the control mechanism in non-selective processing (Green, 1986, 1998; Grosjean, 1997, 1998, 2001) are considered.

**Control**

The issue of the degree to which language access is non-selective involves two specific views: the inhibitory control model (Green, 1986, 1998) and the language mode model (Grosjean, 1997, 1998, 2001). De Groot (2002, p.57) labels these views respectively: total non-selectivity (the inhibitory control model) and partial non-selectivity (the language mode).

Green (1986, 1998) suggests that lexical access is basically non-selective, and that production in the appropriate language is rendered possible by means of control activity. According to Green (1998), when one attempts to produce a word in an intended language, one initially activates the specified conceptual representation, which points to a lemma in the appropriate language. Green (ibid.) postulates that this specification of language is conducted with *a language tag*. For Green, each lemma has a language tag, which accounts for the difference of translation equivalents in terms of semantic and syntactic representations (1998, pp.71-72). For instance, at the syntactic level translation equivalents of "moon" in German and French are associated with different genders (e.g. *der Mond* and *la lune*), and at the semantic level, the French word *balle* does not completely correspond with a translation equivalent word "ball" in English. Therefore, by specifying a language tag, a speaker can control the language code when s/he produces a word in certain language, translates a word from one language into another, and switches languages in conversation. Green (1986, 1998) proposes the inhibitory control (IC) model, which assumes that appropriate output is possible because of activation and inhibition of lemmas in terms of each lemma's language tag. Thus, Green's view postulates that initial language access is totally non-selective and the inhibitory control of lemmas with inappropriate tags produces the output in the required language. This is why a speaker is able to avoid producing a word in the wrong language when s/he manipulates two languages in the case of translation and code-switching tasks.

On the other hand, Grosjean (1997, 1998, 2001) assumes that language access is partly non-selective. He proposes that bilinguals' receptive and productive auditory language processing occurs in a monolingual-bilingual mode continuum. According to Grosjean (1998), this continuum ranges from a total monolingual language mode to a total bilingual language mode. He explains the case of the total monolingual mode (see the dotted vertical line 1 in Figure 15 below) in terms of situations where bilinguals are communicating only with a monolingual in one of two languages.

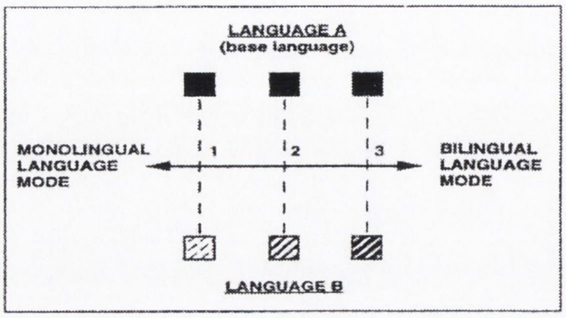


**Figure 15** Visual representation of the language continuum. The bilinguals' positions on the continuum are represented by the broken vertical lines and the level of language activation by the degree of darkness of the squares (black is active and white is inactive).

Thus, language A, which is a base language (the main language which is used in conversation), is completely activated (indicated as a black square in Figure 15), while language B is deactivated. On the other hand, the total bilingual mode (the dotted line 3) can be found when bilinguals are communicating with other bilinguals who also use the same two languages. Therefore, both languages are activated by the bilinguals, although the degree of activation may not be identical (language A is still a base language as it is represented in a black square, while language B is slightly less active as it is represented in somewhat a lighter square). Grosjean (1998) suggests that this mode is applied in cases where bilinguals find it easier to mix other languages (guest languages) with the base language in communication. In addition, there is another mode – intermediary mode (dotted line 2) – which can be found between the extremes of the continuum. When bilinguals are in this mode, they may communicate with bilinguals who are not very confident about the other language (language B). Thus, although a part of the language B is activated, Language A is still the base language (see Figure 15).

Grosjean (1997) argues that the level of guest language activation in each case of communication involves various factors. They are: the listeners' situation (e.g. guest language fluency and expectations for code-switching and borrowing, etc.), the level of activation of the base and guest language, code-switching constraints (related to syntactic, semantic, and pragmatic constraints), and the properties of guest words (e.g. in terms of phonotactics, phonetics, and interlanguage neighbours) (p.240-246). On the basis of such a view, Grosjean (1997), proposing the Bilingual Model of Lexical Access (BIMOLA), makes the following two claims; i) Bilinguals have two autonomous language networks (including features, phonemes, and words) as a subsystem in a single language system; thus, they have independent systems but they are also connected to each other. ii) Bilinguals manipulate the monolingual language mode and the bilingual language mode. Thus, Grosjean attempts to account for the mechanism of two integrated lexicons, with a guest language being activated or deactivated in accordance with various factors. Like Green, this view also claims language-non-selective access and agrees with the idea that the language chosen for communication is selected by bilinguals' higher level of control. In particular, the focus of Grosjean's "language mode" proposals is the context in which language is spoken, and for him, this affects the bilinguals' language selectivity in processing words.

According to Grosjean (2001), several experimental studies on visual word processing supply evidence of "language mode" (Grainger and Beauvillain, 1987; Dijkstra et al., 1998). In Dijkstra et al.'s (1998) study, similar RTs were obtained for English-Dutch homographs and English non-words in the English lexical decision task in Experiment 1 (see more detailed illustration in 2.3.1, the Bilingual Interactive Activation model, p.45). Grosjean (ibid.) explains that this reflects the bilinguals' monolingual mode, because no distracters in non-target language (Dutch) were presented. Further, Grosjean (ibid.) argues that the outcome of facilitation effects for cognates demonstrates the guest language (Dutch) being partly activated, although the base language is English at the monolingual end of the continuum (the dotted line 1 in Figure 15). On the other hand, the third experiment produced strong facilitation effects for interlingual homographs, when both English and Dutch control words and both English and Dutch non-words were included in an English and Dutch lexical decision task (a general lexical decision task). According to Grosjean (ibid.), this result is due to the bilinguals' positioning at the bilingual end of the continuum, where both lexicons were active because the bilinguals were instructed to be prepared for the stimuli from both languages.

A number of speech production studies have attempted to investigate how and when the control occurs. The views with regard to the site of language selection vary, from the lemma level (Hermans, et al., 1998; Green, 1998), the phonological level (Costa, et al., 2000; Colomé, 2001), to multiple levels (Kroll, Bobb and Wodniecka, 2006). Although this controversy has not yet reached a clear conclusion (Abutalebi and Green, 2007, 2008), it seems that a majority of researchers support the principal idea that initial lexical access is non-selective and that the subsequent control process enables the language-appropriate output. This notion led Dijkstra, van Heuven and their colleagues to revise the BIA model in terms of language nodes and the task/decision system (Dijkstra, van Heuven, 2002; see the Bilingual Interactive Activation model in 2.3.1 for detailed illustration.).

In the next section, we consider some pertinent issues relating orthography and L2 processing, which is one of the significant elements in L2 word recognition.

## 2.4 Orthography in L2 processing and the Japanese writing system

Orthographic processing plays an essential role in visual word recognition. Although the central goal of this chapter is to investigate the organisation and processing of the bilingual lexicon, it may be beneficial to consider some issues concerning L2 orthographic processing, which would enable a better understanding of L2 lexical processing. It appears that cross-linguistic studies offer very little evidence for the bilingual system of orthographically dissimilar languages. In this section, general issues concerning L1/L2 orthography are firstly addressed. The discussion will be later centred on the Japanese (L1) writing system and its effect on English (L2) orthographic processing, which is related to the experimental studies in Part Two.

### 2.4.1 Writing system

Writing systems in languages are generally seen to have two aspects: orthographic representation and depth (Koda, 1999, 2005). From the representational point of view, writing systems can be divided into three kinds: alphabet, syllabary, and logography. Each letter of an alphabet represents a phoneme such as *t* for /t/ in English and that of a syllabary represents a syllable such as た for /ta/ in Japanese *Hiragana*; thus they are phonologically-based. In the case of logography, each unit represents a morpheme; for instance, Japanese *Kanji* 雨 meaning 'rain' represents several phoneme(s) such as /u/ /ame/ /ama/; therefore, it is semantically oriented.

With respect to the depth aspect, the writing system is measured in terms of the extent to which grapheme-phoneme correspondence is transparent. Languages such as Italian and Serbo-Croatian have transparent correspondence—each grapheme has a one-to-one correspondence with a phoneme—they are said to have shallow orthographies. On the other hand, in less transparent languages such as English, the grapheme-phoneme correspondence is less regular, and thus, the writing system of these languages is regarded as being relatively deep. The essential point of this measurement is that, according to the Orthographic Depth Hypothesis, the extent of orthographic depth predicts the degree of phonological involvement in lexical access (Frost, 1994). Shallow orthographies indicate that phonological information is retrieved prior to lexical access by computational analysis of segmental sequences within a word on the basis of grapheme-phoneme conversion rules. In the case of deep orthographies, the Orthographic Depth Hypothesis suggests that retrieval of phonological information occurs after lexical access, owing to its nature of irregular correspondence between graphemes and phonemes. As the degree of orthographic transparency differs across languages, the manner of phonological involvement also varies depending on the lexical system.

### 2.4.2 L1 word recognition

Word recognition involves association of orthography, phonology and semantics. For decades, literatures on English orthography, due to the fact that it is an alphabetic language, have centred on the question of how phonological decoding is involved in lexical access; the trend shifted from the obligatory view (Rubenstein, Lewis and Rubenstein, 1971) to the optional view (Baron, 1973; Besner and Hildebrandt, 1987; Green and Shallice, 1976; Taft, 1982).

Recent studies on non-alphabetic languages seem to agree with the view that phonological codes play an important role also in logographic languages (Perfetti and Zhang, 1995; Saito, Matsuda and Kawakami, 1998; Sakuma et al., 1998), although it should have a direct access to semantics. However, as the Orthographic Depth Hypothesis proposes, it is also logical to assume variations in phonological involvement depending on the types of writing systems. Studies on Japanese *Kana* and *Kanji* provide evidence of different processing mechanisms for two different writing systems within one language (Feldman and Turvey, 1980; Saito, 1981; Shimamura, 1987). Morita and Matsuda (2000) also found that in Japanese *Kanji* recognition, both semantics and phonology are readily accessible, but that semantics is more closely associated with orthography than with phonology. Phonological information may also be important in logography, but it appears that its retrieval process involves different mechanisms from the case of an alphabet.

A variety of writing systems entail diverse processing mechanisms. Indeed, in L2 word recognition research, a considerable amount of evidence, relating the effect of L1 orthography on L2 orthographic processing, is available (e.g. Akamatsu, 1999, 2003; Fender, 2003; Koda, 1990, 1999; Wang et al., 2003). The next section focuses on the matters related to what determines L2 word recognition.

### 2.4.3 L2 word recognition

Koda (1996, 2005) proposes three central issues concerning L2 word recognition. They are:

1. extent of L2 orthographic processing experience,
2. orthographic distance between L1 and L2, and
3. transfer of L1 orthographic knowledge to L2 processing.

First, it is commonly supposed that the exposure to L2 orthography is related to efficiency in L2 orthographic processing performance. Some studies offered evidence for this assumption in terms of speed (Haynes and Carr, 1990) and in terms of combination of speed and stability (Segalowitz and Segalowitz, 1993; Akamatsu, 2008). Segalowitz and Segalowitz's (1993) proposed that word recognition practice may result in two types of change: i.e. automatisation that may be involved in qualitative change in processing mechanisms, and simple 'speed-up' in processing implementation. Akamatsu (2008) adopted their proposal and observed his participants' lexical decision performance after 7-week word recognition training. The results showed that after training, participants' performance improved in speed and accuracy. Furthermore, correlational analyses of reaction time (RT) and coefficient of variation (CV) of the RT indicated that for high frequency words, word recognition performance was associated with simple speed-up of task processing, while for low-frequency words, it reflected automatisation. This outcome was interpreted that for high frequency words, participants already attained the automatisation stage, whereas with reference to low-frequency words, structural reorganisation in word recognition processing mechanisms occurred through training. Cross-linguistic studies also supplied evidence for L2 experience resulting in efficiency in L2 word recognition. Akamatsu (2002) found L2 experience effects with different L1 backgrounds. The result of his study yielded similar patterns of reading behaviour for highly proficient ESL participants with different L1 writing systems (i.e. Chinese, Japanese and Persian); with regard to high-frequency words, all participants processed irregular words as fast as regular words, while for low-frequency words, they processed irregular words slower than regular words.

Secondly, it seems that orthographic distance between L1 and L2 also has a significant impact on L2 word recognition performance. A number of studies provided evidence for benefits of L1-L2 orthographic similarity on L2 word recognition (Akamatsu, 1999, 2003; Fender, 2003; Koda, 1999). Fender's (2003) second experiment using a sentence reading task compared English word integration performance of ESL learners with different L1 backgrounds –Arabic (alphabetic) and Japanese (non-alphabetic). Although the result elicited no significant difference in speed, Arabic ESL learners were more accurate than Japanese ESL learners. Similarly, there is as much evidence with respect to negative effects of L1-L2 orthographic differences on L2 word recognition. Evidence of negative effects will be explained in detail later in the case of Japanese (L1) and English (L2) in 2.4.6.

Third, L1 orthography processing skills tend to transfer in L2 word recognition in the case where L1 and L2 do not share the writing system (Chikamatsu, 1996; Koda, 1990; Wang et al, 2003). Koda (1990) examined different kinds of phonological processing strategies employed in L2 (English) reading, depending on L1 orthography background: i.e. alphabetic (Arabic and Spanish) and logographic (Japanese). The results indicated that in the case of participants with alphabetic L1 background, their English reading performance was substantially affected by presentation of phonologically inaccessible items (Sanskrit symbols). In contrast, participants with logographic L1 background processed phonologically inaccessible items as fast as nonsense English names. Logographic language can be processed without the access of phonological code and this L1 skill seemed to transfer in their L2 processing strategies. Chikamatsu (1996) offered further evidence for transfer of L1 skills to L2 orthographic processing. Chikamatsu observed how Chinese (logographic L1 background) and English (alphabetic L1 background) participants processed their L2 Japanese *Kana* words (syllabary). The results showed that Chinese participants used more visual information, while English participants depended more on phonological information.

In summary, the issue of L1 orthographic effect cannot be ignored when one considers the issue of L2 word recognition, even though there may be some commonality in the process of L2 word recognition development across writing systems (e.g. Akamatsu, 2002). Various cases of L1 effect on L2 word recognition were discussed so far. The focus of discussion will be gradually directed to the particular case: i.e. the effect of Japanese (L1) orthography in English (L2) processing. This is preceded by a brief introduction to the Japanese writing system and by a discussion of a significant issue related to the Japanese writing system.

### 2.4.4 The Japanese writing system

As was briefly introduced earlier, the Japanese language includes two types of orthography: i.e. *Kana* and *Kanji*. *Kana* (*i.e. hiragana and katakana*) is a syllabary; for instance, a letter か represents a syllable /ka/. *Hiragana* and *katakana* syllabaries represent exactly the same phonemes but are used in different occasions. *Hiragana*, in principle, can be used for any Japanese words but is commonly used for non-content words and functional words such as particles or case markers, while *katakana* is usually used for loan words (e.g. ラジオ derived from 'radio' represents phonemes /rajio/). In contrast to *Kana*, *Kanji* is a logography – i.e. a letter 音 represents meaning 'sound' and several phonological units such as /oto/, /ne/, /on/ and /in/. It is possible for all the words to be written in *Kana*; however, the relatively simple phonological system in the language entails a number of homonyms. Therefore, *Kanji* appropriate to the meaning in the context is usually chosen in order to avoid ambiguity. For instance, はし /hashi/ has 3 homonyms; and thus, there are 3 ways to write it in *Kanji* such as 橋, 端 and 箸.

### 2.4.5 Processing of *Kana* and *Kanji*

Researchers have discussed for decades whether the processing of *Kana* and *Kanji* differs in terms of processing route as well as speed. Saito (1982) suggests that *Kana* words are processed in the order graphemic → phonemic → semantic processing, whereas *Kanji* words are processed in the order graphemic → semantic → phonemic processing. With regard to speed of *Kana* and *Kanji* processing, Feldman and Turvey (1980) found that colour words written in *Kanji* were named more slowly than the same colour words written in *Kana*, even though these words are conventionally written in *Kanji*, probably because of the easier access to the phonology for *Kana* than for *Kanji*. Shimamura (1987) also reports that *Kanji* colour words were named more slowly than the same colour words written in *Kana* (Experiment 1). However, when participants were asked to respond to stimuli by pressing keys—in other words, when verbal responses were not required—*Kanji* words were identified faster than the same words written in *Kana* (Experiment 3). Furthermore, in the Stroop test (Experiment 1), he found more Stroop interference in the processing of *Kanji* than in the processing of *Kana* words. On the basis of these results, Shimamura (1987) concluded that *Kana* and *Kanji* would access meaning and phonology differently. *Kana* words may be associated with easier access to phonology than *Kanji* words, whereas *Kanji* words may be associated with easier access to meaning than *Kana* words. However, it has to be acknowledged that all the Japanese stimulus words used in his experiments were conventional *Kanji* words (colour words and spatial direction words). This might also have been related to the favourable results in respect of *Kanji* word recognition.

Hirose (1984) claims that it is the frequency of association of scripts with individual words which affects the speed of accessing the lexicon via visual presentation. In his experiment, undergraduate students were asked to classify stimulus words according to semantic categories. The stimulus words were divided into three groups: i.e. low-frequency *Kana* words, high-frequency *Kana* words and *Kanji* words. Low-frequency *Kana* words were scripted in *Kana* although they are conventionally written in *Kanji*. On the other hand, high-frequency *Kana* words were those which are conventionally written in *Kana* and were presented in *Kana*. *Kanji* words were scripted in *Kanji* as they are normally written. The results showed that the RTs were longer for non-conventional *Kana* words than for *Kanji* words, but conventional *Kana* words were processed as fast as *Kanji* words. Note that this experiment did not require naming stimulus words but simply required accessing the lexicon.

Yamada, Imai and Ikebe (1990) explored *Kana* processing in terms of familiarity, using a lexical decision task. They propose that for reading conventionally written *Kana* words, the lexicon is accessed directly from the visual orthography, while reading unconventionally written *Kana* words requires assembling phonological information for each syllable within the words in order to access the lexicon. Note that in their experiment, the lexical decision task was used and the task again did not require the naming of stimulus words.

To summarise, these results seem to suggest that when stimulus words are written in the conventional script and naming stimulus words is not required in the task, both *Kana* and *Kanji* are recognised with a similar degree of ease.

### 2.4.6 The effect of knowledge of Japanese (L1) orthography on English (L2) processing

Cross-linguistic studies suggest that non-alphabetic L1 experience gives a negative effect on English processing, on the basis of the view that alphabetic and non-alphabetic orthographies involve different mechanisms in terms of the phonological information access process (Akamatsu, 1998; Koda, 1999). Koda (1999) precisely summarises the difference in manners with regard to accessing phonological codes between alphabet and logography as follows:

> Alphabetic readers rely heavily on intraword analysis in obtaining a word's phonology, whereas logographic readers retrieve phonological information lexically through whole-word (or morpheme) activation. (Koda, 1999, p.53)

It seems that syllabary also would not require intraword analysis for phonological access, due to the fact that it commonly consists of the combination of a consonant and a vowel (Akamatsu, 1998).

Owing to much attention paid to phonological awareness in L1 reading development research, it has been widely believed that development of phonological segmentation skills and of the abilities to analyse phonemic structure of a spoken word are related to reading mastery in an alphabetic language (Bryant et al., 1990; Perfetti, 1992; Stahl and Murray, 1994; Yopp, 1988). Akamatsu (1998) argues that for Japanese learners of English, lack of such experience in their L1 affects the English word recognition process. Most Japanese learners of English start learning to read English after they have established the mechanism of Japanese word recognition. When they read a word in English, they seem to have difficulty adjusting their processing mechanism. Koda (1997) also addresses the disadvantage that L1 Japanese readers have in developing skills in the computational analysis of the phonemic constituents of a word:

> To wit, if, indeed, a high level of phonemic awareness results from experiential exposure to alphabetic script, an assumption can be made that readers with nonalphabetic L1 backgrounds are seriously handicapped. Since nonalphabetic readers do not engage in phonological processing at the phonemic level, they are unlikely to develop phonemic sensitivity to the same extent as alphabetic L1 readers. Further, because of their limited phonemic awareness, we can hypothesize that nonalphabetic L1 readers may experience considerable difficulty in mastering English phonological processing skills. (Koda, 1997, pp.44-45)

Koda (1999) offers evidence of lack of L2 intraword structural sensitivity for non-alphabetic L1 speakers. Koda compared the orthographic acceptability judgment performance between Korean (non-Roman alphabetic) and Chinese (logographic) ESL learners. The results demonstrated that illegality of English letter strings affected the performance of Chinese participants more than that of Korean participants. This indicates the disadvantages of non-alphabetic L1 experience on identifying L2 intraword structural information as compared with alphabetic (although orthographically different) L1 experience.

Akamatsu (1999, 2003) provided further evidence using case-alternation (e.g. cAsE aLtErNaTiOn), claiming that one of the effects of lack of phonemic sensitivity is inefficiency in English word recognition. Akamatsu regarded efficient word recognition as reflecting intraword structure sensitivity in lexical processing, and assumed that speed of recognition of case-altered words by integrating visually distorted letter information may indicate efficiency in word processing. The results showed that the effect of case alternation was significantly stronger in terms of speed for ESL learners with Chinese and Japanese (non-alphabetic) L1 background than for those with Persian (alphabetic) L1 background in individual word recognition (Akamatsu, 1999) as well as in reading texts (Akamatsu, 2003).

The organisational variation in L1 orthography tends to have a major impact on L2 orthographic processing. Evidence from some studies comparing alphabetic / non-alphabetic languages suggests that negative effects of non-alphabetic L1 experience on alphabetic L2 processing may be due to a lack of intraword structural sensitivity. This indicates the importance of cognitive aspects of language skills required for efficient processing in the language in question. An implication of the discussion above is that development of such skills deserves more attention in L2 reading instruction. Koda (2005, 2006) argues that metalinguistic awareness development is one of the major factors for current L2 reading acquisition research.

**Conclusion**

This chapter investigated the mechanisms of the bilingual lexicon. The discussion principally centred on the development of the L2 lexicon and lexical relations between L1 and L2. The examination of three bilingual models (the BIA/BIA+ model, the RHM and the distributed feature model), and a number of pertinent empirical studies, helped us understand the bilingual system at various levels.

The BIA/BIA+ model (Van Heuven, *et al.*, 1998; Dijkstra and Van Heuven, 2002), extending the view of the interactive-activation model (e.g. McClelland and Rumelhart, 1981; see Chapter 1, 1.2), proposes that formal (lexical) memory is integrated between languages. It also suggests that lexical access occurs simultaneously across languages. The RHM (Kroll and Stewart, 1994) deals with linkage between the bilingual lexicon and concepts. This model is important in that it accounts for the structural change of bilingual memory in terms of developmental stages. It was argued, however, that this model has weakness in so far as it fails to make a clear distinction between concepts and semantics. Although it could be said that this model implicitly suggests a process of *semantic* development, it does not take account of the case where conceptual constituents of the semantics for translation equivalents differ between languages. This issue forms a central focus of the distributed feature model (De Groot, 1993), which argues that the degree of conceptual overlap may vary depending on word type, invoking in particular the role played by cognate status and concreteness. Although this somewhat abstract notion of "the degree of conceptual overlap" tends to be criticised, this model seems to offer a useful initial investigative reference point with regard to the semantic perspectives of the bilingual lexicon. Now we recall a question which was raised earlier in relation to Wolter's (2001) claim of organisational differences between the L1 and L2 mental lexicons (see discussion in 2.2). I have queried whether they are simply caused by the different levels of L2 development, or also by the inherent differences between L1 and L2 lexicons. The distributed feature model (De Groot, 1993) seems to offer an example that the organisational differences between the L1 and L2 lexicons may be also due to the nature of words which may differ across languages depending on the word types.

On the basis of a number of experimental studies related to these models, a conclusion was drawn with respect to bilingual organisation and processing. After five decades of controversy surrounding the integration or separation of the bilingual lexicon, there seems to be a general consensus which accepts the 'interconnection' view (Cook, 2002; Singleton, 2003b). Furthermore, the problem of language-selective/ non-selective access has also been resolved. The view of 'initial non-selectivity' is now generally agreed upon (Green, 1986, 1998; Grosjean, 1997, 1998, 2001). This reveals the complex nature of the bilingual language system, in spite of its efficient processing system. The interconnected bilingual lexicon enables information from both languages to be activated in parallel, and it is the control mechanism which inhibits the non-target language.

It was earlier noted that very little attention has been paid in the study of bilingual development and processing to the bilingual system in the languages which do not share orthography, despite its importance as one of the factors in understanding the mechanisms of bilinguals' visual lexical processing. To my knowledge, the hypothesis of the RHM regarding the asymmetrical strength of the conceptual link between L1 and L2 has scarcely been investigated among the languages which do not share writing systems. As Dijkstra and van Heuven (2002, p.183) note, predictions posited in the BIA+ model in respect of between-language orthographic interaction do not apply in the case of languages with no orthographic similarity. Furthermore, the model gives no clear indication relative to the actual mechanisms of semantic interaction across languages which do not share writing systems (see discussion in pp.54-55). The empirical studies in Part Two will examine the issue of the conceptual link in L1 and L2 (Chapter 5 and 6) and the issue of the cross-linguistic semantic interaction (Chapter 7) in the case of two languages which do not share the writing systems (i.e. Japanese and English).

The distributed feature model discusses the degree of semantic similarity/difference between translation equivalents. A question seems to remain to be solved as to how language-non-selective semantic activation may occur for translation equivalents whose semantic representations share fewer conceptual components such as abstract words. This matter will be dealt with also in the empirical study in Chapter 7.

In the next chapter, we will focus on the issue of bilingual semantics in order to investigate the mechanisms of semantic organisation and processing. It is well known in the study of L1 semantics that semantically related pairs of words are processed faster than the semantically unrelated pairs (Mayer and Schvaneveldt, 1971). Apparently, meanings are associated between words. Bilingual semantic studies have tended to be limited so far in that they have dealt only with individual lexical items across languages such as translation equivalents. It seems to be important for semantic studies to take account of inter-lexical relations in order to reveal in a broader perspective the nature of semantic interconnectivity and language-non-selectivity in the bilingual lexicon.

# Chapter 3 The organisation and processing of bilingual semantics

## Introduction

In the previous chapter, the issue of bilinguals' representation and processing of individual lexical items was discussed. As far as the semantic issue is concerned, De Groot's standpoint in terms of the degree of semantic overlap between languages seems to be convincing (i.e. that relating to compound and co-ordinate systems). As was noted earlier, factors determining the degree of integration and separation between two languages may include word type (cognateness, concreteness, animacy/inanimacy, etc.), language distance, stage of language development and attrition, recency of language exposure, etc.

With regard to L1 semantic studies, linguists and cognitive psychologists have conventionally studied semantic relations between words. The recent more broadly based inter-lexical approach to semantics—supplanting traditional studies using one-to-one translation equivalents—furnishes a new insight into the organisation and processing of the bilingual semantics. Semantic overlap between two languages may be better represented in terms of two distinctive but interconnected semantic networks for the bilingual lexicon. Moreover, one may argue that the inter-lexical approach has plausibility in respect of language processing, where knowledge of a broad range of paradigmatic and syntagmatic relations is required for the reception and production of continuous texts. The following comment of Heredia and Brown (2004) advocates bilingual research beyond the single-word level.

> Overall, most of the studies that we covered in this review have utilized the isolated word as the experimental unit. However, recent developments in the field suggest that bilingual research is beginning to move away from the isolated-word level and to address other general language-processing issues such as bilingual sentence processing and figurative language processing.

(Heredia and Brown, 2004, p.244)

This chapter begins with a review of L1 studies referring to semantic organisation and processing (3.1). Discussion focuses on how inter-lexical semantic relations can be best described in terms of their representation and processing. This focus is then applied in respect of the bilingual semantic system and bilingual semantic processing (3.2). The chapter also addresses the question of how semantic overlap between languages might be depicted. It is suggested that collocational associations may reflect inter-lexical semantic connections, which enable continuous texts/speech, in accordance with Hunston's (2002) view that collocations represent 'a semantic profile.' It can be assumed that semantic similarity and difference between languages affects semantic development in L2. In other words, in broad terms, the greater the semantic differences across languages, the slower the acquisition of L2-specific semantics is likely to be. One solution that may be adopted by learners to this problem is known as parasitism of L2 semantics on L1 semantics. Thus, the structure of L2 semantics differs in terms of developmental stage. This issue is discussed with respect to the processing of L2 semantics in the perspective of L1-L2 connectivity.

### 3.1 Semantic organisation and processing in L1

The study of semantic organisation started from a linguistic standpoint, and invoked such models as the structural approach and componential analysis. Recent approaches derive from the perspectives of cognitive psychologists, such as prototype theory and the network model, the latter model addressing the question of how knowledge of semantic relations may be processed. The issue of semantic processing is also explored on the basis of a review of an array of empirical evidence. Discussion of L1 semantics is considered appropriate here, because the nature of the L1 semantic system and its mechanisms is also one of the basic properties of L2 semantics, which is the central issue to be explored in the empirical study.

### 3.1.1 Semantic studies in L1: From the structuralist approach to the cognitive- psychological approach

Structuralists understand sense relations in terms of the arrangement of semantic patterns, and the particular kinds of pattern they study are termed '*semantic fields.*' This notion of semantic fields started to emerge in the 1920s (Lyons, 1977, p.250), on the basis of ideas promulgated earlier by the Swiss linguist de Saussure. For field semanticists, semantic relations principally involve paradigmatic relations. Paradigmatic relations refer to those obtaining between lexical items which can be substituted for each other within the same grammatical slot (Lyons, 1973), relationships such as synonymy, antonymy and hyponymy. For example, the word *man* has paradigmatic relations with *woman* (antonymy), *guy* (synonymy), *person* (hyponymy), so that the phrase *the tall man* can be replaced with *the tall woman*, *the tall guy* and *the tall person*. The structural approach is thus concerned with the general pattern of semantic relations between words.

On the other hand, the componential analysis to semantics pays attention to how to explicate similarities and differences between two particular words. Componentialists consider that each word can be identified by a set of defining features (Katz and Fodor, 1963). According to this view, the semantics of each word consists of the necessary defining features – which implies that very precise distinctions between words can be drawn and that relations between words can also be very clearly represented. This approach was first developed by anthropological linguists as a part of their research on relations of kinship terminologies (Leech, 1981, p.91); thereafter, it was widely used in semantic studies. The approach assumes that it is possible to identify minimal distinctive components of meaning or semantic features. For example, the semantic relations between *woman* and *boy* can be explicated in terms of three semantic dimensions (i.e. species, maturity and sex); thus:

*woman*: +HUMAN +ADULT –MALE
*boy*: +HUMAN –ADULT +MALE.

This approach appears to offer an elegant way to represent relations between particular words by focusing on similarities and differences at a micro level. However, this elegance has been argued to be over-simplistic and overly rigid. Carter (1998, p.18) argues that there are unlimited ways to sub-classify semantic features for lexical items. For example, the meaning of the word *seal* can be analysed in terms of features such as +ANIMATE –HUMAN but also in terms of features such as –FEATHER –HAIR –HUMAN. Carter (*ibid.*) also notes that the componential approach cannot identify the critical contrastive determinant for lexical items where the meaning is analysed along two or more dimensions. Thus, for example, *man* is in contrast with *woman* when the MALE factor is focused on, while *girl* is in contrast to *woman* when the ADULT factor is considered. Furthermore, from a stylistic perspective, the word *girl* can in some contexts have the same meaning as *woman*. Moreover, Leech (1981) refers to several types of contrastive relations: binary taxonomy (e.g. *alive* +LIVE: *dead* –LIVE), multiple taxonomy (e.g. *gold*, *copper*, *iron*, *mercury,* which may all be categorised as METAL but are different kinds of metal), polarity (e.g. the degree of being BIG can be represented in a scale between *large* and *small*), hierarchy (e.g. LENGTH can be represented by *inch*, *foot*, and *yard*). This illustrates the fact that contrastive relations are not as simple as they may have seemed. Binary notation is not sufficient to encompass the complex and diverse relations that present themselves. As Leech (1981) comments, "meaning is fuzzy" (p.119). Thus, the componential approach is generally recognised as not being sufficiently comprehensive.

The componentialist's problem with regard to the complex and fuzzy aspects of word meanings is dealt with by cognitive psychologists. The structuralist and componentialist focus is on the relatedness of words in terms of the classification of words into groups on the basis of meaning and on the question of how meanings can be logically described. On the other hand, the cognitive-psychological approach investigates how the concepts associated with words are perceived and organised in the mind. Cognitive psychologists suggest that people can cope with the fuzziness of word meanings by identifying prototypes for semantic categories. This approach is generally labelled '*prototype theory*.'

Prototype research began with studies of the perception of colours (Berlin and Kay, 1969) and forms (Labov, 1973). Labov (1973) investigated the prototype of a particular object: *cup*. In his study, variously shaped line-drawings of cup-like objects were individually presented to subjects with and without contexts (e.g. a coffee-drinking context, a potatoes-at-dinner context, etc.), and subjects were instructed to name the objects. The results demonstrated that people's category recognition for cup, bowl, vase, etc. varied in terms of the width and depth of the objects, and that the boundaries of categories were far from clear: as the width of objects increased, subjects were *less* likely to recognise them as 'a cup,' and *more* likely to recognise them as 'a bowl.' The boundary areas between categories were also greatly influenced by the context variables (e.g. neutral context, coffee context, etc.). This study advanced the notion of 'fuzzy boundaries' between categories, highlighting the grey areas between good examples and bad examples.

Cognitive psychologists subsequently shifted their attention from the perception of colours and objects to words (Rosch, 1973, 1975, 1978; Coleman and Kay, 1981; Lakoff, 1987a, 1987b; Jackendoff, 1992). These word-oriented studies investigated, for example, how people can recognise an ostrich as well as a pigeon and a robin as a kind of bird (Rosch, 1973, 1975, 1978), and how people define the verb *lie* (Coleman and Kay, 1981). Such issues had already been discussed by the philosopher, Ludwig Wittgenstein with reference to the definition of *game*. Wittgenstein ([1945] 1953) argued that concepts may not be arranged systematically in accordance with common features, but rather may be organised in terms of a broad sense of similarities, with some features overlapping or dropping between categories. For example, ball-games may or may not include winning and losing elements in the way that card-games do. In the case of ball-games where children throw balls against a wall and catch them, winning and losing is not a feature. The classical notion of semantic categorisation in word definition is enriched by prototype research.

Rosch (1973, 1975, 1978) sees words as being organised in the mind according to categorical structures. For her, the human ability to identify that a robin and an eagle are both birds but a squirrel is not, is founded on our cognitive processing. She claims that people recognise these words in terms of the common elements that the items share in the specific category (e.g. birds). According to Rosch, identifying a cluster of these common characteristics enables one to recognise exemplars (good examples) of the categories, so that it is often said that a robin is more bird-like than a duck is. Rosch (1978) also argues that the common characteristics are required only to some extent. They are not always necessary to fulfil the conditions of the category *bird*, so that people can recognise a penguin and a robin with a broken wing as birds, even though neither of them can fly. In order to substantiate this claim, Rosch investigated how labels of objects are identified by means of rating tests and verification tests (Rosch, 1973, 1975).

Similarly, Coleman and Kay (1981) noted that the verb *lie* consists of three characteristics; i) P (proposition) is false; ii) S (the speaker) believes P to be false; iii) In uttering P, S intends to deceive A (an addressee). However, they found that these characteristics are not always necessary in the use of this verb. There are some situations where people regard the statements as a lie even though none of the three above elements are included in the case. There are also some situations where people do not regard the statements as a lie although all three are included, such as when one intends to show politeness. For Coleman and Kay, these allow some degree of fuzziness for the concept of *lie*.

However, Lakoff (1987a) disputes Coleman and Kay's (1981) view that prototype is identified by a group of features which are weighed by relative importance. Lakoff (1987a) argues that such a view is superficial, and suggests that prototype is concerned with the internal structure of human cognition regarding concepts, which he calls *cognitive models*. According to Lakoff, *cognitive models* enable one to organise knowledge established via one's experience. Lakoff and Johnson (1999) emphasise that such a cognitive system is incorporated with perception and bodily movement, in particular, a sensorimotor device. That is, we are able to judge "what is real" partly by the sensorimotor system and partly by the cognitive system. This incorporation is termed by them *embodied mind.* Thus, for them, categorisation of concepts involves bodily experience as well as reasoning activities. They argue that concepts are organised in terms of neural structures and that prototype functions as characterising the categories in the neural structures. Lakoff and Johnson summarise their view of *embodied mind* as follows:

> Philosophically, the embodiment of reason via the sensorimotor system is of great importance. It is a crucial part of the explanation of why it is possible for our concepts to fit so well with the way we function in the world. They fit so well because they have evolved from our sensorimotor systems, which have in turn evolved to allow us to function well in our physical environment. The embodiment of mind thus leads us to a philosophy of embodied realism. Our concepts cannot be a direct reflection of external, objective, mind-free reality because our sensorimotor system plays a crucial role in shaping them (Lakoff and Johnson, 1999, p.43-44).

Reconsideration of the conceptual categorisation system and prototype effects allows Lakoff to view them as being caused by internalised abilities rather than by external phenomena or representation interpretations. The standpoint that the conceptual architecture is structured by a neural system appears to account for how the higher level (cognitive) constitution and the lower level (sensorimotor) constitution are engaged.

Jackendoff (1992) generally agrees with Lakoff's viewpoint in that he also considers that categorisation of concepts is possible due to humans' internal abilities rather than the systematic mechanism of characteristics being clustered. Jackendoff's (1992) view of conceptual semantics is derived from the viewpoint of generative linguistics (Chomsky, 1986). As generative linguists see humans as being able to generate an infinite number of sentences from a finite set of rules, Jackendoff assumes humans are also able to generate an infinite number of concepts from a finite set of mental primitives. These features are desirable for a model of natural language, since human brains are of finite capacity, yet humans can produce and understand a very large volume of concepts. Jackendoff considers that there are internalised schemas in a humans' mind, which enable people to compare new information with the existing concepts in order to judge the conformity of these two items. Thus, using their DOG schemas, humans can even recognise, for instance, a collie as a kind of dog, when they encounter it for the first time. For Jackendoff, mental representation of word meanings is organised according to the characterisation of the conceptual elements, which for him accounts for the creative abilities of human cognition.

Cognitive psychologists' centre of interest is conceptual organisation and human cognition's capacity to cope with the fuzziness of word meanings. We have to bear in mind that semantics is independent of concepts. The fact that the cup-bowl boundary and the use of *lie* are influenced by contextual situations obviously demonstrates the difference between conceptual and linguistic systems. If one focuses entirely on linguistic meanings, cognitive psychologists' approach becomes problematic. Singleton (2000, p.79) argues that

> Conceptual semantics has been criticised on the ground that there is not sufficient hard evidence to support the view that linguistic meaning exactly parallels conceptual structure. It is also claimed that linguistic meanings do not actually reflect the fuzziness of concept structure.

It is natural that a linguistic structure which is supposed to be systematic has limitations in respect of the extent of its correspondence to flexible mental operations.

Prototype theory does not fully account for semantic organisation. However, it may be possible to say that prototype theory has moved semantic studies forward in that the trend of discussion shifted from rigid systematic perspectives to more flexible and comprehensive perspectives. In the case of two languages, prototype theory may be able to shed light on the slight semantic differences associated with translation equivalents across languages. In particular, Lakoff and Jackendoff's understanding of the cognitive system seems to be useful when we consider how people's mind can handle concepts relating to L2 words which might be similar to but also slightly different from the meanings of the translation equivalents in their L1. Lakoff's claim in respect of bodily experience might also be linked to the difficulty of acquiring the concepts of foreign words without being in the environment where the language is spoken.

Cognitive psychologists go beyond the level of dealing with fuzziness of word meanings. They investigate how word meanings may be organised. The following section introduces the so-called network model (Collins and Quillian, 1969; Collins and Loftus, 1975). Based on the semantic network model, the discussion progresses from the issue of semantic organisation to the issue of semantic processing, exploring the mechanism of this model through empirical evidence derived from a number of experiments.

### 3.1.2 The semantic network and its processing

The notion that semantic relations might be organised in a network was first suggested by Collins and Quillian (1969) in their hierarchical network model. Collins and Quillian (1969) claim that the network includes lateral and vertical relations, and is arranged in terms of conceptual hierarchies. They propose that the hierarchies include a superordinate level (e.g. *animal*), a basic level (e.g. *bird*, *fish*, etc.), and a subordinate level (e.g. *robin*, *sparrow*, *canary* etc.). According to this view, each concept at each level is represented by defining features – for instance, an animal *breathes, eats* and *has skin* (at the superordinate level), a bird *has wings, can fly*, and *has feathers* (at the basic level), and a canary *can sing* and *is yellow* (at the subordinate level) (see Figure 16 below).

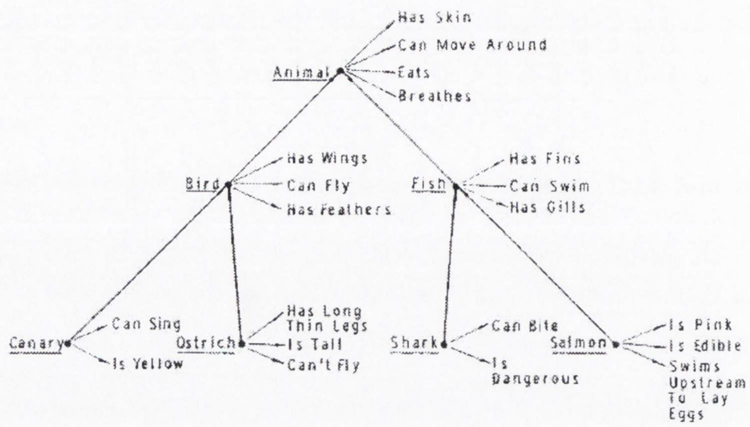


**Figure 16** A schematic representation of concept relatedness in a stereotypical fragment of human memory (where a shorter line represents greater relatedness). (Collins and Quillian, 1969, p.412)

Collins and Quillian (1969) postulate that the verificational processing of concepts and hierarchical categories and of concepts and features might be easier when they are at the same level than when they are at a different level. For example, in the case of the verification of the concept-category relations, "A canary is a bird" may be more difficult to process than "A canary is a canary." Moreover, "A canary is an animal" may be even more difficult to process than "A canary is a bird." Likewise, with regard to the verification of concept-feature relations, "A canary can fly" may be more difficult to process than "A canary can sing." Furthermore, "A canary has skin" may be even more difficult to process than "A canary can fly." This view was examined by Collins and Quillian (ibid.) by means of so-called semantic verification tasks. In this experiment, sentence stimuli were controlled in terms of the degree of hierarchical distance between concepts and their categories and between concepts and their features. Participants were asked to decide whether the stimulus sentences were true or not. The study yielded faster RTs where the relationship between concepts and categories was closer. The same phenomena were observed in respect of concept-feature relations.

This model offered evidence of cognitive economy. This refers to the phenomenon that semantic information is likely to be registered only in the nearest available node of the network and any nodes lower than this inherit the same information, so that space may be saved for the other information. Given the assumption that semantic structure is economical in nature, it is generally assumed that processing slows for items which are stored at different levels in the memory network. However, this model was soon criticised for its limitations. As the notion of prototype emerged, it became problematic. The model did not take account of the possibility that items in the same category may have different values. For example, prototype research suggests that *robin* be perceived as more typical of the category *bird* than *canary* (Rosch, 1973, 1975), although both of them are subordinates of *bird.* Therefore, according to prototype theory, the verification time should be faster for "A robin is a bird" than for "A canary is a bird." It is argued that Collins and Quillian's model, with its emphasis on hierarchical distance, cannot explain differences relating to typicality. Smith, Shoben, and Rips (1974) examined this issue and their study supplied evidence of correlation between typicality and processing speed. Faster processing of verification was observed for semantically more related category-subordinate pairs; that is, verification times of sentences such as "A robin is a bird" were quicker than sentences like "An ostrich is a bird." This shows that the semantic network is not only organised according to hierarchical relationship, but also to typicality and, presumably, frequency of words.

**The spreading activation model**

The hierarchical network model was revised and extended further to the spreading activation model by Collins and Loftus (1975). Collins and Loftus (1975) propose that words may be organised in a semantic as well as a lexical (phonemic and orthographic) network – but not in a strict hierarchical structure – in accordance with the distance between the properties of words. While Collins and Loftus (*ibid.*) also mention the concept of lexical network, the discussion in the present thesis focuses on semantic properties in memory structure.
According to Collins and Loftus, the semantic network is structured according to the degree of semantic resemblance between the concepts of words. Therefore, when semantic properties of certain words have more in common, the words have

stronger links between them than for those which have less in common. Hence, accessibility of a word increases when it is preceded by a similar word in terms of semantic properties. For example, when the word *vehicle* is recognised, although the word *fire-engine* follows, the initial word continues to stimulate other neighbouring nodes of any kind of vehicle such as *ambulance*, *car*, *bus*, and *truck*. However, when the word *red* is recognised and is followed by *fire-engine*, nodes of other kinds of vehicles may remain active, but activation of *cherry*, *rose*, or *sunset* is likely to be inhibited (see Figure 17 below).

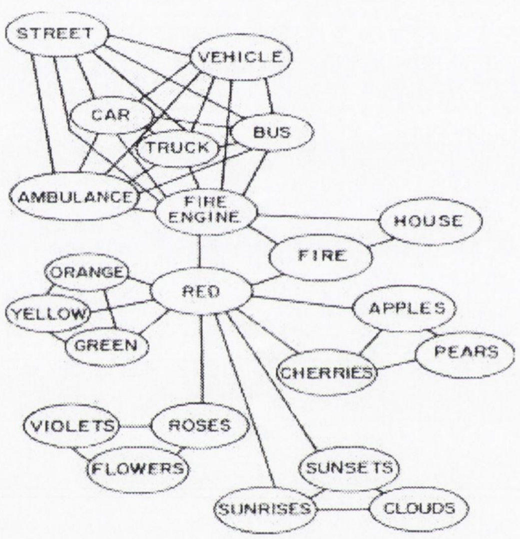


**Figure 17** Illustration of the hypothetical memory structure for a 3-level hierarchy. (Collins and Loftus, 1975, p.241)

Collins and Loftus (ibid.) explain that this inhibition occurs due to the semantic distance between *fire-engine* and non-vehicle-related items such as *cherry*, *rose*, and *sunset*. To summarise, this model emphasises the view that the degree of accessibility may be determined not only by the hierarchical network but also by characteristics of word-meanings relative to the relevant prototype. Another important point in this model concerns the manner of processing. The spreading activation model suggested that the semantic activation spreads in parallel – in other words, that the activation of a single node simultaneously stimulates several related nodes in the semantic network.

The spreading activation model proposed a conceptualisation of the organisation and processing of semantic memory. This made it possible to theoretically explain the generally accepted results of semantic processing studies by Meyer, Schvaneveldt and their colleagues (Meyer and Schvaneveldt, 1971; Meyer, Schvaneveldt and Ruddy, 1975). Meyer, Schvaneveldt and Ruddy (1975) employed experiments using a semantic priming paradigm where letter strings appeared one at a time, the first letter string being followed by the second letter strings. The effects of semantic relatedness in word recognition were tested in Experiment 1 and 3 by comparing subjects' reactions to associated (e.g. BREAD-BUTTER) and unassociated (e.g. NURSE-BUTTER) stimuli. The experiments provided faster RTs for stimuli which were preceded by semantically associated words than for stimuli which were preceded by unassociated words. This is referred to as 'the semantic priming effect.' Such semantic priming effects were observed under all the task conditions—for intact and degraded stimulus presentations (Experiment 1, 3), and for the pronunciation task and the lexical decision task (Experiment 3).

In addition to Meyer, Schvaneveldt and their colleagues' studies, semantic priming effects were examined by a number of researchers, by means of various experimental paradigms—naming tasks (e.g. Balota and Lorch, 1986; Peterson and Simpson, 1989; Seidenberg et al., 1984), lexical decision tasks (e.g. Balota and Lorch, 1986; Beer and Diehl, 2001; McNamara, 1992, 1994; McNamara and Altarriba, 1988; Neely, 1977; Seidenberg et al., 1984; Zeelenberg et al., 1998) and word production tasks (e.g. Dell, 1986). On the basis of these and other studies, the semantic priming effect is generally accepted; the common view is that when a certain concept is activated, related concepts are also activated, which facilitates the processing of these related concepts.

This phenomenon of semantic priming effects is commonly observed under two major conditions: a short stimulus onset asynchrony (SOA) between the prime and the target, and the use of masking. As far as the SOA is concerned, the widely held view is that priming effects are influenced by the length between the onset of priming words and the onset of target words. Neely (1977) presented an influential study addressing his suggestion regarding the sensitivity of SOA in priming effects, based on the notion of automatic and controlled processing proposed by Posner and Snyder (1975). This notion comes from the assumption that semantic processing is potentially rapid and automatic. On the other hand, Posner and Snyder (1975) argue that conscious processing occurs when subjects engage in attention programming, in other words, strategies. For Posner and Snyder (ibid.) subjects may be able to control information processing by obtaining "information from a particular input channel or area of memory" (p.73) and by performing "particular operations upon received information" (p.73). Accordingly, in the case of the lexical decision task for the primed stimuli, it is thought that the conscious processing occurs when subjects employ strategies regarding their prediction about the following items (target items), based on the information from primed words (Neely, 1977).

In Neely's (1977) study, the prime-target pairs derived from categories (e.g. *bird*) and exemplars (e.g. *robin*), and the change of priming effects for these pairs in the lexical decision tasks were examined using different SOAs (250ms, 400ms, 700ms, 2000ms). It emerged that automatic processing was observed only at the short SOAs (shorter than 400ms). At the SOA of 250ms, the facilitation effects (faster reaction times) were produced for the semantically related prime-target pairs (e.g. *bird-robin*, *body-heart*); however, they diminished as the SOAs increased. For Neely (ibid.), this occurred because SOAs of longer than 400ms allow conscious attention to take effect in lexical decision processing. This issue with regard to strategic processing was also investigated by examining expectancy of the categorical exemplar typicality for the stimulus pairs. For instance, in the case that the prime word is *body*, participants were instructed to expect that the target word would be related to a *building* (e.g. door). In other words, they were asked to shift their attention consciously from one semantic category to another. For such pairs (e.g. *body-door*), facilitation effects were observed when the SOAs were *longer* than 400ms.

On the other hand, the trials also included the stimulus pairs for which expectancy strategies do not help the lexical decision. In this case, the prime *body* was followed by unexpected targets (e.g. *body-heart*, *body-sparrow*). For these unexpected pairs, inhibition effects (slower RTs) were found with increase of SOAs (with SOAs longer than 400ms). Such inhibition effects may also be the result of the subjects' prediction strategies; that is, since their expectancy was not correct, the processing slowed. Such conscious processing in terms of strategic prediction occurs when subjects evaluate the relationship between the prime and the target after the lexical access of the target, which is generally known as 'the post-lexical decision check (or post-lexical meaning integration).' Hence, Neely's (1977) study appears to provide evidence which suggests that the SOA is an indicator of whether the effects are due to automatic or conscious processing. In other words, short SOAs (less than 400ms) may prevent subjects from attending conscious processing such as the post-lexical decision check.

Similarly, it is assumed that such prediction strategies for the target items and the post-lexical decision check may be avoided when masking is used (De Groot and Nas, 1991, p.93). For masking, a series of asterisks (*) or hash signs (#) are typically used, and they are presented before or/and after the prime stimuli for a controlled period of time.

Priming effects were further explored by examining mediated priming effects (De Groot, 1983; Balota and Lorch, 1986; McNamara and Altarriba, 1988) and backward priming effects (Koriat, 1981; Seidenberg, Waters, Sanders and Langer, 1984; Peterson and Simpson, 1989). Mediated priming effects come from prime-target pairs which are not directly related (e.g. *bull-milk*) but may link to each other by mediating another concept (e.g. *cow*). Evidence of statistically significant priming effects is reported for such indirectly related pairs in a naming task (Balota and Lorch, 1986) and a lexical decision task (McNamara and Altarriba, 1988). McNamara and Altarriba (1988) note that the effects for the mediated pairs were smaller than for the directly related pairs (Experiment 3), which indicates greater semantic distance in the network between mediated pairs than between directly related pairs.

The backward priming (target→prime) studies aim to examine whether spreading activation is directional. For instance, priming effects are expected to occur when a target word (e.g. *baby*) is preceded by a prime word (e.g. *stork*). However, it was investigated whether priming effects could be found for the prime and the target in the reverse direction—that is, where, for example, the word *stork* is preceded by the word *baby*, which is generally termed backward priming. Evidence of backward priming effects was provided in a lexical decision task (Koriat, 1981; Seidenberg, et al., 1984; Peterson and Simpson, 1989) and in a naming task (Peterson and Simpson, 1989). Peterson and Simpson's (1989) study offers evidence that backward priming effects may occur as a result of automatic processing in very short interstimulus intervals (ISI) (e.g. 0ms), in which processing of the prime and the target temporally overlap. Since the second item (the prime in the semantic association) is presented while the first item (the target in the semantic association) is still being processed, lexical access to the prime (the second item) is facilitated by the related target (the first item). However, when the ISI is longer (e.g. 200ms), the facilitation effects obtained in the lexical decision task may be due to controlled processing.

Extended priming studies appear to verify the phenomenon that recognition of a word is facilitated when it is preceded by a word which is related directly, indirectly, or bidirectionally. As was previously described, the spreading activation model claims that these effects are due to the active pre-activation of the related concepts, this being triggered by the activation of the prime words (Collins and Loftus, 1975; Posner and Snyder, 1975). The general approach of this model, it might be noted, later evolved into the basis of revised versions in the form of ACT* ("Adaptive Control of Thought star," Anderson, 1983) and ACT-R ("Adaptive Control of Thought rational," Anderson, 1993).

Revised versions of the spreading activation model were proposed by Anderson (1983, 1993), these being labelled ACT* and its updated version, ACT-R. These models intend to draw a comprehensive picture of human cognition, which is often called 'cognitive architectures' (Anderson, 2000, p.15). By attempting to provide a broad perspective on information processing, they seem to be able to describe the mechanism of spreading activation. Anderson (1983, p.21) states that the ACT is different from conventional spreading activation models in that his revised models distinguish declarative knowledge from procedural knowledge in long-term memory. In declarative memory, according to Anderson, associative information such as propositions (e.g. *hate, Bill, Fred*), temporal strings (e.g. *one, two, three*), and spatial images are stored. On the other hand, procedural memory is responsible for processing production. These two types of memory are related to the performance of information storage and retrieval (using declarative knowledge), and of production (using procedural knowledge). According to Anderson (1993, p.18), declarative knowledge refers to knowledge about facts such as 'Washington, DC is the capital of the United States.' On the other hand, procedural knowledge represents the ability to use knowledge by means of matching and execution; for instance, the ability to speak English. To illustrate, when a word is recognised, relevant information stored in an associative network in declarative memory is retrieved and matched with the input, and production is executed by using procedural memory. Such information processing is implemented through the mediation of working memory, in which information is currently being processed, and also temporally stored.

ACT* and ACT-R predict priming effects by assuming parallel spreading activation. According to Anderson (1983), when the prime item is presented, this item functions as a source of activation, and the activation spreads simultaneously to all related nodes in the whole network (i.e. declarative memory). Therefore, when the related target is presented, it is already pre-activated by spread of activation, and thus is recognised faster than an unrelated target. The strength of activation varies as a function of the degree of association between the source and the activated items. Thus, the level of activation increases with the increase of relatedness between these items. On the other hand, the activation rapidly decays as the relatedness between them decreases.

Anderson (1983, 1993) developed the concept of spreading activation, which seems to be able to account for more complex mechanisms of priming effects. Particularly, as Anderson (1993, p.20) argues, the distinction between two types of memory (i.e. declarative and procedural memory) appears to be useful in that the distinction may offer flexible solutions to issues surrounding the use of memory in information processing.

On the other hand, Ratcliff and McKoon (1988, 1995) query whether the spreading activation model truly accounts for priming effects. Ratcliff and McKoon (ibid.) proposed the compound-cue model on the basis of the conception of the cue (prime-target) association mechanism originally suggested by Gillud and Shiffrin (1984) and Murdock (1982). Ratcliff and McKoon argue that priming effects may be caused by the process of matching target words with recently presented words (priming words) in short-term memory, rather than by pre-activation of related words. For them, in lexical decision tasks, the prime and the target are compounded as cues in short-term memory so that the degree of connectivity of the compound is assessed. This computes the familiarity value of the compound, referring to all the relevant information in long-term memory. When the degree of compound connectivity is found to be strong, the familiarity level is said to be high. Ratcliff and McKoon claim that this production of familiarity value affects the time and accuracy of the response in lexical decision tasks. To illustrate, if the familiarity value of the compound is high due to strong connectivity, the processing of lexical decision is facilitated—that is, a faster and more accurate response is produced (i.e. priming effects).

However, this model can be seen to have some limitations. The model is principally designed as an alternative to the spreading activation model, in explaining priming effects in the binary condition of lexical decision tasks. Therefore, its postulations with regard to the mechanism of priming effects is unlikely to apply to other tasks such as naming tasks, as Balota (1994, p.345) points out. Also, the involvement of short-term memory in the priming effects is questioned (Beer and Diehl, 2001).

Beer and Diehl (2001) examined the prediction of the compound-cue model as to whether short-term memory involves priming effects, using a combination of a digit span task and a lexical decision task. They postulated that if priming effects are the result of matching of the compound cue in short-term memory, a digit span task which uses short-term memory would interfere with the priming effects in question. On the other hand, if the priming phenomenon occurs within long-term memory, as the spreading activation model suggests, no interference should be found. First, participants were asked to memorise short (two), medium (four) and long (mean of 6.9) digit strings (a digit span task), and then to perform lexical decision tasks involving both the prime and the target. Immediately after the lexical decision task, they were required to recall the digit strings by typing them. Beer and Diehl (2001) report that the digit span task did not affect the priming effects in the lexical decision performance. In other words, reliable priming effects were obtained for related pairs as opposed to unrelated pairs, even for the trials which required high loading of memory by the memorisation of long digit strings in the digit span task. Beer and Diehl conclude that this outcome supports the prediction of the spreading activation model that memory load in short-term memory is unlikely to be related to priming.

The spreading activation model was also adopted in language production research. Dell (1986) included the concept of spreading activation theory in his production model. Evidence of this proposal was provided by studies of speech errors (i.e. slips of the tongue).

More recent models proposed by Levelt and his colleagues, called a network model of lexical access (Bock and Levelt, 1994) and WEAVER++ (Levelt et al., 1999) are designed to depict the lexical network organisation and processing in terms of both recognition and production. Levelt and colleagues attempt to illustrate the relations of concept, lemma (i.e. syntactic, in their model) and lexeme (i.e. form) properties in terms of lexical organisation and processing. The major objectives of their studies are to investigate how the notion of spreading activation might work in the global lexical network where each linguistic property (semantic, syntactic and lexical) is connected to each other (see 1.3 Levelt's model for more detailed explanation). However, in this thesis, the discussion is confined to semantic matters. According to Levelt and his colleagues, semantics (the terminology *lexical concepts* is used in their model) belongs to conceptual memory and links to syntactic memory at the lemma level. The semantic network is represented as being organised and processed in line with what the spreading activation model (Collins and Loftus, 1975) postulates. Bock and Levelt (1994) provide detailed illustration with regard to the manner of the semantic network as follows.

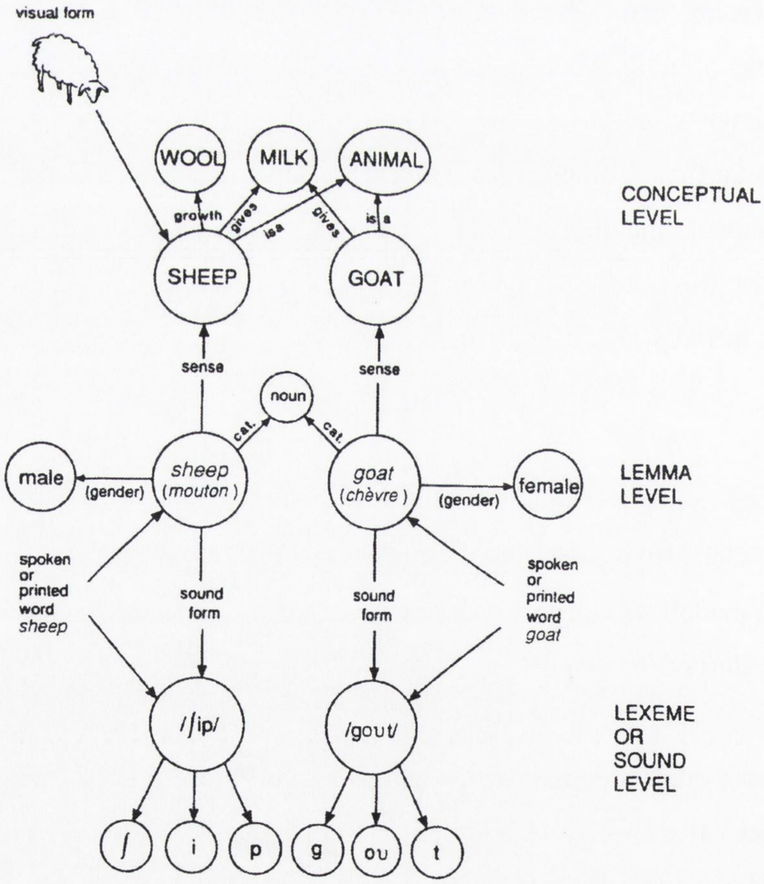


**Figure 18** A part of the lexical network. Note that the arrows represent types of connections within the network, not the flow of information during production or comprehension. (Bock and Levelt, 1994, p.951)

The node of the word *sheep* is connected to the node *animal* by an IS A link (i.e. a sheep IS An animal), to the node *milk* by a GIVES link, and further, to the node *goat* directly or through those *animal* and *milk* links. Hence, when the word *sheep* is stimulated, activation spreads to these related nodes (see Figure 18 above).

Speech errors are often seen to demonstrate spreading semantic activation. Bock and Levelt (1994) claim that three kinds of speech errors (i.e. substitutions, blends and exchanges) reveal the manner of spreading semantic activation (see Levelt's model in 1.3 for detailed explanation of these speech errors). Bock and Levelt (1994) argue that experimental studies involving picture interference (Lupker, 1979; Glaser and Düngelhoff, 1984; Schriefers, Meyer and Levelt, 1990) also provide evidence of spreading activation. In picture interference studies, word distracters are used in picture-naming tasks. For the word distracters, various kinds of words are selected in relation to picture stimuli such as superordinates, identical words, subordinates, semantically close associates, phonologically related words, and unrelated words. Such studies elicit the result that picture naming responses (e.g. *sheep*) are slower when the distracters are semantically related (e.g. *goat*) to the picture stimuli than when they are unrelated (e.g. *house*). Bock and Levelt (1994) suggest that this phenomenon results from the inhibition process of semantically related distracters (e.g. *goat*) which are more activated than unrelated distracters (e.g. *house*). This is because once the picture stimulus (e.g. involving the denotatum of *sheep*) is presented, the concept *sheep* spreads activation to the concept encapsulated in *goat*, which means that subjects find it difficult to ignore the distracter. Such evidence of spreading semantic activation with reference to speech errors and picture interference studies further helps us understand network organisation and processing in lexical access.

The discussion so far has been related to studies of semantic organisation and processing in L1. It concluded by concurring with the view that the semantic dimension of the mental lexicon is organised in the form of an association network, and that the nodes of the network are connected to each other on the basis of semantic relatedness (the spreading activation model, Collins and Loftus, 1975; ACT* and ACT-R, Anderson, 1983, 1993; a network model of lexical access, Bock and Levelt, 1994; WEAVER++ Levelt, et al., 1999). In this perspective the distance between nodes reflects the degree of semantic relatedness between the relevant words, and according to the degree of semantic relatedness, when a word is recognised and produced, related words are automatically activated. This activation is seen as spreading simultaneously to several nodes starting with the nearest nodes to the current stimulus item and spreading to further nodes (one-step mediated priming effects, Balota and Lorch, 1986; McNamara and Altarriba, 1988; two-step mediated priming effects, McNamara, 1992; and backward priming effects, Koriat, 1981; Seidenberg, Waters, Sanders and Langer, 1984; Peterson and Simpson, 1989).

On the basis of such a view, I would next like to address the issue of semantic organisation and processing in the case of the bilingual lexicon. In this connection, I explore how two networks from each language may be structured in a bilingual's mind. This matter is considered taking account of the fact that the semantic quality of translation equivalents from two languages may not sometimes be identical. The exploration of bilingual semantics also covers cases where the bilingual lexicon may be unbalanced depending on acquisition level in L2. These two points – the nature of the two languages in question and the situation of individual bilinguals – are regarded as major elements in determining the degree of connection between two lexicons (see discussion in Chapter 2, 2.3.2). In relation to the exploration of questions in terms of the organisation of bilingual semantics, the discussion further proceeds to the issue of bilingual semantic processing.

### 3.2 The bilingual semantic network and bilingual semantic processing

In this section, the semantics of the bilingual lexicon is explored within the framework of the association network perspective, where nodes are seen as connected within and between languages. It is assumed that the degree of semantic connectivity between languages may vary in terms of word types, grammatical class, stage of language development, language distance etc. (see discussion in Chapter 2). To illustrate, on this view the nodes from each language may be nearly integrated for words such as concrete words and cognates, while they may be separated but somewhat associated for words such as abstract words and non-cognates. Further, the network of the second language may replicate that of the first language when the bilingual's L2 acquisition is at an early stage, and the associative links of the network for the L2 may also be weaker than those of the network for the L1. The closeness and the distance of nodes across languages may also relate to degrees of cultural similarity and difference. The semantic priming studies prove that some words are more likely to be associated than other words due to a larger degree of semantic relatedness (e.g. Meyer and Schvaneveldt, 1971; Meyer, Schvaneveldt and Ruddy, 1975; Balota and Lorch, 1986; McNamara, 1992, 1994; Beer and Diehl, 2001; see detailed discussion in 3.1.2). The way some words tend to occur with particular words rather than with others often varies between languages. For example, in English, the word *admit* is more likely to occur with *truth* than with *marriage*, while in Japanese, the translation equivalent *yurusu* is more likely to occur with *kekkon* (marriage) than with *shinjitsu* (truth). It appears that the manner of cross-linguistic collocational association of words represents how the nodes of the bilingual semantic network connect to each other within and between languages. The focus of this section is to analyse cross-language differences of semantic constellation in terms of collocational association. The discussion also extends to the issue of how bilinguals' collocation processing in one language may be affected by knowledge of collocational associations in another language. It was noted in Chapter 2 that access to the bilingual lexicon is, in principle, language-non-selective in the initial stage of processing. A general outline will be provided here with regard to what factors may influence the degree of the effects of the non-target lexicon on target language processing.

### 3.2.1 A semantic network in two languages

The notion of the bilingual network was initially expounded by Paradis (1987) from a neuropsychological perspective. Paradis (*ibid.*) proposes the

Subset Hypothesis, which claims that the bilingual lexicon consists of a distinctive network for each language under a single cognitive system. Thus, Paradis assumes that two individual languages are organised as subsets of a neural network system, in such a way that each system functions in a particular manner, but elements from each network system are interconnected across languages. Paradis (1987) describes this mechanism as follows:

> Bilinguals have two subsets of neural connections, one for each language (and each can be activated or inhibited independently because of the strong associations between the elements) while at the same time they possess one larger set from which they are able to draw elements of either language at any time. (Paradis, 1987, p.9)

This view seems to account for the phenomenon whereby an arbitrary language can be selected while two languages are simultaneously activated (Green, 1986, 1998; Grosjean, 1997, 1998, 2001). Herwig (2001) illustrates this bilingual network system, where each node is interconnected within and between languages.

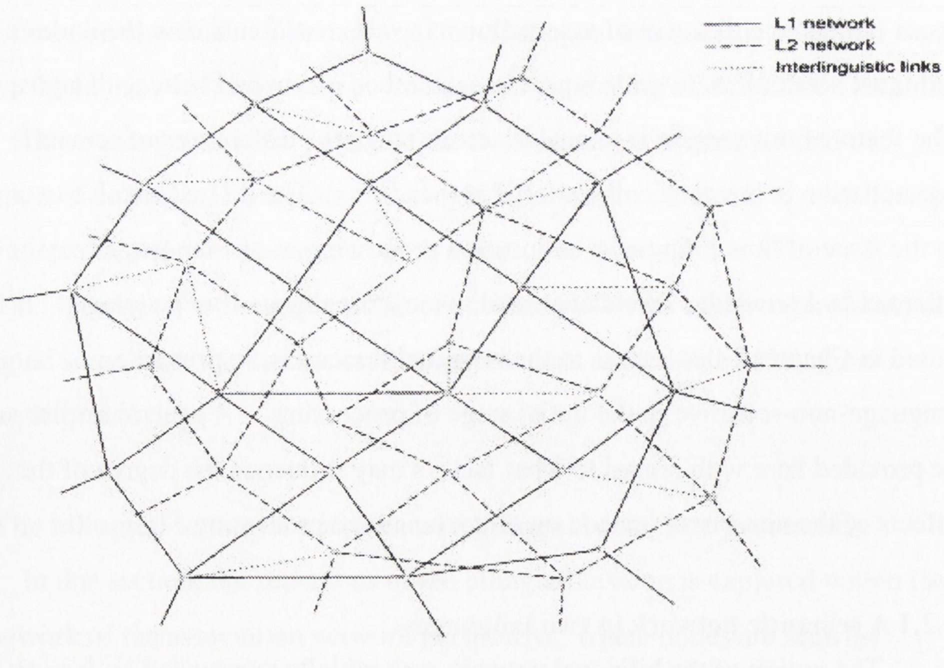


**Figure 19** Network model of the bilingual mental lexicon. (Herwig, 2001, p.117)

The network system depicted above represents the whole lexicon, which is generally regarded as consisting of two lexical levels: lemma (semantics and syntax) and lexeme (phonology and orthography) (Levelt, 1993). Thus, the interconnection of lexical nodes across languages should occur at both these lexical levels. When discussion focuses on the semantic level, semantic connectivity across languages may be measured by the degree of conceptual overlap between the two semantic representations for the translation equivalents (De Groot, 1993). As was described in Chapter 2, apart from the issue of individual differences between bilingual speakers, the conceptual overlap between languages has been examined in terms of conceptual and linguistic categories: concreteness, animacy, emotiveness, cognate status, and grammatical class. It was argued that such general distinctions have limitations, since they do not tell us more than the *likelihood* of the occurrence of the phenomena under discussion; one may readily find exceptional cases (e.g. culture-affected concrete words such as *altar*, *saidan* and *butsudan*; see discussion in Chapter 2, p.83). Thus, as was argued earlier, De Groot's (1993) distributed feature model is important in that the model can explain why some translation equivalents share very similar meanings, while others do not (Heredia and Brown, 2004). At this point we shall investigate particular examples from the specific languages dealt with by the present study in order to explore how semantic similarities and differences in the bilingual lexicon can be identified.

The following case study is based on my preliminary study with regard to semantic connectivity of the bilingual network, focusing on the semantic difference between translation equivalents (Ueno, 2003). In this study, a free association task was used.

**Cross-linguistic connectivity in the semantic network: the case of the English words *admit* and *allow*, and the Japanese word *yurusu***

A free association study using nouns and verbs supplies evidence of different patterns of semantic mapping between English and Japanese (Ueno, 2003). In this study, the stimulus items were pairs of synonymic English words which are generally translated into single words in Japanese. For instance, both *admit* and *allow* are translated into a single Japanese word '*yurusu.*' Participants were 40 Japanese undergraduate students and 15 native speakers of English (Americans and Canadians) educated to at least undergraduate degree level. Participants were asked to write up to 5 association words in English for each stimulus item within one minute. The results demonstrated that similar association words were provided by both Japanese undergraduate students and native speakers of English. However, it was also found that native speakers of English supplied more associations which were unique to English mappings than Japanese undergraduate students. For example, *admit*, which is derived from the old French word *ammettre* and the Latin word *admittere*, defined as "to let to or into," consists of two meanings i) "to accept a truth (unwillingly)/ to accept responsibility for doing/saying something wrong /illegal" and ii) "to allow to enter/join" (Oxford University Press, 2006; Cambridge University Press, 2006). On the other hand, *allow*, which is derived from the old French word *alouer* (and also from the Latin words *allaudare* and *allocare*), defined as "to praise" and "to bestow, assign," includes the following definitions: i) "to permit" and ii) "to make something possible" (Oxford University Press, 2006; Cambridge University Press, 2006). As far as the Japanese word *yurusu* is concerned, it is derived from the concept "to loosen/let loose something/someone," and can be defined as i) "to allow a person to do something," ii) "to admit (into a school/college)," iii) "to forgive someone mistakes/sins," iv) "to be indulgent to someone doing something as a result of lack of attention or caution," and v) "to permit (of time/space/ weather)" (Nimura, 2002).

Thus, the Japanese word *yurusu* shares the concepts of "to allow to enter/join" with the English word *admit*, and shares the concepts of "to permit" and "to make something possible" with the English word *allow* (see Figure 20 below). However, the concepts which are not shared across the languages such as "to accept a truth (unwillingly)/ to accept responsibility for doing/saying something wrong /illegal" for *admit* and *yurusu*, are regarded as English-unique concepts.

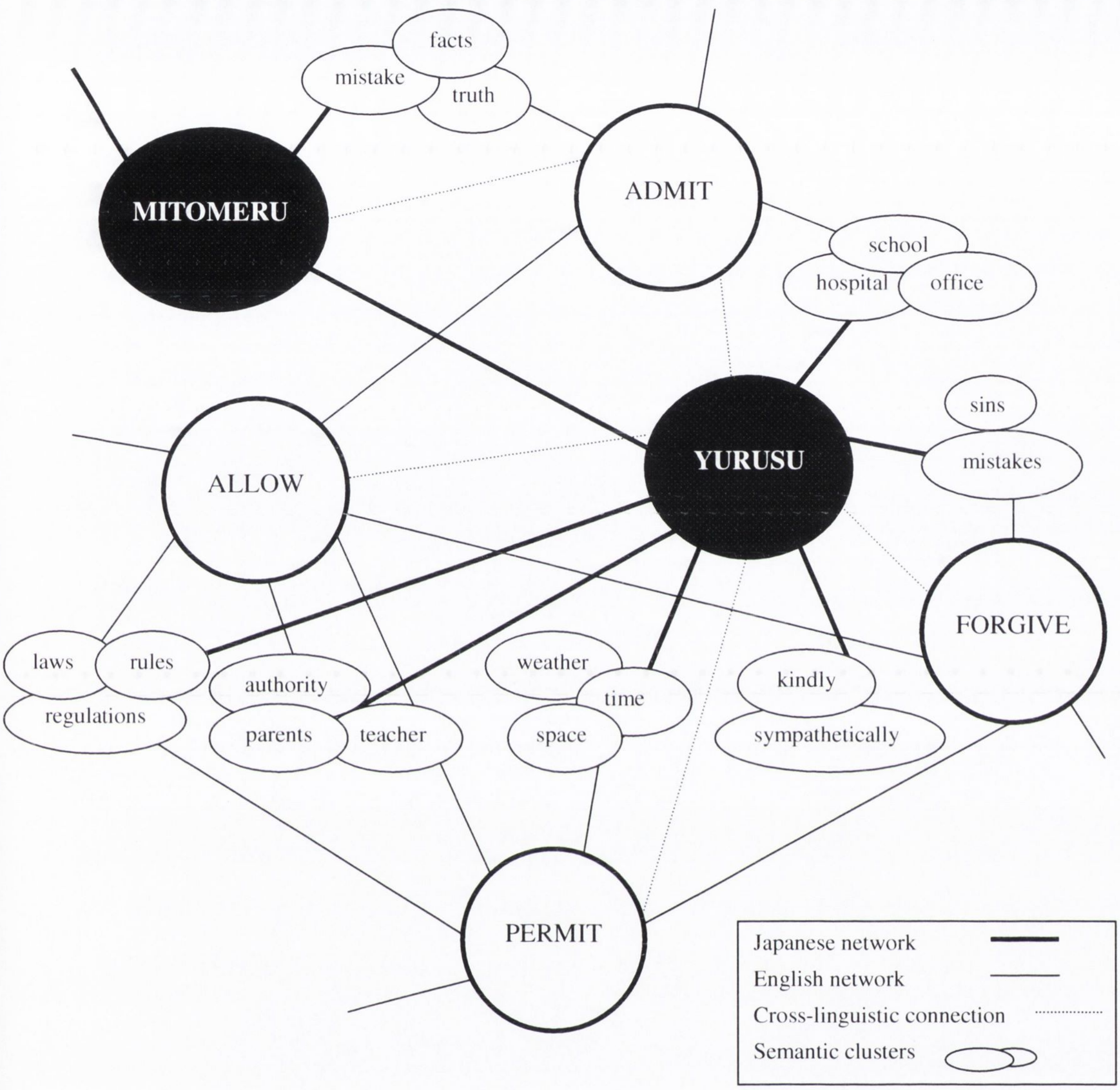


**Figure 20** The bilingual semantic network

Correspondingly, in the case of the stimulus item *admit*, Japanese participants tended to respond with a greater number of words which reflect the commonality of meaning between the English and Japanese translation equivalents - such as *permission, accept, allow*, *let*, *enter, school, office*, and *test,* than with words which consist of English-unique concepts. In fact, although the majority of responses from the native speakers of English were related to the relevant English-unique concept – e.g., *truth*, *guilt*, *confess*, *deny* and *honesty*, Japanese participants produced none of these associations. This may be because in

Japanese, this concept links to another word, *mitomeru*, which includes this concept, "to recognise/acknowledge (one's error) or to admit (a fact)," as well as other concepts "to see or notice, to approve of (a plan), to judge/consider/ regard a thing (a person) as something or someone" (Nimura, 2002) (see Figure 20 above).

Furthermore, instead of producing associates of the English-unique concept associated with *admit*, Japanese participants supplied responses such as *forgive*, *marriage*, *parents*, *love* and *kind*, whereas native speakers of English produced none of these. These words seem to be rather associated with *forgive, approve of,* and *allow*. Thus, Ueno (2003) concluded that the free association test revealed the English lexicon of these Japanese undergraduate students being strongly affected by their Japanese lexicons. In particular, for these Japanese participants, the concept of *admit* consists partly of the concepts common to the two languages (e.g. *school*), and partly of irrelevant concepts from the translation equivalent, *yurusu* (e.g. *forgive*, *allow*, *permit*). This may be more likely to occur in the case of less frequent, abstract, and non-cognate verbs such as *admit*, than in the case of more frequent, concrete cognate nouns. This seems to be in line with the broadly accepted standpoint that L2 semantics is parasitic on L1 semantics in the early stage of L2 acquisition (Kroll, 1993; Levelt, 1993; de Bot, Paribakht and Wesche, 1997; Jiang, 2000).

The results of the word association study above are illustrated as an example of how lexical links may differ across languages. The semantic network specific to the language seems to restrict the lexical selection in collocations. Thus, a cross-linguistic analysis of collocations may be useful in investigating the similarities and differences of semantic mapping between languages. The following section focuses on collocations. It gives an account of how collocations are defined, and considers how the semantic mapping of collocations might be represented in two languages.

### 3.2.2 Collocation as a semantic profile

Inter-lexical connections in texts appear to be definable in terms of semantico-syntactic associations. When a particular word is uttered, some words are more likely to follow than others in accordance with the relevant semantic and syntactic relations. For example, the English verb *spend*, which has a semantic field covering various senses of *using up* such as "an amount of money" or "a period of time," is likely to be followed by expressions such as *100 euro, a day, a holiday* (Jackson, 2002, p.18). Such patterns of words which frequently co-occur in sentences are identified as collocations (Greenbaum, 1974). The degree of closeness of a particular lexical partnership in collocations varies depending on the breadth of the collocational range of the items in question – from unrestricted (e.g. *take a look*, *take a letter*, *take time*, *take a walk*) to restricted (e.g. *stark naked*, *pitch black*) (Carter, 1998, pp.70-71).

Collocation was first given serious attention and explored by corpus linguists in the 1960s (Halliday, 1966; Sinclair, 1966). The initial aims and methods of corpus linguistics are precisely described by Carter (1998) as follows:

> In Sinclair (1966) and Sinclair et al. (1970) the aim was to study large quantities of text in order to focus in a statistically significant way on the company kept by particular words and for the 'strength' and 'weakness' of partnerships to be expressed in terms of percentile frequencies of co-occurrence. (Carter, 1998, p.53)

Thus, corpus linguists have attempted to investigate lexical compatibility by collecting numerous samples from authentic written and spoken texts and by computerising them in order to be able to avail themselves of statistical analysis. Such statistical analysis has become a common approach to explore collocation (e.g. Hoey, 1991; Sinclair, 1991; Hunston, 2002), and during the past 40 years, corpus research has progressed remarkably. At present, a number of computerised corpora are available ranging in size from one million words of written American English (the Brown Corpus) to more than 320 million words of written and spoken British English (COBUILD).

On the other hand, Hoey (2005) draws attention to the psychological perspective of collocation. He discusses that the psychological approach illustrates the *phenomenon* of collocation, whereas the statistical approach provides *evidence* of collocation. Collocations appearing in texts originally come from lexical association in the mind. Hoey (2005, p.7) explains as follows:

> … collocation is fundamentally a psychological concept. What has to be accounted for is the recurrent co-occurrence of words. If they were stored in our minds separately or in sets, the kinds of collocational naturalness … would be inexplicable.

Hoey claims that pervasiveness of collocation can be accounted for by the fact that words are primed to occur with their collocates.

Hunston (2002) suggests that collocation can be seen as an indicator of semantic association in a lexical network. Hunston (ibid., p.76) comments, in relation to her corpus study, that "the list of collocation gives a kind of semantic profile of the word involved." According to Hunston, the study of a corpus reveals patterns of semantic connection. For example, the verb *leak* is likely to be associated with *oil, water, gas, roof*, which are for their part associated with the phenomenon of a fluid or gas entering/escaping through a hole or crack. In addition, the meaning of *leak* is extended metaphorically, and hence the word also tends to be associated with *documents, information, report, memo, confidential, press, details, letter, news* and *draft* (Hunston, 2002, p.76).

Thus, the collocational associations of a word seem to sketch a mental schema of semantic linkage within a lexical network. In other words, they appear to indicate what kind of word meanings the semantics of a given word tends to link to. Such semantic links in relation to collocational associations were illustrated by the cases of the English words *admit* and *allow* and the Japanese word *yurusu* earlier (see Figure 20). Hence, collocational associations appear to point to and reflect the semantic constituents of the words in question. In the following section, the semantic components of the word *admit* are outlined using corpus data relative to collocational associations. An attempt is also made to demonstrate how the semantic components of this word might appear when it figures in the lexicon of unbalanced bilinguals. This is done by using L2 learners' association data from a free association test conducted by the author (Ueno, 2003).

**A semantic analysis of *admit* on the basis of corpus data and data from L2 learners**

Now, let us examine what a corpus can tell us with regard to the usage of *admit* — specifically, with which words it is likely to combine and in which context this word is used. The table below (Table 2) represents the most frequent nine words which are likely to combine with the verb *admit*, according to the BNC (British National Corpus). The asterisk (*) shows the location of the word *admit*, and the numbers indicate how many times each word (on the left) appears on the left five (L1-5) and right five (R1-5) locations.

The table below demonstrates that *admit* is most typically used in the context of "to accept a truth (unwillingly)/ to accept responsibility for doing/saying something wrong /illegal." It appears that THAT, IT and MUST are commonly used together with *admit* in this context.

**Table 2** Frequency and locations of the words co-occur with *admit* (source of data: BNC)

| N | WORD | TOTAL | LEFT | RIGHT | L5 | L4 | L3 | L2 | L1 | * | R1 | R2 | R3 | R4 | R5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ADMIT | 3674 | 20 | 28 | 9 | 6 | 4 | 1 | 0 | 3626 | 2 | 3 | 6 | 8 | 9 |
| 1 | TO | 2482 | 1767 | 715 | 55 | 41 | 30 | 19 | 1622 | 0 | 370 | 95 | 58 | 90 | 102 |
| 2 | I | 1746 | 1131 | 615 | 71 | 77 | 204 | 539 | 240 | 0 | 250 | 170 | 74 | 65 | 56 |
| 3 | THAT | 1272 | 113 | 1159 | 39 | 31 | 23 | 19 | 1 | 0 | 910 | 55 | 75 | 57 | 62 |
| 4 | THE | 1195 | 420 | 775 | 167 | 84 | 133 | 36 | 0 | 0 | 172 | 180 | 117 | 151 | 155 |
| 5 | IT | 717 | 117 | 600 | 40 | 44 | 22 | 10 | 1 | 0 | 376 | 103 | 39 | 42 | 40 |
| 6 | MUST | 562 | 551 | 11 | 1 | 6 | 0 | 14 | 530 | 0 | 0 | 2 | 3 | 3 | 3 |
| 7 | AND | 545 | 339 | 206 | 79 | 88 | 103 | 34 | 35 | 0 | 9 | 35 | 57 | 53 | 52 |
| 8 | OF | 521 | 170 | 351 | 64 | 52 | 45 | 9 | 0 | 0 | 31 | 22 | 91 | 109 | 98 |
| 9 | WAS | 503 | 183 | 320 | 35 | 53 | 84 | 10 | 1 | 0 | 4 | 110 | 94 | 60 | 52 |

See the examples for THAT, IT and MUST as follows:

> (1) The bitterness he was feeling twisted his mouth, and Kate tried to put things right. But if you're honest you'll **admit** *that* you weren't quite sure if I was going to make trouble for you! There! Kate had put his worries into words. He bent to kiss...
>
> (2) You really lost your cool, you've got to **admit** *it*; and it was obvious that you thought I was completely off my trolley, so you see; As it happens, Cassie, no...
>
> (3) ... I know. I 'm going to run a marathon on Wednesday I 'm worried about that, two, two days of packing, I've got funny. Yeah, yeah. I *must* **admit**, I think it had been better if they'd moved it all over the weekend and then just put it straight again on the Monday, that would be...

In the case of THAT, the table indicates that THAT most commonly appears just to the right of *admit*, that is (R1: 910 times out of the total of 1272 occurrences). Example (1) illustrates '*admit* THAT....' With regard to the case of IT, this word seems to appear typically also on the right to *admit* (376 times out of the total of 717 occurrences). This refers to the fact that IT co-occurs with *admit* in the form of 'admit IT,' as example (2) demonstrates. Further, according to the table, MUST is commonly preceded by *admit* (530 out of the total of 562 occurrences). Example (3) illustrates the usage of "MUST *admit....*' In addition, TO in R1 (370 times out of the total of 2482 occurrences) may represent how *admit* is employed in the context as below. See the following examples:

> (4) ...own, see. Do your shopping, then go round the shops there! But this is up out of the way! I bet they have seen a change! Yeah, they'll never **admit** *to* you! No, well you see they'll admit it in their annual returns. But, er..., it doesn't get put in the paper you know individually. It's just, you...
>
> (5) ...setting, with the motto Spero Meliora engraved on the seal. I never took off the signet Leslie now wrote and never would **admit** *to* myself

why I didn't. But you know I always loved you, darling, and, being a mere male, didn't have to take it off. What false advan…

(6)…wife, Miranda, I had them down as a sort of suicidal Sonny and Cher. Doogie was Scottish; well, he would be, nobody would **admit** *to* coming from Inverness if they weren't; and had absolutely no sense of humour. It was almost as if it had been surgically removed…

Both (4) and (5) exemplify the pattern, '**admit** *to* someone,' meaning 'to confess to someone.' On the other hand, (6) represents the pattern '**admit** TO gerund,' meaning 'to accept the truth of having done something.'

The co-occurrence of **admit** and TO is also found for another definition of *admit*. In this context, TO appears in R2 (95 times out of the total of 2482 occurrences). The second definition is 'to allow to enter/join,' as was explained earlier. See the following three examples.

(7)…practitioner diagnoses as an irreducible right inguinal hernia. He refers Mr Brown to the Outpatient Clinic where the consultant arranges to **admit** him *to* hospital promptly, because of the risk of strangulation. Mr Brown is in fact admitted to hospital 10 days later for repair of his hernia…

(8)…of these surfaces as you can: tables should be covered, floors should be carpeted, and windows should be curtained unless it is essential to **admit** daylight *to* the scene. If, in spite of these precautions, your recordings still have an unpleasantly boomy quality, you will then need to…

(9)…of illegal drugs. He's been remanded in custody until the 5th of March. Read in studio Students have stepped up their protest over plans to **admit** men *to* one of Oxford University's last remaining women's colleges. They say they've been promised full consultation with the college…

The three examples above illustrate that *admit* and TO co-occur in the form of '*admit* someone/somehing TO [PLACE]…' In particular, (8) shows that admit can also be used for allowing non-animates (e.g. daylight) to enter.

The results of the corpus analysis with regard to the collocations of *admit* seems to be consistent with the native speakers' responses for the stimulus *admit* in the free association test discussed earlier (Ueno, 2003). To illustrate, *admit* is used in two ways: "to accept a truth (unwillingly)/ to accept responsibility for doing/saying something wrong /illegal" and "to allow to enter/join.' Furthermore, the first context occurs more commonly than the second context (see Figure 21 below).

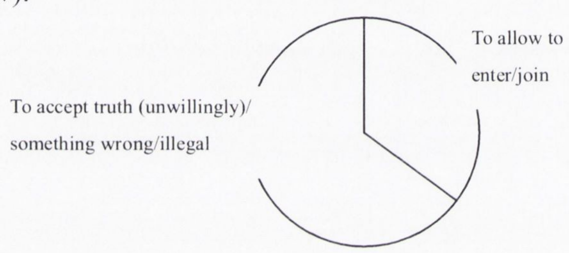


**Figure 21** Semantic schema of *admit*

However, for the L2 learners (Japanese participants), their L2 semantics of *admit* is not complete (the semantics of *admit* is indicated by the dotted line in Figure 22 below). The semantics of *admit* is here associated with one of the concepts that semantics of the Japanese word *yurusu* includes, 'to allow to enter/join.'

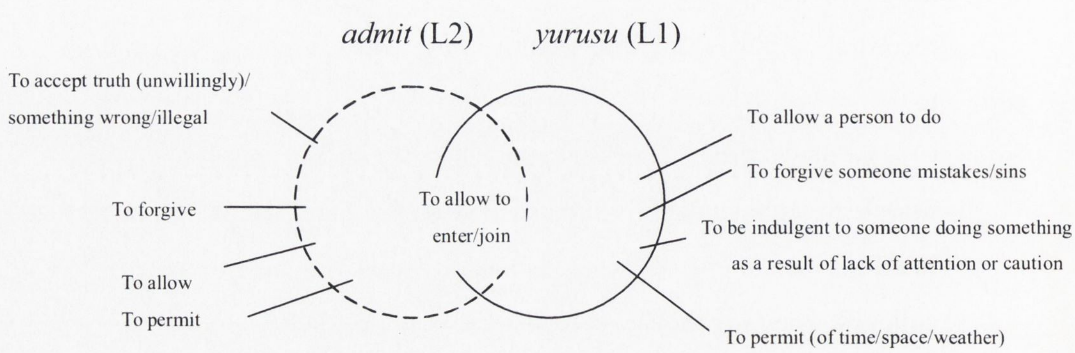


**Figure 22** Semantic schema of *admit* and *yurusu* in the case of Japanese learners of English

The concept, 'to allow to enter/join,' is the only common concept between *admit* and *yurusu*; therefore, this concept may remain strong in Japanese learners' semantics of *admit*. Moreover, since semantics of *yurusu* also includes other concepts (i.e. 'to forgive,' 'to allow' and 'to permit'), the semantics of *admit* may adopt these other concepts of *yurusu*, as Ueno (2003) suggests (see the section 'cross-linguistic connectivity in the semantics network'). The relative frequency of the use of the word *admit* obtained through the corpus analysis provides evidence supporting the results of the free association test with respect to the native speakers. In other words, it seems to correspond to the English native speakers' mental lexicon for the word in question. This also indicates that the English mental lexicon of Japanese participants is affected by their L1 lexicon.

To summarise, the examples of *admit* and *yurusu* suggest that the semantic composition of an L2 word can be strongly influenced by the semantics of its L1 translation-equivalent. This is natural at the early stage of L2 acquisition: we recall in this connection Lakoff's (1987a, Lakoff and Johnson, 1999) and Jackendoff's (1992) views on cognitive ability (pp.142-144). Learners with little experience of an L2 adopt a mental schema based on lemma of the L1 equivalent words in order to make up for missing L2 semantics. However, as the learners gain more experience with the L2, their internalised cognitive abilities enable them to compare the semantics of the two languages and to notice similarities and differences. This causes learners to correct and expand the schema of L2 semantics adopted from L1 lemmas, which may eventually lead to the creation of relevant L2 semantics.

Thus, L2 semantic parasitism in relation to L1 semantics may be defined by semantic overlap between languages and the adoption of concepts from L1 translation-equivalents. The extent of such influence may vary in accordance with individuals' L2 acquisition level. A number of researchers (Kroll, 1993; Levelt, 1993; de Bot, Paribakht and Wesche, 1997; Jiang, 2000) claim that the extent of the influence is larger for novice learners than for more proficient learners. This can be expected particularly when there are large semantic differences between languages. The next section considers how this might relate to L2 semantic processing.

### 3.2.3 Development of L2 semantics and bilingual semantic connectivity

Chapter 2 discussed the notion that bilingual lexical access is language-non-selective at the initial stage (Green, 1986, 1998; Grosjean, 1997, 1998, 2001). Cross-language semantic processing has been studied by some researchers using a semantic priming paradigm in a lexical decision format. Interlingual priming effects were found for cognates (De Groot and Nas, 1991; Gollan, Forster and Frost, 1997) and concrete words (Jin, 1991) but not for non-cognates and abstract words (see Chapter 2, 2.3.1 for details). The researchers in question argue that this offers evidence that the concepts of cognates and concrete words are shared across languages. Furthermore, Fox (1996) reports that interlingual semantic priming effects were also obtained with respect to a stimulus list which included both concrete and abstract words.

Previous studies seem to suggest that the interactive connection between bilingual semantic networks is more discernible when the degree of conceptual overlap across languages is larger - such as in the case of cognates and concrete words. It is predicted that, compared with these words, for cross-linguistic pairs whose patterns of semantic mapping are different from each other (e.g. *admit* and *yurusu*), the between-language connectivity may be less steady. The question is how cross-linguistic interactive activation may be correlated to bilinguals' L2 semantic development. If L2 acquisition is at the stage where L2 semantics is dependent on L1 semantics, is the bilingual semantic link from L2 to L1 tight - resulting in rapidly spreading activation from L2 *admit* to L1 *yurusu*? On the other hand, as the L2 ability develops and L2-specific semantics (e.g. the concept of "to accept a truth (unwillingly)" for *admit*) is acquired, does L2 semantics become independent of L1 semantics – slowing access from L2 semantics to L1 semantics? The speed of access from L2 semantics to L1 semantics may reflect the degree of semantic interconnectivity between L1 and L2 relative to the constitution of the bilingual lexicon. This issue is discussed on the basis of an empirical study (Chapters 4-8) with a view to shedding light on the development of bilingual semantic organisation and processing.

**Conclusion**

This chapter investigated semantic organisation and processing with respect to the monolingual and bilingual lexicon. First, a broad range of L1 semantic studies were reviewed in an endeavour to arrive at a satisfactory understanding of semantic representation and processing. The organisation of sense relations was discussed from the classic linguistic viewpoint and also from the cognitive psychological perspective. The cognitive psychological approach to semantics suggested that semantics may be organised according to semantic relatedness in the form of a network and that semantics may be processed by means of activation spreading between the nearest nodes (Collins and Loftus, 1975). The latter model was examined in the light of a number of empirical studies using a semantic priming paradigm, whose results broadly favour this standpoint.

As regards the bilingual lexicon, it was argued that the semantic network for each language is organised and processed not only within, but also between languages, nodes of the networks being interconnected according to semantic relatedness across languages (Paradis, 1987). This proposed scope of interconnection and interaction between bilingual semantic networks is in line with the viewpoint of the general bilingual studies discussed in Chapter 2. The chapter further pursued the question of how interconnectivity in bilingual semantics may be related to the degree of semantic overlap and distance between languages, and also suggested that collocational connections may reflect the semantic components of a word. On the basis of the results of a word association task conducted by the author of the current thesis (Ueno, 2003), this issue was considered with reference to the English word *admit* and the Japanese word *yurusu*. It was argued that the development of the L2 lexicon may vary depending on the degree of semantic overlap and distance between languages, which may affect the manner of bilingual semantic connectivity. The synthesis of the results from the free association task and the corpus analysis indicated that in the case of the L2 word whose semantic difference with the L1 translation equivalent is relatively distinctive such as *admit* and *yurusu*, the bilinguals' L2 mental lexicon tends to be affected by their L1 lexicon. This issue of semantic connectivity in relation to L2 semantic development is investigated in the empirical study reported in Chapter 7 on the basis of the following questions:

- Does parasitism of L2 semantics on L1 semantics enhance semantic access from L2 to L1?

- If L2 acquisition has reached the level where L2 semantics is independently established from L1 semantics, does the semantic interconnective link between L2 and L1 wither away? Does language-specific L2 knowledge also render lexical access language-selective?

Inter-lexical connections in collocations might be represented by bilinguals in a 'compound' manner across languages or in a language-specific (i.e. 'co-ordinate', De Groot, 1993) manner. These two types of representations for collocations are likely to affect the manner of processing. As was briefly suggested earlier, there are a number of factors involved here – notably, on the one hand, the relationship between two given languages (e.g. in terms of language distance), and on the other hand, the situation of individual bilinguals (e.g. in terms of L2 acquisition levels and recency of exposure to L1 and L2).

## Part two: Empirical Study

# Chapter 4 Introduction to experiments

Part One reviewed theories relating to the organisation and processing of the L1 lexicon (Chapter 1) and the bilingual lexicon (Chapter 2). The bilingual semantic system and processing mechanisms were then explored on the basis of these theories as well as on the basis of pertinent empirical evidence concerning this issue (Chapter 3). The discussion in this last chapter also highlighted the fact that in the case of the bilingual lexicon, semantic development in L2 affects the organisation and processing of bilingual semantics. The theoretical review indicates the following general view with regard to the bilingual semantic system:

i) Semantic associations are organised according to semantic relatedness, and are interconnected within and across languages in accordance with the connectivity of the nodes of two networks.
ii) Therefore, when a semantic item is recognised, activation spreads automatically to several related items in parallel, within and between languages.
iii) Furthermore, when L2 acquisition is at the initial stage, L2 semantics is incomplete and is dependent on L1 semantics. As L2 acquisition progresses, L2-specific semantics is established independently of L1 semantics.

The three principles above raise the issue of how L2 semantic development affects semantic interconnectivity between languages. This issue is investigated in an empirical study with specific reference to Japanese-English bilinguals.

In order to pursue the question of the relationship between the interlingual semantic connectivity and L2 semantic development, the process of L2 semantic development has to be first examined. The matter of L2 semantic development relative to L1 semantics was discussed in Chapter 2 in the context of the treatment of the Hierarchical model (Potter *et al.*, 1984) and the Revised Hierarchical model (Kroll and Stewart, 1994) (see discussions in 2.3.1). The empirical study accordingly begins with an examination of these two models in specific connection with the case of Japanese-English bilinguals, by means of an experiment which deploys a picture-naming task and a translation task (Chapter 5). The Revised Hierarchical model is re-examined by observing concreteness effects in the translation performances (Chapter 6). Furthermore, the issue of interconnectivity in bilingual semantics is investigated in relation to the L2 developmental stages, using a semantic priming task with stimulus items derived from language-specific semantic associations (De Groot, 1993) (Chapter 7). A more detailed outline of each chapter follows below.

Chapter 5 examines the development of the L2 lexicon in terms of concept mediation. The issue under scrutiny is whether a transition from word association to concept mediation (Potter *et al.*, 1984) occurs in the case of Japanese-English bilinguals. This is examined by comparing performance on a picture naming task and an L1→L2 translation task with Japanese-English bilinguals at four acquisition levels. The chapter also tests Kroll and Stewart's (1994) hypothesis which postulates that even for proficient bilinguals, translation performance tends to be asymmetrical, which may reflect a stronger conceptual link emanating from the L1 lexicon than from the L2 lexicon. For this study, the bidirectional (L1→L2 and L2→L1) translation task is used with the same population of Japanese-English bilinguals as participated in the previously outlined tasks.

Chapter 6 re-examines Kroll and Stewart's (1994) hypothesis by observing the size of concreteness effects in bidirectional translation performance with Japanese-English bilinguals from three proficiency levels. Observation of concreteness effects derives from De Groot and Poot's (1997) postulation that the size of concreteness effects indicates the degree of conceptual mediation because conceptual memory is more likely to be shared for concrete words than for abstract words (see detailed illustration in Chapter 2, The Revised Hierarchical Model, p.65).

Chapter 7 focuses on L2 semantic development in Japanese-English bilinguals. This part of the study investigates how semantic networks are interconnected across languages depending on the stage of L2 semantic development. In the experiment, the semantic priming technique is used in a lexical decision task. Participants' reactions to two types of semantically related English pairs derived from Japanese collocations and from English collocations are compared with their reactions to semantically unrelated English pairs. The results are analysed with a view to probing the influence of knowledge of L1 collocations on L2 semantic processing. According to the 'initial language-non-selectivity' view (Green, 1986; Grosjean, 1997), it may be expected that when an L2 (English) word is presented, activation spreads not only within the L2 semantic network but also to the L1 (Japanese) semantic network at the initial stage of processing. This part of the study further investigates whether the magnitude of L1 influence is different or not depending on the semantic developmental stage, and if it is, how different it is. Conclusions are drawn with regard to the relationship between the semantic organisation of the bilingual lexicon and the quality of semantic interconnection between known languages.

Participants in the experiments outlined above were Japanese-English bilinguals and native speakers of English. In the experiments discussed in Chapter 5, participants were four groups of Japanese-English bilinguals. They were English-speaking college (EC) students, senior high school-level (SH) students and junior high school-level (JH) students, who were, in fact, divided into two groups according to L2 learning background. (The American terms high-school and junior high-school are conventionally used to translate *koutou-gakkou* and *chu-gakkou* respectively.) With regard to the English-speaking college students, they were undergraduate and postgraduate students at the University of Dublin, Trinity College, and their English abilities were sufficiently advanced to allow them to communicate at academic level. In the experiment reported in Chapter 6, three groups of Japanese-English bilinguals constituted the experimental sample. In addition to English-speaking college (EC) students and senior high school-level (SH) students, Japanese undergraduate-level college (JC) students participated in this experiment. Owing to the fact that this experiment was conducted one year after the previous experiments described in Chapter 5, the attributes of participants were slightly different between these experiments (see Chapters 5 and 6 for detailed information). In Chapter 7, the same groups of Japanese-English bilinguals (EC, JC and SH) as in the experiment in Chapter 6 again participated in the experiment. The experiments described in Chapters 6 and 7 were conducted in the same period. In addition to these bilinguals, native speakers of English also participated in this experiment. For each experiment, participants were given a nominal payment of 1.5 euro or its equivalent.

With regard to the data analysis for the experiments, the data consist of reaction times (RTs), errors (i.e. incorrect responses) and omissions (i.e. the items for which subjects produced no response). The analyses of the RTs were carried out using the weighted ANOVA (Analysis of Variance) program (the weighting takes account of the fact that the variability of the responses increases as the RTs increase) available within the statistical package Data Desk. The analyses for the error and omission data were carried out using the statistical package STATA. The models used for these analyses were Generalised Linear Models. These are similar to the traditional General Linear Model (i.e. Multiple Regression and ANOVA) but take into account the appropriate statistical structure for the random variation of the counts. In the case of RTs, the random variation is described by a Normal Distribution; for the error and omission data, the appropriate statistical model is Binomial Distribution, which directly models the counts. Since the count numbers are small, it would be inappropriate to model the corresponding proportions as being normally distributed, as is often done in the literature. Paired t-tests were also carried out in order to compare statistically individual pairs of RT data, using the statistical package SPSS.

Lastly, it may be relevant to note the method of data treatment used in the whole empirical study in relation to the issue of subject and item analyses. In this study, for the analysis of reaction time (RT) data, the mean numbers of RTs were calculated for each participant. Similarly, for the analysis of error and omission data, the total number of errors and omissions was counted for each participant. In other words, in this study, only analyses by participant have been performed, although it appears that analyses *both* by participant and by item have often been used (Clark, 1973). Clark (*ibid.*) claims that analysis by participant alone is appropriate if it is assumed that *participants* are the only random effect while *items* are a fixed effect. In this case, according to Clark (*ibid.*), the items selected for each item type (e.g. high-frequency, concrete words) are regarded as the only available candidates for the type in question. However, the selected items are merely examples of a number of items which could fit the condition of the type. Thus, he concludes that *items* should be also treated as a random effect as well as *participants*. However, McNamara (2005) argues that this is not correct. He discusses the point as follows:

> Most treatment effects in psychology are fixed effects. It is indeed rare that experimental conditions are randomly selected from a population of possible conditions. The effect of subjects, however, is usually considered a random effect. In a good experiment, subjects are randomly selected from a well-defined population, and a replication of the experiment would include a new random sample of subjects, not the same subjects. It is important to appreciate that the word "random" is not used idly in the definition of a random effect.... In my experience as a producer and consumer of semantic priming experiments, the materials are never randomly selected — or even pseudorandomly selected — from a population of possible items; in fact they are usually selected or constructed to meet peculiar demands of the experiment or to maximize the strength of the experimental manipulation. Thus, although an experimenter may wish that his or her materials could be treated as a random effect, they almost always will be a fixed effect.
>
> (McNamara, 2005, p.57-8)

On the basis of this view, McNamara (*ibid*, p.56) asserts that "joint reporting of $F_1$ [results of subject analysis] and $F_2$ [results of item analysis] is never correct; one should report either $F_1$ or the appropriate quasi-F ration (or its approximation, minF')." His view with regard to item analysis appears to be convincing owing to the nature of psychological experiments — that is, the high degree of control in an experimental design. On the other hand, subjects in psychological experiments tend to be recruited from the same institutions, same course and same class, but those who voluntarily agreed to participate in the experiments actually participated in them. Thus, subjects are somehow haphazardly selected. However, items are deliberately selected; therefore, in my view, it is not appropriate to treat items as the random effect.

In summary, the focus of the empirical study includes an examination of the existing theories regarding the development of bilinguals' conceptual / semantic systems and investigation of the underexplored mechanisms with regard to the relation between the interlingual semantic connectivity and L2 semantic development. Investigation of the developmental processes of the bilingual semantic system is important, since this issue remains relatively unknown. Francis (2005) argues for the necessity of a developmental approach to bilingual research as follows:

> Researchers have only begun to address the development of conceptual/semantic structures in bilinguals. Developmental models of bilingual language acquisition are likely to be important in the future of bilingual research because they allow for changes in representation with learning. Although cognitive psychologists have studied extensively the organisation of bilingual lexical and semantic representation in proficient bilinguals, far less attention has been given to the question of how the representation got to that point (one exception is Kroll's revised hierarchical model…). Surprisingly little is known about what it means cognitively for a person to go from being monolingual to bilingual because data on appropriate cognitive tasks across different levels of learning are sparse. There are very few cross-sectional cognitive studies that examine bilinguals across several different levels of language acquisition in the literature

> (notable exceptions are the work of Chen, 1990; De Groot and Poot, 1997; Mägiste, 1984, 1985, 1992) and apparently no longitudinal cognitive studies. (Francis, 2005, pp.257-258)

The main purpose of this study is to help develop insight into the mechanisms of the bilinguals' semantic system.

# Chapter 5 Examination of the Hierarchical Model and the Revised Hierarchical Model

### Introduction

This chapter is concerned with experiments which examine the Hierarchical Model (Potter *et al.*, 1984) and the Revised Hierarchical Model (Kroll and Stewart, 1994). As was explained in Chapter 2, the Hierarchical Model claims that at the early stage of L2 acquisition, when L2 words are recognised, the L1 lexicon is accessed in order to retrieve the meaning of the L2 words (word association stage) (see Figure 11 in Chapter 2). As acquisition progresses, according to the model, a direct link between the L2 lexicon and concepts is established and L2 words are understood without the mediation of the L1 lexicon (concept mediation stage) (see Figure 11). Thus, the model predicts that L2 learners at the early stage of acquisition will translate L1 words into the L2 faster than they name pictures in the L2 owing to the associated relationship between the L1 and L2 lexicons. To illustrate, the processing of (1) *perception of L1 word*, (2) *L2 word retrieval*, and (3) *production of L2 word* in forward translation is seen as faster than the processing of (1) *perception of images*, (2) *concept retrieval*, (3) *L2 word retrieval*, and (4) *production of L2 word* in the picture-naming (Potter *et al.*, 1984; Kroll, 1993). On the other hand, the model suggests that as acquisition proceeds, learners will perform a translation task as fast as a picture-naming task because the mediation of concepts will underlie also in the forward translation – namely, (1) *perception of L1 word*, (2) *concept retrieval*, (3) *L2 word retrieval*, and (4) *production of L2 word*.

Kroll and Curley (1988) and Chen and Leung (1989) suggest that the transition from word association stage to concept mediation stage occurs sometime after two years of L2 learning. As was illustrated earlier (see Chapter 2 in pp. 57-58), in these studies, only learners who had learned their L2 for less than 30 months (Kroll and Curley, 1988) and for approximately two years (Chen and Leung, 1989) showed evidence of being in the word association stage.

The current experiment examines whether the transition from word association stage to concept mediation stage truly occurs in the case of Japanese-English learners/bilinguals, using a picture naming task and an L1→L2 translation task. If the Hierarchical Model's prediction is correct, Japanese learners of English who have learned their L2 (English) for less than two years will translate L1 words into equivalent L2 words faster than they name pictures in their L2. On the other hand, learners/bilinguals who have learned the L2 for more than two years will name pictures approximately as fast as they translate L1 words into equivalent L2 words.

As far as the Revised Hierarchical Model is concerned, as was illustrated in Chapter 2, Kroll and Stewart (1994) claim that lexical association from L2 to L1 is likely to remain even after L2 acquisition has developed to a point where a direct link is established between the L2 and concepts. On this basis, they assume that the route from L1 to L2 will be weaker than that from L2 to L1 because the L1 lexicon tends to be larger and more strongly bound to concepts than the L2 lexicon (see Figure 12 in Chapter 2). For them, the notion of such concept mediation in L1→L2 translation processing predicts slower processing of L1→L2 (forward) translation than of L2→L1 (backward) translation. This prediction is supported by a number of empirical studies (e.g. Kroll and Stewart, 1994; Sholl, Sankaranarayanan, and Kroll, 1995), although there are exceptions to this trend, notably De Groot and Poot's (1997) study (see p.65 for detailed discussion). Kroll and Stewart also claim that asymmetry tends to be stronger as proficiency decreases.

The experiment in this study investigates whether this prediction is borne out in the case of Japanese-English learners/bilinguals at four levels of L2 acquisition. If the Revised Hierarchical Model's claim is correct, Japanese-English L2 learners/bilinguals will translate a Japanese word (L1) into an English word (L2) more slowly than they translate an English word into a Japanese word. It is also predicted that the magnitude of asymmetry (i.e. slower forward translation than backward translation) will be in inverse proportion to proficiency level.

**5.1 Hypotheses**

The hypotheses addressed by the experiments are as follows:

1. Examination of the Hierarchical Model:

If the claim regarding the word association stage is true, then, in the case of Japanese-English L2 learners with *less* than two years experience of L2 learning, the mean correct RTs for forward (L1→L2) translation will be faster than those for picture-naming in L2. If the transition to concept mediation truly occurs, in the case of Japanese-English L2 learners/bilinguals with *more* than two years experience of L2 learning, there will be no difference in the mean correct RTs between picture-naming and forward translation performance.

2. Examination of the Revised Hierarchical Model:

If it is true that conceptual link with L1 remains stronger in bilinguals and that the route from L1 to L2 will be weaker than that from L2 to L1, the mean correct RTs of Japanese-English L2 learners/bilinguals for forward translation will be longer than those for backward translation. Also, the magnitude of asymmetry (longer RTs for forward translation than backward translation) will be larger for lower-proficiency participants than for higher-proficiency participants.

**5.2 Method**

*Subjects* 49 native speakers of Japanese participated in the experiments. These 49 people were divided into 4 groups: English-speaking college (EC) students, senior high school-level (SH) students, and two groups of junior high school-level students (JH1 and JH2). The 13 English-speaking college students were proficient in English. They were undergraduate and postgraduate students at the University of Dublin, Trinity College, and had lived in English-speaking countries (Ireland, England, and Scotland) for 2-11 years, with an average of 3.8 years. The 13 senior high school (SH) students were aged 16-17 and had learned English in Japanese schools for 4 years. The 23 junior high school (JH) students were aged 13-14 and had learned English in Japanese schools for less than 2 years, with an average of 1.2 years. In interviews conducted with members of this group, it emerged that 10 students had learned English privately for 2-9 years in addition to their school education (JH1). The average period of time spent learning English was 7.2 years. The other 13 JH students had never learned English before they began studying English in junior high school; therefore, their exposure to English had been for no more than 2 years, with an average of 1.2 years (JH2). Thus, JH learners were divided into two groups (JH1, JH2) according to whether they had learned English for more or less than two years. This is pertinent, as the critical point for the transition to concept mediation seems to be around two years after the onset of L2 learning (see Kroll and Curley's (1988) and Chen and Leung's (1989) studies in Chapter 2). None of the subjects from junior and senior high schools in Japan had ever lived in English-speaking countries before they participated in these experiments.

*Stimulus materials* In all, 51 items were used for three kinds of tasks: i.e. picture naming, forward translation and backward translation tasks (see Appendix A). Data from the picture naming and forward translation tasks was analysed for an examination of the Hierarchical model; and data from the forward and backward translation tasks for an examination of the Revised Hierarchical model. These 51 items were from 12 semantic categories (four-footed animals, articles of furniture, parts of the human body, etc.). The pictures were line drawings of objects adopted from the pictures in Snodgrass and Vanderwart (1980). The relevant words were the names of the pictures, were concrete and non-cognate, and had straightforward translation equivalents in the other language.

These items were divided into three blocks, with 17 items being examined for each task (i.e. picture naming, forward and backward translation). Therefore, the same item was never presented more than once in any form for the same subject. Word length of the stimulus items in each writing system was matched as closely as possible across blocks. English words had 3-9 letters (the first block: the average of 4.5 letters; the second block: 4.6; the third block: 5.1); Kanji words had 1-3 characters (the first block: 1.3, the second block: 1.1, the third block: 1.5); and

Kana words had 2-4 letters (the first block: 2.3, the second block: 2.4, the third block: 2.7) (see Chapter 8 for the issues of word length control across the writing systems.)

The word frequency of the object names ranged from 10 to 392 times per million with a mean of 74.7 in the BNC (British National Corpus) (Leech, Rayson and Wilson, 2001) counts. The acquisition level of English words for Japanese learners ranged from Level 1 to Level 3 (out of 8 levels) with a mean of 1.9, according to the JACET (Japan Association of College English Teaching) Basic Word List (2003). The JACET word list is based on the BNC frequency levels and on the regularity of occurrence of words in English textbooks in Japanese senior high schools. Level 1 includes the most frequent words as listed in the BNC and occurring in Japanese textbooks. As far as the pictures of objects are concerned, the degree of agreement between object images and their names, as defined by Snodgrass and Vanderwart (1980)[1], ranged from 81-100% with a mean of 90.2%. With regard to the Japanese words, it was explained earlier in Chapter 2 that the Japanese language uses two types of writing systems: *Kana* (*hiragana* and *katakana*) and *Kanji* (see 2.4.4 for detailed explanation). In the experiments, the most frequent way of writing a given word (as described by Ukita, Sugishima, Minagawa, Inoue and Kasyu, 1996) was used. Prior to the real experimental sessions, 5 practice items were presented for each kind of task. These items were controlled in the same fashion as that described above.

*Apparatus* Stimulus items were displayed on a 15-in. LCD, XGA (1024×768) driven by a Toshiba personal computer (dynabook E7/518PME) with a memory of 256MB, using Mobile Intel Pentium 4 processor-M 1.80GHz. Each task was programmed with the experimental software E-Prime version 1.1, which was able

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[1] Snodgrass and Vanderwart (1980) investigated the norms for name agreement in respect of 260 standardised pictures as well as the norms for image agreement, familiarity and visual complexity. Out of a total of 219 participants in their study, 42 subjects participated in the name agreement task. These participants were presented with 260 pictures and asked to write the first names that come to mind. The percentage of participants who gave the most common names for the pictures was interpreted as the degree of agreement between object images and their names.

to deal with programming and data collection in milliseconds. The voice response was also timed in milliseconds by the Serial-Response Box. The voice key of the Serial-Response Box collected vocal latencies, and a Sony external recorder recorded subject reactions.

*Procedure* In the experiments, 51 items were visually presented on the computer screen in randomised order to the individual subjects. As was described earlier, these items were divided into three blocks, with 17 items being examined for each task (i.e. picture naming, forward and backward translation), in order to avoid presenting the same item more than once in any form for the same subject. The presentation order of blocks was also counterbalanced across subjects. The cycle of each block can be described as follows; the stimuli were presented for 750 milliseconds (ms), preceded by the fixation sign (500ms) and followed by blank screen (500ms). A counter invisible to participants started as the stimulus items were presented, and when subjects orally responded to the stimuli by naming pictures or producing translation equivalents, the voice activated the counter to terminate the presentation of stimuli. Then, the blank screen appeared prior to the next cycle. The counter was terminated automatically if subjects did not respond within 4500ms, after the presentation of stimuli, and the next cycle of the trial followed. The stimuli were presented for 750ms, as a result of a pilot study with 3 junior high school students aged 12-13 who had learned English for less than 2 years. In the pilot study, exposure duration time for stimulus items was gradually increased in 50ms intervals from 500ms. Since the three students commented that the exposure duration of 750ms was long enough to recognise pictures, Japanese words, and English words, 750ms was chosen for the exposure duration time. The length of the fixation sign was adapted from Kroll and Stewart' s (1994) study.

*Task* The instructions used in this experiment generally replicated Kroll and Stewart's (1994) study (see Appendix D for actual instructions). All three experimental tests (i.e. picture naming, forward and backward translations) were taken individually by subjects. In the case of the picture-naming task, subjects were told in Japanese that they would be presented with pictures on the computer screen and were asked to name the pictures aloud in English clearly and as rapidly as possible. In the case of the forward translation task, subjects were told that they would be presented with Japanese words on the computer screen and were asked to translate the Japanese words orally into English clearly and as rapidly as possible. Similarly, in the case of the backward translation task, subjects were told that they would be presented with English words and were asked to translate the English words orally into Japanese clearly and as rapidly as possible. In all cases, they were asked to remain silent till they actually produced the intended responses. In other words, subjects were asked not to produce any irrelevant sound such as "uhm" before their real responses. They were also asked to remain silent if they did not know the correct responses in order to avoid activating the voice key. Before the real experimental sessions, subjects rehearsed for each task with 5 practice items, and after the author confirmed that subjects understood the procedure correctly, the real experiments started.

### 5.3 Results

The correct reaction times (RTs), error and omission data were statistically analysed. Some items that demonstrated a high rate of errors and omissions were excluded from the analysis: i.e. high omission rates involving unsuccessful perception of the pictures *balloon* (90%) and *needle* (78%)[2], and high error rates involving multiple responses with regard to the translation of the English word *fly* into Japanese (*hae* [insect *fly*] and *tobu* [verb *fly*], 86%). The number of errors and omissions was also analysed, except for items for which the voice key apparatus did not recognise responses.

In the experiment, three tasks were administered; the picture-naming task and the forward translation task were compared to examine the Hierarchical Model, and

[2] The unsuccessful perception of these items might have been derived from the fact that the line-drawings of objects were relatively simple; the visual complexity of the line-drawings for both items was rated 1.55 on a 5-point scale (1=very simple, 5=very complex) in Snodgrass and Vanderwart's (1980) study. Without context, they might have looked ambiguous (see Appendix A). It was considered inappropriate to include responses to such items in the analysis.

the forward and backward translation tasks were compared to examine the Revised Hierarchical Model. If the Hierarchical Model is correct, we expect that JH2's RTs for forward translation will be faster than those for picture-naming; in contrast, other participants will produce equally fast RTs for forward and backward translations. If the Revised Hierarchical Model's prediction is true, we expect that the RTs for forward translation will be longer than for backward translation. Also, the magnitude of asymmetry will be larger for lower-proficiency participants than for higher-proficiency participants. Table 3 below shows the overall correct RTs and error and omission data of three tasks for each subject group.

**Table 3** RTs (ms), error and omission data (percentages with raw numbers in parentheses) for picture naming, forward translation and backward translation tasks

| Subjects | | Picture naming | Forward Translation | Backward Translation |
|---|---|---|---|---|
| EC | RT | **1021** | **1102** | **1217** |
| | Errors | 5.43% (12) | 0% (0) | 1.81% (4) |
| | Omissions | 3.62% (8) | 2.71% (6) | 0.90% (2) |
| SH | RT | **1370** | **1432** | **1436** |
| | Errors | 6.33% (14) | 5.88% (13) | 10.86% (24) |
| | Omissions | 16.74% (37) | 21.27% (47) | 11.76% (26) |
| JH 1 | RT | **1325** | **1385** | **1607** |
| | Errors | 3.53% (6) | 3.53% (6) | 11.18% (19) |
| | Omissions | 19.41% (33) | 21.18% (36) | 17.65% (30) |
| JH 2 | RT | **1319** | **1328** | **1667** |
| | Errors | 7.24% (16) | 3.62% (8) | 9.05% (20) |
| | Omissions | 26.70% (59) | 43.44% (96) | 43.44% (96) |

*The percentages of error and omission data were calculated by dividing the raw numbers by 221 (17 x 13) for EC, 221 (17 x 13) for SH, 170 (17 x 10) for JH1 and 221 (17 x 13).

RTs were analysed using weighted analysis of variance (ANOVA). The results showed the significant main effects for both subject groups ($F=10.9$, $p<.0001$) and task types ($F=7.2$, $p<.001$). However, none of the interactions was statistically significant. This indicates that response patterns for each task type were, in general, similar across subject groups. The post hoc tests (Bonferroni tests) for subject groups and task types demonstrated the following results. As was expected, the RTs of the most proficient bilinguals were significantly faster than those of the rest of participants. Comparison of the RTs between the picture naming task and the L1→L2 translation task did not yield a statistically reliable difference, while comparison of the RTs for the bidirectional translation tasks yielded a significant difference ($p<.005$).

Error and omission data were analysed using Generalised Linear Models (see Chapter 4 for explanation). In the case of the error data, there were significant main effects both for subject groups ($z=36.0$, $p<.0005$) and for task types ($z=40.8$, $p<.0005$). The interaction between subject groups and task types also yielded strong significant difference ($z=-32.0$, $p<.0005$). This indicates that the patterns of responses for each task type were not the same for all subject groups.

As far as the omission data is concerned, there was a strong main effect for subject groups ($z=5.6$, $p<.0005$). As the proficiency level decreased, the omission rates dramatically increased (EC, 2.41%; SH, 16.59%; JH1, 19.41%; JH2, 37.86%). The omission rates in the case of bidirectional translation tasks were particularly large for the least proficient learners compared with other subject groups (see Table 3). There was no main effect for task types. Furthermore, there were also no interactions between subject groups and task types. Thus, the omission pattern for each task type was generally similar across the subject groups.

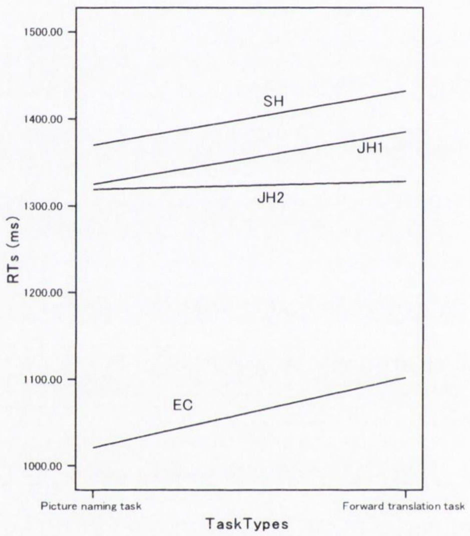
The RT data were further analysed and considered in terms of the two hypotheses concerning the Hierarchical Model and the Revised Hierarchical Model, as was indicated earlier.

### 5.3.1 Examination of the Hierarchical Model: Comparison of picture-naming and forward translation tasks (Hypothesis 1)

RTs for the picture-naming task and the forward translation tasks were analysed by paired *t*-tests. The results of analyses show that the most proficient bilinguals (EC) named pictures in their L2, 81ms faster than they translated L1 into L2, this difference approaching significance ($t$= -2.089, $p$<.06)[3]. On the other hand, none of the other groups' RTs exhibited a statistically significant difference between the two tasks, although the results showed a decrease in the picture-naming advantage with decreasing proficiency levels (see Table 4 and Figure 23 below).

**Table 4** (left) and **Figure 23** (right) Picture naming advantage for each subject group (ms)

| | Forward translation -picture naming |
|---|---|
| EC | 81 (p<.06) |
| SH | 63 |
| JH1 | 60 |
| JH2 | 8 |




*Discussion*

The outcome did not confirm the hypothesis regarding the learners who had learned their L2 for less than two years (JH2). These learners (JH2) did not, as predicted by the Hierarchical Model, perform the translation task faster than the picture-naming task, but performed the picture-naming task as fast as they performed the forward translation task. In the case of learners who had learned their L2 for more than two years, the results for secondary school level learners (JH1 and SH) confirmed the hypothesis, while the results for the most proficient

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3 When the significance level is set up as $p$<.05, $p$<.06 and .07 are regarded as marginally significant. See some cases in De Groot and Poot (1998). "On the analyses of the RT data… approached significance on the analysis by items, … F2 (2, 544)=2.90, p=.06." "This interaction… was about also significant (by participants) and marginally significant (by items) on the analyses of omissions, F1 (2, 58)=5.75, p<.01, and F2 (2,546)=2.46, p=.09."

level learners (EC) were not consistent with the hypothesis. JH1 and SH produced approximately equal RTs for forward translation and picture-naming tasks, whereas EC showed marginally significantly faster RTs for picture-naming.

The unexpected result with regard to the least proficient learners (JH2) is possibly because of the fact that the stimulus words chosen in the experiment were high-frequency concrete words (see Appendix A) and that such relatively easy words were likely to have been registered in their mental lexicon from an early stage of L2 learning. For these words, acquisition could have developed and have already reached the concept mediation stage. However, this model cannot explain why the most proficient learners (EC) showed a marginally significant effect for their picture-naming performance. It seems to be necessary to re-examine the model and the processing mechanism it implies in respect of the two tasks (i.e. the picture-naming task and the forward translation task). The Hierarchical Model postulates that at the concept mediation stage, the processing of (1) *perception of images*, (2) *concept retrieval*, (3) *L2 word retrieval*, and (4) *production of L2 word* in picture-naming is seen as approximately the same as the processing of (1) *perception of L1 word*, (2) *concept retrieval*, (3) *L2 word retrieval*, and (4) *production of L2 word* in forward translation (Potter *et al.*, 1984; Kroll, 1993).

It was earlier argued in Chapter 2 that the Hierarchical Model is somewhat opaque with respect to the distinction between conceptual representation and semantic representation (Paradis, 1997; Pavlenko, 1999, see Chapter 2 for detail discussion). When we take this point into consideration, the following processes for the two tasks are postulated.

Picture-naming process:

(1) image perception

(2) concept retrieval

(3) L2 semantic access

(4) production of L2 phonology

Forward translation process:

(1) L1 letter string perception

(2) L1 semantic retrieval

(3) concept retrieval

(4) L2 semantic access

(5) production of L2 phonology

The proposal above suggests that L1 word recognition should take longer than image recognition, because L1 word recognition involves L1 semantic retrieval, while the concept can be retrieved directly from the image. This seems to explain why all the participants in this study evinced faster RTs for the picture naming task. In previous studies, it seems that the results for more proficient participants also showed slight picture-naming advantages (Kroll and Curley, 1988; Chen and Leung, 1989). The reason why the picture-naming advantage grew as proficiency increased would probably be because, as acquisition proceeds, L2 semantics develops and becomes gradually independent of L1 semantics. In the present study, the proficient bilinguals were undergraduate/postgraduate students in an L2 speaking college (cf. earlier studies, where the proficient bilinguals were undergraduate students in an L1 speaking college - Potter *et al.*, 1984; Kroll and Curley, 1988; Chen and Leung, 1989; Chen, 1990). Therefore, their L2 proficiency was at a level where they were able to communicate in the L2 at an academic level. For them, the process of *image perception – concept retrieval – L2 semantic access* was likely to have become more automatic, while the process of *L1 semantic retrieval – concept retrieval – L2 semantic access* may, in fact, have become less familiar and less automatised. The marginally significant result for the proficient bilinguals (81ms, $p<.06$) may demonstrate that they have, to some extent, developed independent L2 semantics. Although the result did not reach the conventional significance level (.05 level), it is quite close and suggests a potentially interesting effect.

In the early stage of L2 acquisition, L2 semantics appears to be non-existent or very weakly established in the L2 lexicon. The fact that in previous studies, the least proficient participants produced faster RTs for L1→L2 translation than for picture-naming may be interpreted as follows (Kroll and Curly, 1998; Chen and Leung, 1989). Their L2 semantics was parasitic on L1 semantics, and, therefore, processing from *L1 semantic retrieval* to *accessing primitive L2 semantics* would be very quick. Green (1998) talks in this connection about 'lemma association' (see the discussion in Chapter 2, the Revised Hierarchical model, p.70). I suggest that the L2 acquisition process could be better understood by investigating to what degree L2 semantics has developed rather than whether the transition from 'word association' to 'concept mediation' has occurred or not.

*Conclusion (Hypothesis 1)*

The results of this experiment examining picture naming and forward translation tasks did not confirm the hypothesis with regard to the word association stage. In the case of the participants with less than two years of L2 learning (JH2), the mean RTs for forward translation were not faster than those for picture naming. It was discussed that the fact that relatively easy words were used in the experiment could have been responsible for this result. It is possible that these learners had already reached the concept mediation stage for these words. The hypothesis regarding concept mediation was generally confirmed. In the case of secondary school level learners (JH1 and SH), there was no difference in the mean RTs between picture naming and forward translation performance. However, the most proficient bilinguals (EC) showed marginally significantly faster RTs for picture naming than for forward translation ($p<.06$).

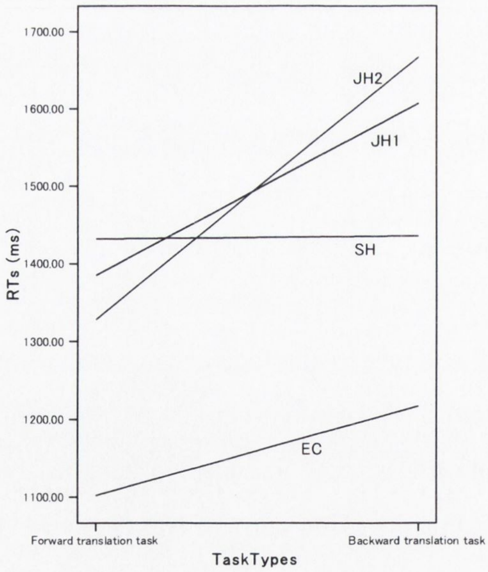
The model and processing mechanisms addressed by the two tasks were reconsidered. The distinction between semantic representation and conceptual representation was taken into account and the results were explained in the light of L2 semantic development. It was suggested that the growing picture-naming advantage with increasing proficiency levels may reflect the L2 semantic development process and that the marginally significant result for the most proficient learners may demonstrate somewhat advanced L2 semantic development. These learners communicate in the L2 on an everyday basis, and the establishment of an L2 semantics independent from L1 semantics probably made the process of moving from L1 semantic retrieval to L2 semantic access less automatic.

### 5.3.2 Examination of the Revised Hierarchical Model: Comparison of forward and backward translation (Hypothesis 2)

The analysis of forward and backward translation exhibited a general tendency of longer RTs in backward direction than in forward direction. However, the statistical analysis showed no difference between these tasks (see Table 5 and Figure 24 below). An exception was the result in the case of the least proficient learners (JH2), which approached the significance level ($t=-2.044$, $p<.07$). These results, even though the L1→L2 translation advantages for EC, JH1 and JH2 were large, are related to the large degree of variability. The Standard Error for EC was 65.75, for JH1 it was 167.72 and for JH2 it was 166.16.

**Table 5** (left) and **Figure 24** (right) Forward translation advantage for each group (ms)

| | Backward translation -forward translation |
|---|---|
| EC | 114 |
| SH | 4 |
| JH1 | 222 |
| JH2 | 340 (p<.07) |




*Discussion*

The results did not confirm the hypothesis, which predicted slower RTs for forward translation than for backward translation. According to the Revised

Hierarchical Model (Kroll and Stewart, 1994), the translation asymmetries should reflect a greater degree of conceptual linkage with the L1 lexicon than with the L2 lexicon. It was discussed in Chapter 2 that some experimental studies obtained findings running counter to the RHM's prediction (e.g. La Heij, et al., 1996; De Groot et al, 1994; De Groot and Poot, 1997; see detailed explanation in pp.62-65). De Groot and Poot's (1997) study provided evidence which showed no statistically significant asymmetry between the two directions of translations. They reached the conclusion that their results indicated concept mediation for both routes from L1 to L2 and from L2 to L1.

The results obtained in the current study may be also taken to suggest the same phenomenon; however, it seems plausible to consider the possibility that particular conditions in the experimental design affected these participants' translation performance. As Kroll and De Groot (1997) suggest, different conditions such as different subject groups and different sets of stimulus items can result in different patterns of asymmetry. In the current study, the chosen languages (i.e. English and Japanese) for stimulus items may be related to the unexpected results.

JH2's greater degree of asymmetry with longer RTs in backward translation could plausibly be attributed to the orthographic differences between English and Japanese. As was discussed in Chapter 2, development of intraword structural sensitivity is commonly seen as an essential factor for success in reading in alphabetic languages such as English (e.g. Bryant et al., 1990; Perfetti, 1992). There is some evidence that lack of experience in computational analysis of phonemic components of a word is related to less efficient performance in English word recognition for ESL learners with non-alphabetic L1 background (Akamatsu 1999, 2003; Koda, 1999) (see 2.4.6 for detailed discussion). Unfamiliarity with this analysis for Japanese learners of English would have slowed the processing of word recognition in English, which is the fatal factor in the backward translation task. Novice learner subjects in this study commonly had very little experience in this kind of analysis, which could have affected their L2 word recognition performance, especially when the exposure duration time was relatively short (750ms).

One may further argue that the unexpected results might be related to the fact that the forward translation stimulus list included both *Kana* and *Kanji*. The issues with regard to *Kana-Kanji* processing were also discussed earlier in Chapter 2 (see discussion in 2.4.5). The conclusion of the discussion indicated approximately the same degree of ease for processing *Kanji* as for processing *Kana* when they are scripted in a conventional manner and naming is not explicitly required as a task in the experiment (see Hirose, 1984; Yamada et al., 1990).

As was explained earlier, the Japanese stimulus words in the current study were presented in the conventional scripts with reference to the familiarity list (Ukita, Sugishima, Minagawa, Inoue and Kasyu, 1996), and also, the task did not explicitly require the naming of stimulus words. Participants had to access the lexical entries of Japanese stimuli in the quickest way possible in order to produce the translation equivalents in English. The RT data of all participant groups were again analysed, according to script - *Kana* or *Kanji* presentation - using paired *t*-tests. The results demonstrated no statistical difference between *Kana* and *Kanji* presentations for any participant group (EC: Kana, 1207ms, Kanji, 1067ms, t=-1.564; SH: Kana, 1521ms, Kanji, 1373ms, t=-1.061; JH1: Kana, 1405ms, Kanji, 1367ms, t=-.345; JH2: Kana, 1249ms, Kanji, 1337ms, t=.937).

*Conclusion (Hypothesis 2)*

The results of the present study did not confirm the hypothesis which was derived from the Revised Hierarchical Model. The results showed no statistically reliable difference between the participants' performances for two directions of translation tasks, except for the fact that the result in the case of the least proficient learners (JH2) approached the significance level ($p<.07$). They produced asymmetry with slower RTs for backward translation than forward translation. It was discussed that the backward translation disadvantage seemed to relate to the fact that the experimental design did not take account of the effects of orthographic differences between alphabetic and non-alphabetic languages.

### 5.4 General conclusion

This chapter examined the Hierarchical Model (Potter *et al.*, 1984) and the Revised Hierarchical Model (Kroll and Stewart, 1994). The results of the picture-naming and forward translation tasks did not confirm the hypothesis that the Hierarchical Model posits regarding novice L2 learners (JH2). It was discussed that this outcome was possibly because stimulus words were relatively easy (high-frequency concrete words). According to the model, this result was interpreted that these learners had already attained the concept mediation stage for these words. On the other hand, the hypothesis concerning L2 learners with more experience in L2 (JH1 and SH) was confirmed. However, the result with respect to the most proficient learners (EC) was not in line with the model's prediction; they showed a marginally significant effect for the picture-naming advantage.

The model and processing mechanisms addressed by the two tasks were re-examined taking account of distinction between semantic representation and conceptual representation (Paradis, 1995, 1997; Pavlenko, 1999). At early stages of L2 acquisition, L2 semantics is non-existent or very weakly established (Jiang, 2000) and is, therefore, parasitic on L1 semantics. This phenomenon may be better represented in terms of 'semantic association' rather than in terms of 'word association.' As L2 acquisition proceeds, L2 semantics also develops to the extent where a unique L2 semantics is installed in the L2 lexicon independent of L1 semantics. At this stage, the L2 learner is able to understand fully the meaning of L2 words. At this phase, when L2 words are recognised, concepts should be mediated directly from the L2 lexicon. However, the notion of 'concept mediation' does not tell us much about the *quality* of concepts that L2 words represent in the L2 learners' mind. As De Groot (1993) argues, translation equivalents for L1 and L2 words may not necessarily share the same components of concepts. In this case, the question of 'how well the meaning of the word is understood' may tell us more about the development of the L2 lexicon than the question of 'how much concepts are mediated.' In this study, the experimental design did not include the factor of semantic involvement as an independent variable. Further study is necessary in order to confirm this suggestion.

With respect to the bidirectional translation tasks, the results did not confirm the hypothesis which was proposed on the basis of the RHM. The results in general showed no difference between forward and backward translation. It was discussed that this result may be related to the fact that the experimental design did not take into account the effects of orthographic differences between English (L2) and Japanese (L1). The marginally significant results with regard to asymmetry with longer RTs in backward translation for the least proficient learners (JH2) may support this assumption.

The next chapter re-examines the Revised Hierarchical Model by observing the size of concreteness effects in Japanese-English L2 learners/bilinguals' bidirectional translation performance. This design proposed by De Groot and Poot (1997) is used in order to avoid the possibility that the results are affected by the orthographic difference between English and Japanese.

# Chapter 6 Re-examination of the RHM

## Introduction

The bidirectional translation study in Chapter 5 examined the Revised Hierarchical Model by observing asymmetrical patterns of Japanese-English bilinguals at three developmental stages. The RHM (Kroll and Stewart, 1994) predicts that forward translation should take longer than backward translation on the basis of postulation that forward translation may be associated with concept mediation, while backward translation may use a direct link between L1 and L2 word forms. However, the results of the study in Chapter 5 did not confirm this postulation. The results yielded no statistically different RTs between two translation directions or marginally significant difference with longer RTs for the backward translation direction than for the forward translation direction (JH2: 340ms, $p<.07$). It was discussed that these results may be related to the difference of writing systems between L1 and L2. There is evidence that efficiency in English word recognition can be affected by lack of experience in analysing phonemic structure of a word for ESL learners with non-alphabetic L1 background (Akamatsu, 1999, 2003; Koda, 1999). It seems that the claim of the RHM cannot be examined by the conventional design (i.e. observation of translation asymmetries) in the case of those ESL learners due to the fact that this experimental design does not take account of the effects of orthographic differences between alphabetic and non-alphabetic languages.

De Groot and Poot (1997) offer an alternative way to examine Kroll and Stewart's postulation with regard to the asymmetrical weight of conceptual involvement between forward and backward translation. They propose that the size of concreteness effects may be a useful indicator of the degree of involvement of conceptual memory. This proposition is based on De Groot and her colleagues' studies with regard to concreteness effects. They provided evidence of shorter translation latencies in cross-linguistic performance for concrete words than for abstract words (e.g. De Groot, 1992, 1993; De Groot et al., 1994). De Groot and her colleagues argue that this is due to the fact that the conceptual memory of concrete words tends to be shared across languages, as compared with the case of abstract words (see more detailed explanation in Chapter 2, pp.74-75). Therefore, according to De Groot and Poot (1997), the concreteness effect demonstrates that conceptual memory is involved more for concrete words in bilinguals' translation process than for abstract words, and the larger concreteness effect may indicate more conceptual involvement. On the basis of this postulation, they suggest that the claim of the RHM regarding involvement of conceptual memory in relation to L2 lexical development and translation direction can be examined by observing the size of concreteness effects.

The principal issues that De Groot and Poot (1997) tested in their study are summarised into the following two questions. First, does the concept tend to be more mediated in forward translation than in backward translation as the RHM proposes? If this is correct, concreteness effects should be larger in forward translation than in backward translation. Second, does the degree of concept mediation differ depending on the proficiency levels? In other words, as L2 acquisition develops, is the concept more mediated when the L2 lexicon is activated? If this is correct, larger concreteness effects should be found for bilinguals with higher proficiency level.

The current study investigates these issues with Japanese-English L2 learners/bilingual. That is, the RHM is re-examined by observing the Japanese-English bilinguals' patterns of concreteness effects in translation performance relating to proficiency levels and translation directions. The structure of the experiment replicates De Groot and Poot's (1997) study, although it does not include cognate items because of concerns relating to the complexity of formal relationships between Japanese and English cognates[4]. It seems apparent that the investigation of the concreteness effects also tests De Groot's (1993) proposal with regard to the different degree of concept overlap between

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[4] Japanese cognates include simple cognates (e.g. *chokoreto*, originated from 'chocolate'), false cognates (faux ami) (e.g. *manshon*, originated from 'mansion' but meaning 'a high class apartment'), and modified cognates (e.g. *pasokon*, meaning 'personal computer').

translation equivalents depending on the level of concreteness of a word.

## 6.1 Hypotheses

The following hypotheses are examined in this experiment.

1. If it is true that concept is more mediated in forward translation than in backward translation, in the case of Japanese-English L2 learners/bilinguals, the concreteness effect (i.e. the phenomenon that the mean correct RTs are faster for concrete words than for abstract words) will be larger in forward translation than in backward translation.
2. If it is true that the degree of concept mediation increases according to development of language acquisition, the concreteness effect will be larger for higher-proficiency participants than for lower-proficiency participants.

## 6.2 Method

*Subjects* In all, 60 native Japanese speakers participated in this experiment. These participants consisted of 20 proficient Japanese-English bilinguals (EC), 20 Japanese undergraduate-level (JC) learners and 20 senior high school-level (SH) learners. The 20 proficient bilinguals (EC) were undergraduate and postgraduate students at the University of Dublin, Trinity College, and had lived in English speaking countries (Ireland and England) for 1-14 years, with an average of 4.17 years. The 20 Japanese undergraduate-level (JC) learners were aged 19-20 and had learned English in Japanese schools for 7-8 years. Among these undergraduate-level learners, 17 participants were about to register for the 2nd year of their studies, while the other 6 participants were about to register for the 3rd year of their studies, when they participated in the experiments. None of them had ever lived in English-speaking countries. The 20 senior high school (SH) students were aged 16-17 and had learned English in the Japanese school for 4 years. They were just about to start the 2nd year of their studies when they participated in the experiments. None of them had ever lived in English-speaking countries either. According to the Vocabulary Levels Test (Nation 2001), the percentages of average scores for each participant group are as follows: the most proficient participants (EC) scored 81.4%; the Japanese university level participants (JC) 52.2%; the high school level participants (SH) 31.5%. The statistical analysis using ANOVA showed that there was significant difference between subject groups ($F=162.7$, $p<.0005$). Furthermore, Tukey multiple comparison tests also exhibited significant results for all the combinations of subject groups ($p<.0005$). The senior high school level (SH) learners were chosen as the lowest-proficiency participants in this study. It is predicted that the junior high school (JH) students who participated in the experiments in Chapter 5 would find difficulties in orthographic processing of abstract words and lower-frequency words (see discussion with regard to JH2 in the examination of the Revised Hierarchical Model in Chapter 5, p.167). It is anticipated that poor orthographic processing performance of these subjects would result in unqualified data for testing hypotheses set out in this study.

*Stimulus materials* In this experiment, a total of 128 stimulus items were used. They consisted of 64 English words and 64 Japanese words, which were presented in separate sessions (see Appendix B). These English and Japanese words were not translation-equivalents and no single concept appeared twice in any of the trials. The 64 words in each language-group were divided into two stimulus-groups in terms of concreteness. Concrete words and abstract words were chosen with reference to Paivio, Yuille and Madigan's (1968) concreteness list and De Groot and Poot's (1997) stimulus materials. Both concrete- and abstract-word groups consisted of the same number of high-frequency and low-frequency words. Frequency level was controlled according to the JACET (Japan Association of College English Teaching) Basic Word List (2003) (see Chapter 5 for a detailed account of this word list). The higher frequency words were derived from the Level 1 and the lower frequency words were derived from the Level 3 of the word list (see Appendix B). Thus, these two groups can be identified as 1) high/low-frequency concrete words, 2) high/low-frequency abstract words.

The Japanese stimulus items adopted the most frequent way of writing a given word (as described by Ukita, Sugishima, Minagawa, Inoue and Kasyu, 1996; see Chapter 5 for a detailed account), and were scripted in *Kana* and *Kanji*. As the previous findings (Hirose, 1984; Yamada et al., 1990) and the analysis of RT data for Kana and Kanji stimulus items in Chapter 5 (see the results in p.168) indicate, as long as they were written in a conventional script, the difference of Kana and Kanji scripts in stimulus items was unlikely to be considered as a major factor affecting the results. This view was confirmed by the results of analysis using paired t-tests with regard to the RT data of all participant groups for *Kana* and *Kanji* words in the word list of low-frequency concrete words where both types of scripts appeared. The results showed no statistical difference between *Kana* and *Kanji* presentations for any participant group (EC: Kana, 1229ms, Kanji, 1228ms, t=.020; JC: Kana, 1670ms, Kanji, 1852ms, t=-1.495; SH: Kana, 1945ms, Kanji, 1654ms, t=1.553). Word length was matched as closely as possible within each trial. Word length of the English items ranged from 4 to10 letters (high-frequency, concrete: average of 7 letters; low-frequency, concrete: 7.1; high-frequency, abstract: 7.1; low-frequency, abstract words: 7). Word length of the Kanji items ranged from 1-2 (high-frequency, concrete: the average of 1.4 characters; low-frequency, concrete: 1.7; high-frequency, abstract: 1.8; low-frequency, abstract words: 1.7). Word length of the Kana items ranged from 3-4 (low-frequency, concrete: the average of 3.3) (see Chapter 8 for the issues of word length control across the writing systems).

The experiments also included 7 practice items, which were presented to each language group prior to the real experimental sessions. These items were controlled in the same fashion as that described above.

*Apparatus* The apparatus was the same as that of the experimental studies in Chapter 5.

*Procedure* In each language-group session, 64 stimulus items were divided into two trials in terms of frequency level. The trial involving higher frequency words was always presented first and the trial involving lower frequency words followed. Between these trials, a break was provided, and if participants wished they could rest before resuming the trial. Within each trial, concrete and abstract items were presented in random order to individual subjects. The presentation order of language conditions was counterbalanced across subjects; that is, half of the subjects were first given English stimuli while the other half were first given Japanese (or vice versa). The sequence of tests was as follows: the stimuli were presented for 5000 milliseconds (ms), preceded by the fixation sign (500ms) and followed by a blank screen (500ms). A counter invisible to participants started as the stimulus items were presented, and when subjects responded to the stimuli by producing translation-equivalents, their voice activated the counter to terminate the presentation of stimuli. Then the blank screen appeared before the next stimulus appeared. The counter was deactivated automatically if subjects did not respond within 5000ms of the presentation of stimuli, and the next stimulus was presented.

*Task* The task was the same as that of the bidirectional (forward and backward) translation studies in Chapter 5 (see Appendix D for actual instructions), with the exception that subjects rehearsed for each task with 7 practice items before the real experimental sessions.

**6.3 Results**

For the three variables (2 levels of concreteness, 2 translation directions, and 3 proficiency levels), the reaction times (RTs) were analysed using weighted ANOVA. The data from incorrect responses (errors) and non-responses (omissions) were analysed, using Generalised Linear Models. RTs of error responses were excluded from the analysis (5.27% of all the responses). Additionally, the following two types of responses were also excluded from the analysis: 1) faulty voice key registrations such as responses which were not recognised by the voice key although participants had provided correct responses, and 2) unexpected translation responses, although they could be regarded as correct according to Japanese-English dictionaries. The faulty voice key registrations and the unexpected translation responses respectively occurred in 1.14% and 1.71% of all the responses. Finally, the percentage of omissions was 17.18%. Furthermore, one participant each from JC and from SH produced no correct responses for lower frequency, abstract stimulus items. All the responses from these participants were also excluded from analysis. In order to implement the analyses, it was simplest to take 19 participants from each subject group. Data from the 3 excluded participants accounted for 9.52% of the entire data-set. Therefore, the total percentage of RTs included in the analysis was 65.18%. For the analysis of correct RTs, error and omission data, mean numbers were calculated for each participant.

Analysis of the RTs, error rates and omission rates for concreteness revealed significant main effects in RT data (concrete words, 1455ms; abstract words, 1642ms; $F=93.08$, $p<.0005$) and in omission data (concrete words, 11.92% (435)[5]; abstract words, 20.31% (741); $z=-2.49$, $p<.05$). However, no statistically significant effect was found in error data (concrete words, 4.41% (161); abstract words, 6.47% (236); $z=-1.23$, $p>.1$).

The results of further analyses are shown below according to the two hypotheses set out on the basis of De Groot and Poot's (1997) study which examined Kroll and Stewart's (1994) postulation with respect to conceptual mediation by observing concreteness effects. The first hypothesis tests whether, in the case of Japanese-English bilinguals, concreteness effects (i.e. the phenomenon that the RTs are faster for concrete words than for abstract words) will be truly larger in forward translation than in backward translation. The second hypothesis tests whether, in the case of Japanese-English bilinguals, the concreteness effects will be truly larger for higher-proficiency participants than for lower-proficiency participants.

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[5] The percentages of error and omission data were calculated by dividing the raw numbers (in parentheses) by 3648 ($16 \times 2 \times 2 \times 3 \times 19$).

**The concreteness effect and translation direction (hypothesis 1)**

The interaction between concreteness and translation direction for RTs, errors and omissions was analysed (see Table 6 below).

**Table 6** Mean RTs (ms), and error and omission data (percentages with raw numbers in parentheses) for the interaction between concreteness and translation direction

| Translation direction | Concreteness | RTs | Errors | Omissions |
|---|---|---|---|---|
| Forward translation | high | 1369 | 3.56% (65) | 11.13% (203) |
| | low | 1581 | 4.11% (75) | 21.6% (394) |
| | Effect | **212** | **0.55% (10)** | **10.47% (191)** |
| Backward translation | high | 1542 | 5.26% (96) | 12.72% (232) |
| | low | 1704 | 8.83% (161) | 19.02% (347) |
| | Effect | **162** | **3.57% (65)** | **6.3% (115)** |
| | | ns | z = 2.1, p< .05 | z = -2.0, p < .05 |

*The percentages of error and omission data were calculated by dividing the raw numbers by 1824 (16×2×3×19).

There was no statistically reliable interaction for the RTs, although there were significant differences for error and omission data (errors: $z = 2.1$, $p < .05$; omissions: $z = -2.0$, $p < .05$). The results with regard to errors and omissions yielded different patterns of concreteness effects. Error data produced a larger concreteness effect in backward translation, while omission data showed a larger effect in forward translation.

**The concreteness effect and proficiency level (hypothesis 2)**

The interaction between concreteness and proficiency for RTs, errors and omissions was analysed (see Table 7 below).

The analysis showed significantly different effects only for omissions, but not for RTs and errors. The results regarding omissions demonstrated significantly larger concreteness effects for lower-proficiency subjects (JC: 9.12%; SH: 12.17%) as compared with that of higher-proficiency subjects (EC: 3.86%).

**Table 7** Mean RTs (ms), and error and omission data (percentages, and raw numbers in parentheses) for the interaction between concreteness and proficiency levels

| Proficiency level | Concreteness | RTs | Errors | Omissions |
|---|---|---|---|---|
| EC | high | 1262 | 2.80% (34) | 1.73% (21) |
| | low | 1406 | 3.62% (44) | 5.59% (68) |
| | Effect | **144** | **0.82% (10)** | **3.86% (47)** |
| JC | high | 1525 | 5.18% (63) | 16.04% (195) |
| | low | 1714 | 8.06% (98) | 25.16% (306) |
| | Effect | **189** | **2.88% (35)** | **9.12% (111)** |
| SH | high | 1579 | 5.26% (64) | 18.01% (219) |
| | low | 1807 | 7.73% (94) | 30.18% (367) |
| | Effect | **228** | **2.47% (30)** | **12.17% (148)** |
| | | ns | ns | $z = 2.1, p < .05$ |

*The percentages of error and omission data were calculated by dividing the raw numbers by 1216 (16×2×2×19).

## 6.4 Discussion

*The first hypothesis*

The results of RT data with respect to interaction between concreteness and translation direction did not confirm the first hypothesis. There was no statistically significant difference for concreteness effects between forward and backward translation (see Table 6). Testing this hypothesis is aimed to investigate De Groot and Poot's (1997) postulation that this interaction might test Kroll and Stewart's (1994) prediction that concept mediation may occur more in forward translation performance than in backward translation performance. The outcome of De Groot and Poot's (ibid.) study also did not confirm this hypothesis; it yielded rather *smaller* concreteness effects for forward translation than backward translation. They concluded that this result indicated the involvement of conceptual memory also in backward translation. Thus, the current study can also be interpreted that concept mediation occurred in backward translation as well as in forward translation.

The stronger concreteness effects in backward translation for the error data and the stronger concreteness effects in forward translation for omission data seem to be consistent with De Groot and Poot's (1997) following assumption. De Groot and Poot suggest that errors may be related to incorrect information about the abstract L2 lexicon in backward translation, while omissions may reflect absence of lexis in L2 for abstract words in forward translation.

*The second hypothesis*

The result with regard to interaction between concreteness and proficiency disconfirmed the second hypothesis which predicted a larger concreteness effect for higher proficiency participants. This hypothesis is based on De Groot and Poot's (1997) postulation that the more L2 acquisition develops, the more mediated the concept is when the L2 lexicon is activated. The results of RT data in this study evinced no statistically significant difference in concreteness effects in relation to proficiency levels (see Table 7). This outcome is in line with the findings of De Groot and Poot's (1997) study in that their study also did not yield results favouring the hypothesis. De Groot and Poot (1997) concluded that the lowest-proficiency subjects in their study mediated concepts as much as the higher-proficiency subjects. Following De Groot and Poot's view, the result of this study also leads to the conclusion that concept mediation occurred in the translation performance of the lowest-proficiency subjects as much as in that of the higher-proficiency subjects.

The current study supplied results which disconfirmed both hypotheses. The results indicated conceptual involvement in both translation directions and in all three developmental levels, which run counter to the RHM's (Kroll and Stewart, 1994) predictions. These results are consistent with the findings of de Groot and Poot's (1997) study as was discussed earlier. The more recent study using number-word translation tasks with Dutch-French bilinguals also provides evidence of conceptual mediation in both translation directions for bilinguals in different levels of L2 proficiency (Duyck and Brysbaert, 2004). Duyck and Brysbaert (2004) claim that magnitude effects – i.e. faster RTs for smaller number words (e.g. two) than for larger number words (e.g. eight) – indicate semantic (and thus, conceptual) mediation. In their number-word translation study, the magnitude effects were consistently observed in forward and backward translations and for balanced/unbalanced bilinguals and for novice L2 learners (see Chapter 2, pp.66-67 for more detailed description of their study).

De Groot and Poot (1997) suggest that concept mediation is the norm in the translation process. On the basis of this view, the processes of forward and backward translation were considered earlier in Chapter 2 (see Figure 13). The following is an attempt to explain the mechanism of concreteness effects using such an illustration of the translation process. This attempt includes an account of the issues regarding the distinction between concept and semantics (Paradis, 1995, 1997; Pavlenko, 1999, see Chapter 2 for a detailed discussion). The forward translation process can be illustrated as follows:

(1) L1 letter string perception,
(2) L1 semantics retrieval,
(3) Concept activation,
(4) L2 semantics access,
(5) Lexicalisation,
(6) Selection of an L2 word, and
(7) Production of L2 phonology.

Concrete words share more semantic features between translation equivalents than abstract words (e.g. De Groot, 1993, see Figure 14). Such overlap of semantic features for concrete words facilitates the processing of *L1 semantics retrieval→concept activation→L2 semantics access* in forward translation. The equally strong concreteness effect observed for backward translation in this study suggests that a similar phenomenon of facilitation should have occurred with reverse language direction (i.e. *L2 semantics retrieval→concept activation →L1 semantics access*). Duyck and Brysbaert (2004) discuss the RHM's limitation that it is not flexible enough to predict such different patterns of semantic involvement between concrete and abstract words in the translation process. The result of statistically equally strong concreteness effects for participants with different L2 proficiency levels also appears to indicate that their translation performance has benefitted from overlap of semantic features for concrete words in a similar fashion for these groups of participants.

It would be interesting to investigate how the magnitude of the concreteness advantage owing to the similar semantic features across languages could be affected by the structural differences in bilingual semantic systems in various developmental stages (i.e. dependent/independent L2 semantics on/of L1 semantics). Bilinguals with richer knowledge of L2 semantic information would become more sensitive to semantic differences between languages in abstract words than in the case of L2 learners with less proficiency. Does the postulation with regard to a larger degree of conceptual involvement for higher-proficiency bilinguals assume a larger degree of semantic involvement for these bilinguals? Results of the study with respect to a picture-naming task and a translation task in Chapter 5 seemed to indicate a larger degree of semantic involvement for the most proficient bilinguals (see the results in Chapter 5). However, the results obtained in this study exhibited no statistically significant difference between higher- and lower-proficiency L2 learners. Since this study is not designed to investigate directly the semantic development, it is not appropriate to make further inferences on this issue from the results obtained.

Association of concreteness effects with conceptual involvement is questioned by Kroll and Tokowicz (2001; Tokowicz and Kroll, 2007; see Chapter 2, pp.80-82 for detailed explanation). Tokowicz and Kroll (2007) propose that the typical cross-linguistic concreteness effect reported in the past studies (e.g. De Groot, 1992, 1993; De Groot et al., 1994) may be the result of unambiguousness of concrete words having single translation equivalents as compared with abstract words having multiple translations. They assume that such varying number of translations depending on the level of concreteness of a word derives from the inherent difference in the structure of network connection: i.e. concrete words are strongly connected to few nodes, while abstract words are weakly connected to many nodes. It seems plausible to consider that due to this structural difference, in the bilingual context, abstract words are less likely to overlap in semantic features (and thus weakly connected) among multiple translation equivalents. It appears that Tokowicz and Kroll (2007, p.745) agree with the view that translation equivalents overlap in meaning to varying degrees depending on the level of concreteness of a word. In this respect, this view seems to remain vague. In spite of concept-semantic distinction, it is difficult to separate conceptual involvement and semantic involvement in translation process. The design of the experiment in the present study did not manipulate the number of translations as one of the variables; therefore, we cannot relate this issue with the results obtained. Further investigation would be useful to help us better understand the mechanism of inter-lingual concreteness effects relative to the degree of semantic overlap and number of translations between translation equivalents.

**Conclusion**

In this chapter, the Revised Hierarchical Model was re-examined by observing concreteness effects in Japanese-English bilinguals' translation performance. The results disconfirmed both hypotheses. The results showed equally strong concreteness effects in both forward and backward translations for the participants at three L2 developmental levels, which is not consistent with the RHM's postulation. This study supports the view which suggests concept involvement in the translation performance in both translation directions for L2 learners in different developmental stages (De Groot and Poot, 1997; Duyck and Brysbaert, 2004). The results also offered additional evidence of different semantic structures depending on the word types (e.g. De Groot, 1993); and thus, different degree of semantic involvement.

The next chapter directly deals with the issue of the semantic difference between languages by using language-specific collocations as stimulus items.

# Chapter 7 Interactive connectivity of bilingual semantics

## Introduction

Chapters 5 and 6 examined the conceptual link with the bilingual lexicon in the case of Japanese-English bilinguals. This chapter investigates the semantic connectivity of bilingual networks in L2 processing in terms of the semantic differences between languages.

De Groot (1993) discusses the semantic differences between L1 and L2. She argues that words such as non-cognates and abstract words tend to have language-specific concepts; and thus, they are less likely to share the concepts between bilingual semantic representations. Several L2 developmental studies agree that bilingual semantic organisation may move from a stage where L2 semantics is parasitic on L1 semantics (*the word association stage*, Potter et al, 1984; *the subordinate system*, De Groot, 1993; *the lemma association stage*, Green, 1998; *the formal stage*, Jiang, 2000) to a stage where L2-specific concepts are established (*the compound / co-ordinate system*, De Groot, 1993; *the L2 integration stage*, Jiang, 2000). (See Chapter 2, 2.1 and 2.3.1 for detailed explanation.) According to De Groot (1993), at the latter stage, bilinguals have sensitivity to semantic differences in translation equivalents across languages. On the issue of bilingual lexical processing, it is generally believed that bilingual language access is language-non-selective at the initial stage, and the language-appropriate output is possible through the subsequent control process. This view is accepted in language production studies (e.g. Green, 1986; Grosjean, 1997, 2001; see Chapter 2, 2.3.2) and in word recognition studies at the orthographic level (e.g. van Heuven, et al., 1998), at the phonological level (e.g. Dijkstra, et al., 1999) and at the semantic level (e.g. Talamas, et al., 1999) (see 2.3.1).

In Chapter 3, the semantic difference between the English word *admit* and its translation-equivalent in Japanese *yurusu* was discussed (see 3.2 for detailed explanation). For such words, the manner of semantic network building seems to vary between the languages. The semantic network specific to the language naturally restricts the lexical selection, which results in different patterns of lexical partnership across languages. The English word *admit* tends to occur more with *truth* than with *marriage*, whereas the Japanese word *yurusu* tends to occur more with *kekkon* (marriage) than with *shinjitsu* (truth). Such lexical partnerships are termed 'collocations' in this study; thus, in this respect, collocational associations I refer to here are those which directly reflect semantic associations. Therefore, those which belong to the more "restricted" range of collocations (Carter, 1998, pp.70-71) such as *bread and butter* are not included in the discussion of collocational associations in this study.

It was also argued in Chapter 3 that the two semantic networks built across languages may be interconnected in a bilingual's mind (see Figure 20 in 3.2.1) and that the activation may spread from one language to the other (e.g. Talamas et al., 1999). However, it is not clear how activation spreads from one semantic network to another in the different semantic structures according to the developmental stages. Namely, at the early stage of L2 development, is L1 semantics extensively activated in L2 processing because L2 semantics is dependent on L1 semantics (*the subordinate system*)? In contrast, at the advanced stage of L2 development, is L1 semantics less activated because L2 semantics is independent of L1 semantics (*the compound / co-ordinate system*)?

The aim of the experiment is threefold. First, it verifies whether spreading semantic activation occurs in L2. Second, it examines whether L1 semantics activation may spread in L2 processing. Third, it further investigates the relationship between the level of development in L2 and the magnitude of spreading semantic activation in L1 and L2. On this basis, the following predictions are set up in the case of Japanese-English bilinguals and native speakers of English. 1) If spreading semantic activation in L2 occurs in bilinguals, Japanese-English bilinguals will process pairs of English (L2) words derived from English collocations (English collocation pairs) faster than semantically unrelated English pairs. In other words, English collocation effects will be found. 2) If the initial 'language-non- selective' access occurs at the semantic level as previous studies (e.g. Green, 1986; Grosjean, 1997; Talamas et al., 1999) propose, the Japanese-English bilinguals will process pairs of English words derived from Japanese collocations (Japanese collocation pairs) faster than semantically unrelated English pairs. In other words, Japanese collocation effect will be observed. This is predicted because their knowledge of L1 collocation will influence their L2 processing. On the other hand, native speakers of English will not exhibit Japanese (L1) collocation effects, because they have no knowledge of Japanese. 3) As the bilinguals' L2 proficiency level increases, the degree of Japanese (L1) collocation effects will decrease. This is predicted if it is true that the more developed L2 semantics will create an obstacle in accessing L1 semantics from the L2 due to the greater possibility that L2 semantics is independent of L1 semantics compared with the case of the less developed L2 semantics. On the other hand, it is expected that the less developed L2 semantics facilitates access from L2 semantics to L1 semantics because L2 semantics tends to be parasitic on L1 semantics.

In the experiment, Japanese-English bilinguals performed a lexical decision task in the semantic priming paradigm with three types of English prime-target pairs: i) pairs derived from English (L2) collocations, ii) pairs derived from Japanese (L1) collocations, iii) semantically unrelated pairs. The bilinguals' performance for prime-target pairs generated from language-specific collocational associations was observed in order to investigate interactive semantic connectivity across languages in terms of bilinguals' L2 development. The choice of these languages (i.e. English and Japanese) was meant to offer an answer to the question as to whether or not the bilingual's semantic system can interact between the languages which do not share the same writing systems (see conclusion in Chapter 2).

## 7.1 Hypotheses

The followings address the specific hypotheses.

1. If spreading semantic activation in L2 truly occurs in bilinguals, Japanese-English bilinguals' mean correct RTs for English collocation pairs will be faster than those for semantically unrelated pairs.
2. If the initial 'language-non-selective' access truly occurs, in the case of the Japanese-English bilinguals, the mean correct RTs for Japanese collocation pairs will be faster than those for semantically unrelated pairs. In contrast, in the case of native speakers of English, there will be no difference in the mean correct RTs between Japanese collocation pairs and semantically unrelated pairs.
3. If the more developed L2 semantics creates an obstacle in accessing L1 semantics from L2, the degree of Japanese (L1) collocation effects will be smaller for higher-proficiency participants than for lower-proficiency participants.

## 7.2 Method

*Subjects* In all, 80 people participated in this experiment. These participants consisted of 20 native speakers of English (NS), 20 Japanese students who attended an English-speaking college (EC), 20 Japanese students who attended a Japanese college (JC) and 20 senior high school students (SH). All the native speakers of English, except one, were of Irish origin, but, according to the interview regarding their language background, all of them had English (rather than Irish) as their mother tongue and dominant language. None of them had any knowledge of Japanese, although most of them had learned other languages (including the Irish language). Regarding the other groups of participants (EC, JC and SH), the participants described in Chapter 6 again participated in this experiment.

*Stimulus materials* In this experiment, in total, 96 pairs of prime and target items were used (see Appendix C). The prime items were all existing English words and the target items consisted of 48 actual English words and 48 non-English words (pronounceable pseudo-words). These 48 real English prime-target pairs can be divided into three groups of 16 pairs each. These three groups may be described as follows: i) English prime-target pairs derived from Japanese collocations whose direct translation into English does not make sense (Japanese collocations) - for example, the stimulus pair *forgive-marriage* is derived from a Japanese collocation which means 'to consent to a marriage;' ii) English prime-target pairs which were derived from English collocations but which may not be easily produced directly from Japanese owing to semantic differences in respect of the interlingual translation-equivalents (English collocations) - for example, in the case of *admit-evidence*, the English word *admit* can be translated as '*yurusu*' or '*mitomeru*' in Japanese; *mitomeru* includes the concept of 'to accept a truth (unwillingly)/ to accept responsibility for doing/saying something wrong /illegal,' whereas *yurusu* does not (see 3.2.1, pp.132-134 for more detail); iii) English prime-target pairs which are semantically unrelated and do not make sense either in English or Japanese (unrelated pairs). The collocational conditions of these three kinds of pairs were confirmed by the frequency with which these pairs occur in spoken and written sentences from the British National Corpus (BNC). The frequency was computed using the Word-Smith Tools (see Appendix C). The average frequency of collocations was as follows: 0.13 cases for the Japanese collocation pairs (only 2 cases were found out of 16 pairs, such as 'slim style' and 'cat-cry syndrome'); 204.94 cases for the English collocation pairs; and 0 cases for the unrelated pairs. The acquisition level for Japanese learners of English and the word-length of individual words were also controlled. The average acquisition level was 1.58 out of 8 levels according to the JACET Basic Word List (2003) (see Chapter 5 for an explanation of this list). Word length of the stimulus items was matched as closely as possible. The average word-length of prime words was 4.42 letters and the average word-length of existing English target words was 5.15 letters. The average word length of pseudo-words was also 5.15 letters. Prior to the real experiments, 15 pairs were given in a practice task to each participant. These practice items included all conditions detailed above. Frequency-level and word-length were also matched with those of the real experiments (respectively, level 1.61 and 4.93 letters).

*Apparatus* The entire experimental sessions were conducted with a Toshiba computer (see apparatus in Chapter 5 for the detailed description of the computer) programmed for each task with the experimental software E-Prime version 1.1, which was able to deal with programming and data collection in milliseconds.

*Procedure* A total of 96 pairs were divided into two trials, each of which included the items from all four stimulus types (pseudo-word target pairs, English collocation pairs, Japanese collocation pairs and unrelated pairs). Between these trials, a break was provided, and if participants wished they could rest before they resumed the experiment. All the items were presented in random order to the individual subjects, and the presentation order of trials was also counterbalanced by varying the order for different participants.

The stimuli were presented in the following order: firstly, a mask consisting of six hash signs was presented for 500ms, followed by a prime item, which was presented for 250ms. Immediately after the prime item disappeared, a target item was presented until subjects responded by pressing either of two keys on the ten-key pad. When the participants responded, the target items were immediately replaced by a blank screen, which was presented for 2000ms before the next stimulus pair appeared. In cases where participants did not respond within 5000ms, the target item was automatically replaced by a blank screen. A counter invisible to participants started when the target items appeared and stopped when the participants responded. The counter was also terminated automatically if subjects did not respond within 5000ms. The SOA (stimulus onset asynchrony) of this experiment was 250ms, which was regarded as appropriate for examining automatic processing following Neely's (1977) study. Neely (1977) suggests that language is automatically processed when SOAs are shorter than 400ms. The word recognition problem was anticipated relative to the less proficient group (see the discussion in relation to the effect of non-alphabetic L1 experience on English processing in Chapter 2, 2.4.6). Thus, a pilot study with a word-recognition test was performed with three subjects from the least proficient group (SH). Subjects were presented with 22 English words with an average acquisition level of 1.64 (JACET Basic Word List, 2003) and an average word-length of 5.4 letters (See Appendix C). Participants were asked to name them in English in order to confirm whether or not they recognised the words correctly. As a result of the test, the author confirmed that the exposure duration time of 250ms was long enough for these participants to recognise English words correctly.

*Task* Each participant underwent the experiment individually. Participants were given instructions that described the tasks, for Japanese-English bilinguals, written in Japanese and for native English speakers, written in English (see Appendix D for actual instructions). In the instructions, the participants were told that they would see on the computer screen pairs of letter strings and that they had to decide whether the second string of each pair was a real English word or not as quickly and accurately as possible by pressing key 5 or 6 on the ten-key pad. The right-handed participants were asked to press 6 when they thought the target items were 'real English words' and to press 5 when they thought these items were 'non-English words.' Conversely, the left-handed participants were asked to press 5 for 'real English words' and 6 for 'non-English words.' Participants were orally advised to use their thumbs of the dominant hands for 'real English words' and of their non-dominant hands for 'non-English words.' In this study, responses only concerning 'real English words' were used for analysis; in other words, only dominant-hand responses were analysed. This was considered appropriate, on the basis of evidence that indicates a facilitation of the dominant-hand responses as opposed to the non-dominant-hand responses (Borghi and Scorolli, 2009). They were also told to pay attention to the first string because it may help them in making their response. This instruction was also used in Peterson and Simpson's (1989) lexical decision study and was considered pertinent due to the fact that less proficient Japanese learners of English have less experience of word recognition in English (see Chapter 2, 2.4.6). Prior to the real experiments, participants rehearsed with 15 practice items. When subjects were confident that they had understood the procedure and task correctly, the real experiments began.

### 7.3 Results

The analysis took account only of responses to the 48 real-English word targets from the experimental list. Out of these 48 items, RTs of responses which were correctly answered as real English words were included for analysis (92.13% of all responses to real-word targets). The responses which were not correctly recognised as real English words are named 'errors' in this study. Mean RTs and error numbers were calculated for each participant in order to perform the statistical analysis. The analysis focused on two variables (four subject groups and three stimulus types). The mean RTs and the mean error rates for each subject group are as follows: NS, 797ms (RTs), 3.33% (32)[6] (error rate with raw numbers in parentheses); EC, 787ms, 5.00% (48); JC, 869ms, 11.04% (106); SH, 929ms, 10.63% (102). The mean RTs for each task type are as follows: unrelated pairs, 888ms, 10.63% (136); English collocation pairs, 816ms, 6.72% (86); Japanese collocation pairs, 833ms, 5.16% (66). Table 8 shows the mean RTs and error data for all variables, and Figure 25 illustrates the English and Japanese collocation effects for each subject group.

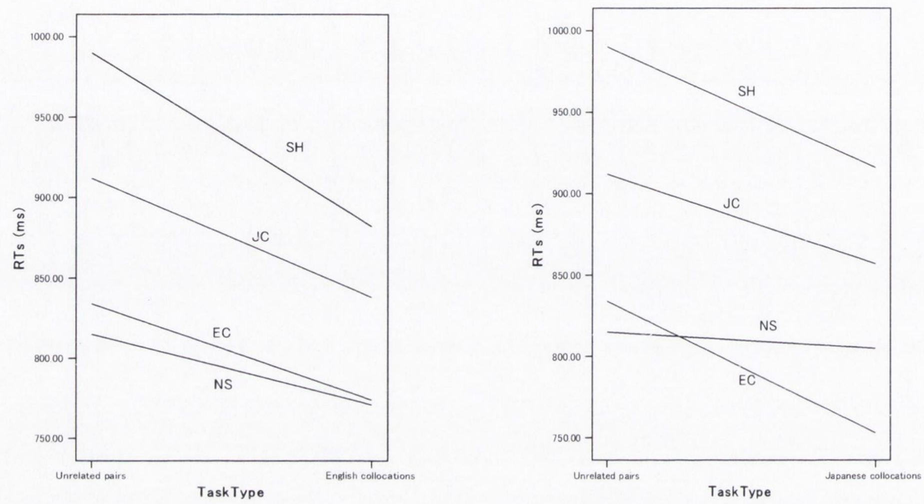
**Table 8** Mean RTs (milliseconds) and error data (percentages with raw numbers in parentheses) for the three stimulus types as well as in respect of English collocation and Japanese collocation effects across the four subject groups

| | Unrelated pairs | | English collocations | | Japanese collocations | | English collocation effect | | Japanese collocation effect | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RTs | Errors | RTs | Errors | RTs | Errors | RTs | Errors | RTs | Errors |
| NS | 815 | 3.44% (11) | 771 | 3.44% (11) | 805 | 3.13% (10) | 43 (p<.07) | 0.00% (0) | 10 (ns) | 0.31% (1) |
| EC | 834 | 7.50% (24) | 774 | 4.38% (14) | 753 | 3.13% (10) | 60 (p<.005) | 3.13% (10) | 81 (p<.0005) | 4.38% (14) |
| JC | 912 | 16.88% (54) | 838 | 9.06% (29) | 857 | 7.19% (23) | 74 (p<.005) | 7.81% (25) | 55 (p<.05) | 9.69% (31) |
| SH | 990 | 14.69% (47) | 882 | 10.00% (32) | 916 | 7.19% (23) | 108 (p<.005) | 4.69% (15) | 74 (p<.05) | 7.50% (24) |

*The percentages of error data were calculated by dividing the raw numbers by 320 (20 x 16) for all subject groups.

[6] The percentages of error data for each subject group were calculated by dividing the raw numbers (in parentheses) by 960 (20 × 16 × 3), and for each task type, by1280 (20 × 16 × 4).

**Figure 25** English (left) and Japanese collocation (right) effects for the four subject groups




## Analyses of RTs

A weighted ANOVA was performed. Only the stimulus-type main effect was statistically significant (F=20.8, p<.0001). Although the subject groups did not provide main effects, there was an interaction between subject groups and stimulus types. This indicates that the responses to the individual stimulus types differ across subject-groups.

Furthermore, paired t-tests were employed in order to examine statistically three hypotheses addressed earlier by observing the priming effects for Japanese and English collocations. First, if spreading semantic activation occurs in L2, Japanese-English bilinguals' RTs for English collocation pairs will be faster than those for semantically unrelated pairs. Second, if the initial 'language-non-selective' access occurs at the semantic level, Japanese-English bilinguals' RTs for Japanese collocation pairs will be faster than those for semantically unrelated pairs. In contrast, the RTs data of native speakers of English should show no difference between these sets of pairs. Third, if the more developed L2 semantics creates an obstacle in accessing L1 semantics from L2, the degree of Japanese collocation effects will be smaller (thus, larger *p* value) for higher-proficiency participants than for lower-proficiency participants.

The results demonstrated that except in the case of the native speakers of English, the English collocation effects for all the subject groups were significant (EC, t=3.3, p<.005; JC, t=3.3, p<.005; SH, t=3.5, p<.005) (see Table 8). The English collocation effects were found by subtracting the RTs for English collocation pairs from the RTs for unrelated pairs. This collocation effect in the case of native speakers of English (NS) was only marginally significant, t=2.0, p<.07. In the case of Japanese collocation effects, except for NS (p>.1), the RTs of all the Japanese-English bilinguals showed significant effects, EC (t=5.3, p<.0005); JC (t=2.2, p<.05); SH (t=2.5, p<.05). If multiple comparisons are carried out (here 8 individual tests were carried out), the critical value for the t-test needs to be increased from 2.09 to 3.1 (using the Bonferroni method). This means that the lower-proficiency learners' (JC, SH) Japanese collocation effects will no longer be statistically significant. This indicates that the most proficient bilinguals (EC) exhibited a truly significant Japanese collocation effect, whereas the effect in respect of the two lower-proficiency learners (JC, SH) was not as strong as that of the most proficient bilinguals. It is assumed that the large variability among the lower-proficiency learners is responsible for these results— the standard error was 24.88 for JC and 30.21 for SH, whereas it was 15.27 for EC.

**Analyses of errors**

Errors in the lexical decision task refer to cases where participants responded to the target item as a 'non-English word' although it was, in fact, a real word. The statistical analysis involved fitting generalised linear models; the results are expressed as z-tests.

The results show that both of the main effects were significant, for subject groups, z=5.9, p<.0005 and for stimulus-types, z=-5.0, p<.0005. In general, as was expected, less proficient subjects (JC and SH) produced more errors than more proficient subjects (NS and EC) and more errors were observed for unrelated prime-target pairs than for Japanese or English collocation pairs (see Table 8). Since there was a tendency for error numbers to differ according to stimulus types in a similar fashion across subject groups, there was no interaction between subject groups and stimulus types.

**7.4 Discussion**

Three sets of hypotheses are examined in this section. The first hypothesis was confirmed. All the groups of Japanese-English bilinguals exhibited English collocation effects, although the effect in respect of the native speakers of English was found only at a marginal level. Thus, it seems that spreading semantic activation in L2 occurs in bilinguals. The second hypothesis was supported. The individual t-tests showed that all Japanese-English bilinguals exhibited significant effects for both English and Japanese collocations, in spite of the fact that the input language was only English. This suggests that Japanese-English bilinguals access their bilingual lexicon in a language-non-selective manner in the initial stage of processing. Thus, it appears that this bilingual interactive activation also occurs at the semantic level. This supplies evidence of the bilingual semantic network being interconnected across languages. On the other hand, the native speakers of English did not exhibit a significant effect for Japanese collocations, owing to the fact that they had no knowledge of Japanese collocations. The third hypothesis was not confirmed. With respect to Japanese collocation effects, the results of the t-test using multiple comparisons showed that larger effects were exhibited *not* for the least proficient learners *but* for the most proficient bilinguals. The parasitism of L2 semantics on L1 semantics seems not to have fostered access from L2 semantics to L1 semantics.

Accordingly, the expected results were found with respect to the first, and the second hypotheses. The visual presentation of L2 words activated not only L2 semantics but also L1 semantics for Japanese-English bilinguals, even though the two languages did not share orthography. This indicates that the bilinguals' semantic processing is language-non-selective in the initial stage. On the other hand, the third hypothesis was not confirmed. Japanese collocation effects were not smaller for higher-proficiency participants than for lower-proficiency participants. In fact, the most proficient bilinguals (EC) showed *stronger* effects.

This result appears to suggest that the bilingual semantics are more strongly connected for higher-proficiency bilinguals than lower-proficiency learners. Then, what is the mechanism behind this result?

The hypothesis in question initially postulated a lesser degree of connectivity between bilingual semantics as L2 acquisition developed; thus, it predicted a lesser degree of L1 semantics activation in L2 processing for bilinguals with more developed L2 than for those with less developed L2. This hypothesis was posed on the basis of the following assumption. For the bilinguals who had lived in the L2-speaking environment for an average of 4.17 years (EC), it was more likely that L2 semantics was developed at the level where the L2-specific concepts are established (*the co-ordinate system*, De Groot, 1993) in comparison with those who had learned their L2 in a formal context in their L1-speaking country for 4 years (SH). This postulation predicted, on the contrary, that in the case of the lower-proficiency L2 learners (SH), the parasitism of L2 semantics on L1 semantics (*the subordinate system*, De Groot, 1993; *the lemma association stage*, Green, 1998) would help activate L1 collocations in L2 processing. The opposite result—namely, the *stronger* Japanese collocation effects for the most proficient bilinguals than for the lower-proficiency learners—suggests that this is not the case. This result actually indicates *more* activation of L1 semantics in L2 processing for bilinguals with more developed L2 than with less developed L2. It may be that activation spreads from L2 semantics to L1 semantics more efficiently as proficiency increases. In other words, bilingual semantics may be more strongly connected between L1 and L2 as L2 acquisition develops.

Analysis of the data yielded by each stimulus item shows that in the case of easy stimulus items in terms of acquisition level and word length, the lower-proficiency participants (SH and JC) also exhibited strong Japanese collocation effects (e.g. *cat-cry, thin-tea, warm-mind, stand-plan*, etc.; see Table 9 below). However, as the degree of difficulty for the stimulus items increased, the Japanese collocation effect diminished or disappeared for the least proficient participants, while it tended to remain for the most proficient participants (EC) (e.g. *allow-anger, slim-style, hear-carefully, laugh-kindly, forgive-marriage, borrow-toilet*; see Table 9). These results seem to indicate that the activation of L1 collocations is facilitated for those words which tend to be registered in the mental lexicon earlier and for those whose lexical knowledge is more likely to be developed.

**Table 9** RTs and effects of Japanese collocation pairs for each stimulus pair arranged by the level of difficulty of stimulus items in terms of acquisition level and word length

| prime | | | target | | | NS | | EC | | JC | | SH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prime | AQ | WL | Target | AQ | WL | RTs | Effects | RTs | Effects | RTs | Effects | RTs | Effects |
| cat | 1 | 3 | cry | 1 | 3 | 834 | -19 | 763 | 71 | 797 | 115 | 759 | 231 |
| thin | 2 | 4 | tea | 1 | 3 | 795 | 20 | 696 | 139 | 711 | 201 | 734 | 256 |
| warm | 1 | 4 | mind | 1 | 4 | 736 | 79 | 693 | 141 | 712 | 200 | 734 | 256 |
| ride | 1 | 4 | ship | 1 | 4 | 829 | -14 | 726 | 108 | 846 | 66 | 857 | 133 |
| stand | 1 | 5 | plan | 1 | 4 | 813 | 2 | 604 | 230 | 657 | 255 | 691 | 299 |
| teach | 1 | 5 | road | 1 | 4 | 767 | 48 | 652 | 182 | 801 | 111 | 889 | 101 |
| accept | 1 | 6 | test | 1 | 4 | 736 | 79 | 751 | 83 | 870 | 42 | 808 | 182 |
| write | 1 | 5 | picture | 1 | 7 | 760 | 55 | 761 | 73 | 834 | 79 | 904 | 86 |
| heavy | 1 | 5 | disease | 1 | 7 | 883 | -68 | 871 | -37 | 1138 | -226 | 1024 | -34 |
| arm | 1 | 3 | clock | 2 | 5 | 831 | -16 | 651 | 183 | 716 | 196 | 843 | 147 |
| allow | 1 | 5 | anger | 2 | 5 | 806 | 9 | 691 | 143 | 813 | 99 | 965 | 25 |
| slim | 5 | 4 | style | 1 | 5 | 840 | -25 | 701 | 133 | 921 | -9 | 961 | 29 |
| hear | 1 | 4 | carefully | 1 | 9 | 800 | 15 | 866 | -32 | 993 | -81 | 1167 | -177 |
| laugh | 1 | 5 | kindly | 6 | 6 | 846 | -31 | 867 | -33 | 1088 | -176 | 1080 | -90 |
| forgive | 3 | 7 | marriage | 2 | 8 | 812 | 3 | 839 | -5 | 927 | -15 | 1095 | -105 |
| borrow | 2 | 6 | toilet | 3 | 6 | 813 | 2 | 854 | -20 | 1079 | -167 | 1105 | -115 |

Note:* Effects are calculated by subtracting RTs for each item in the Japanese collocation list from the average RTs for unrelated pairs (NS, 815ms; EC, 834ns; JC, 912ms; SH, 990ms). ** AQ stands for acquisition level and WL stands for word length.

It may be worth noting that the decrease of the Japanese collocation effect for the more difficult words seemed not to be caused by inefficient orthographic recognition. The English collocation effect hardly diminished or disappeared in the case of the more difficult words, even though the level of difficulty for the stimulus words was approximately the same in both the Japanese and the English collocation lists (see the average acquisition level and the average word length for each task type in Appendix C).

It appears that the results of the item analysis confirm the tendency that cross-language semantic activation is facilitated in the case of the more advanced development of L2 acquisition as compared with the case of the less advanced development of L2 acquisition. The following attempts to explain the mechanism of the semantic interconnection between L1 and L2 with respect to L2 developmental stages on the basis of the results discussed above.

**Development of L2 semantics and the bilingual semantic connectivity**

The parasitic relationship between the L2 semantic network and that of the L1 does not seem to result in easy access from L2 semantics to L1 semantics. Similarly, the more developed L2 semantics which is more likely to be independent of the L1 semantics does not appear to create an obstacle to a certain semantic linkage between the L2 and the L1. This suggests that the bilingual semantic network of highly proficient bilinguals is interconnected, but this 'interconnection' seems to differ from the parasitical link of L2 semantics to L1 semantics in the case of the lower-proficiency L2 learners. At the early stage of L2 acquisition, learners' L2 semantics has not yet been fully established, and L2 semantics is dependent on L1 semantics (e.g. *the subordinate system*, De Groot, 1993; *the lemma association stage*, Green, 1998). However, it may be that access from L2 semantics to L1 semantics is not automatic, because the connection between L1 and L2 semantics is incomplete. On the other hand, when bilinguals' L2 semantics develops and L2 semantics is more likely to be established independently from L1 semantics, dynamic interconnection between the semantics of the L1 and the L2 seems to become possible. For instance, when the L2 word *forgive* is presented, the activation automatically spreads to all the related nodes of concepts within and across languages (see Figure 26 below).

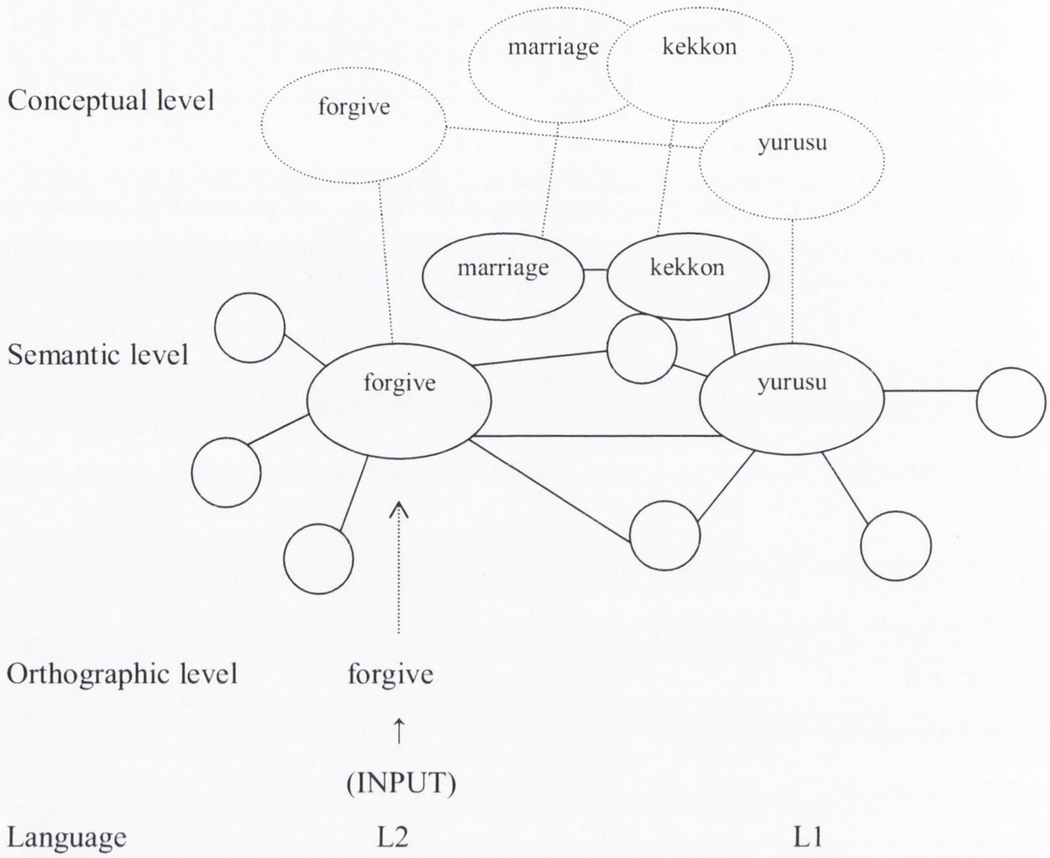



**Figure 26** Spreading activation from the L2 semantics 'forgive' to 'marriage' via the L1 semantics 'yurusu'

Therefore, the L1 word *yurusu* is activated as one of the related nodes, which further activates *kekkon* meaning 'marriage' in English, and *marriage* is also automatically activated owing to its semantic similarity with *kekkon*. For the most proficient bilinguals, access from L2 to L1 semantics may be automatic; hence the strong L1 collocation effect. This appears to account for the tendency of the less proficient participants to exhibit a strong L1 collocation effect for easier stimulus words, whose semantics would have been relatively developed.

The L1 collocation effects can be compared with mediated semantic priming effects (De Groot, 1983; Balota and Lorch, 1986; McNamara and Altarriba, 1988; McNamara, 1992; see Chapter 3, 3.1.2). From the perspective of mediated semantic priming studies, the explanation of L1 collocation effects is offered as follows: in order for activation to spread from L2 *forgive* to *marriage*, L1 *yurusu* (and *kekkon*) have to mediate. According to McNamara and his colleague (McNamara and Altarriba, 1988; McNamara, 1992), the effects diminish as the number of mediators increase. This supplies evidence that the semantic network is organised in terms of semantic distance; thus, spreading activation occurs through the neighbouring nodes of the network. If L2 collocations are assumed to be directly related pairs and L1 collocation pairs to be mediated pairs, larger L2 collocation effects are expected than L1 collocation effects. However, this study has produced the results which run counter to this view. The most proficient bilinguals exhibited effects as large for L1 collocation pairs as for L2 collocation pairs (see Table 8). This suggests that cross-linguistic semantic processing differs from mediated semantic processing in that the former deals with two distinct semantic systems (i.e. L1 and L2) which typically have different weights in terms of the size and the density of information. The result supports the claim that the semantic networks for each language function as a subset of one semantic system (Paradis, 1987). However, it also shows that the mechanism of interconnectivity between the two networks is complex and the manner of interactions in bilingual semantic processing is dynamic. Cross-language interconnectivity is considerable and L1 semantics seems to be highly active while L2 semantics is processed.

In this study, a particular length of SOA (250ms) was chosen in the experiment. The length of SOAs is regarded as playing a major role in controlling the manner of semantic activation in participants' semantic processing in psycholinguistic experiments. As was explained earlier (see Chapter 3, 3.1.2, pp.120-121), Neely (1977) suggests that automatic processing is related with short SOAs whereas conscious processing is associated with long SOAs. It may be that the critical point for automatic/conscious processing varies depending on the participants' developmental stages in the language in question. The developmental study in semantic processing may benefit from the manipulation of the SOA length. A series of hypotheses for further study will be proposed at the end of this chapter.

**Conclusion**

The semantic processing of native speakers of English and of Japanese-English bilinguals was observed. The results supplied evidence that in bilinguals, spreading semantic activation occurs within the L2 semantic network as well as across the entire bilingual semantic network. This supports the standpoint of initial language-non- selectivity (e.g. Green, 1986; Grosjean, 1997, 2001; van Heuven et al., 1998). In particular, these results offer evidence that even in languages which do not share orthography, language-non-selectivity at the semantic level is a feature of bilinguals' lexical processing mechanisms. The study also investigated the manner of semantic interconnectivity across languages in L2 developmental stages. The results of the experiment showed the larger effect of L1 semantic knowledge on L2 processing for bilinguals with higher L2 proficiency than with lower L2 proficiency.

The item analysis of Japanese collocation effects with regard to lower-proficiency participants provides additional evidence for this outcome. Stronger Japanese collocation effects were exhibited for the easier stimulus items whose lexical knowledge is more likely to be developed than the case of the more difficult items, whereas the effects diminished or disappeared for the more difficult items.

These results seem to suggest that spreading activation from L2 semantics to L1 semantics occurs more efficiently as L2 acquisition proceeds. It was discussed that the interconnectivity between bilingual semantic networks for proficient bilinguals may qualitatively differ from the parasitic connection between L2 semantics and L1 semantics in lower-proficiency learners. Since the L2 semantics of the lower-proficiency learners is not yet fully established, the interlingual connection may be still incomplete in the bilingual semantic network. As Francis (2005, pp.257-8) argues, the issue of language-non-selectivity in relation to L2 developmental stage has as yet received surprisingly little investigation. Obviously, in the future it would be worthwhile to investigate the qualitative change in the semantic link between L2 and L1 in the course of second language acquisition.

On the basis of the results provided in this experiment, the following question needs to be pursued: how might the parasitic linkage between L2 and L1 semantics be qualitatively different from the interconnectivity of the bilingual semantic network in proficient bilinguals? It was suggested that the qualitative differences in the bilingual semantic linkage for the L2 learners at the early stage and the advanced stage of acquisition may be related to the efficient/inefficient manner of cross-language spreading activation. It is widely accepted that the length of SOAs (stimulus onset asynchrony) affects the manner of semantic activation in the priming process. Neely (1977) reported that with the short SOA such as 250ms, semantic activation for the target items was facilitated; however, when the SOA went beyond the critical point, which was 400ms in the case of his participants (native speakers of English), the inhibition effect was observed. Neely (ibid.) explains that at the short SOAs semantics is automatically processed, while longer SOAs allow conscious attention to take effect in the processing (see Chapter 3, 3.1.2 for detailed explanation).

On this view, it may be that the manipulation of the length of SOAs can reveal the efficient/inefficient manner of semantic activation across languages. On the basis of such postulation, the following hypotheses are posed.

i) If lower-proficiency learners' activation from L2 to L1 semantics is inefficient, they will produce stronger effects for Japanese collocations with longer SOAs than with an SOA of 250ms.
ii) On the other hand, in the most proficient bilinguals, the non-target language will be inhibited with longer SOAs, resulting in a decrease in the magnitude of Japanese collocation effects.

Hypothesis i) is based on the assumption that less proficient learners' parasitic linkage between the two languages is inefficient and that cross-linguistic semantic access is slow. If this is true, their facilitation of spreading semantic activation in the non-target language would occur later than that of proficient bilinguals. Thus, with longer SOAs than 250ms (e.g. 400ms or 500ms), the non-target language (Japanese) collocation effects may increase. On the other hand, hypothesis ii) predicts that for proficient bilinguals, as the processing passes the initial stage, the control system would inhibit activation of the non-target language (Green, 1986, 1998; Grosjean, 1997, 1998, 2001; see discussion in 2.3.2 Control). Therefore, with longer SOAs such as 400ms or 500ms, it is expected that Japanese collocation effects may decrease.

In relation to this question, exploration of the control system with regard to less proficient learners may also be beneficial to L2 developmental studies. In other words, it may be worthwhile investigating whether the control system works at an even later stage (e.g.600/700ms) or whether it does not work at all.

This study explored the mechanism of spreading semantic activation from L2 to L1. It is also necessary to investigate whether activation of L1 semantics spreads to L2 semantics in L1 processing and how the size of spreading activation from L2 to L1 may differ in relation to the developmental stage. The magnitude of spreading activation may vary depending on L2 acquisition level and recency of exposure to L1.

Verification of these hypotheses could prove to be fertile ground for further research into the mechanisms of the bilingual mental lexicon.

# Chapter 8 Conclusion of the empirical study

Three types of experiments were employed with Japanese-English bilinguals, the experimental tasks consisting of a picture-naming task, a translation task and a priming task. On the basis of the results of these experiments, the developmental process of L2 semantics in the case of Japanese-English bilinguals was discussed.

In Chapter 5, the relevance of the findings with regard to the transition from word association to concept mediation (Potter *et al.*, 1984) was first examined. All the participants except for the highest-proficiency participants produced approximately equal RTs for a forward translation task and a picture-naming task. This result indicated that they were all at the concept mediation stage. It seemed that the lowest-proficiency participants had already reached the concept mediation stage for the relatively easy words used in the experiment (i.e. high-frequency concrete words). In contrast, the highest-proficiency participants showed a marginally significant effect ($p<.06$) for their picture-naming performance. In the discussion, attention was directed toward the fact that this model does not take account of the semantic role in picture-naming and translation processing. If the semantic role is taken into consideration, it is assumed that the processing of *L1 letter string perception – L1 semantic retrieval – concept retrieval – L2 semantic access* in forward translation is slower than the processing of *image perception – concept retrieval – L2 semantic access* in picture-naming. The result with respect to the highest-proficiency participants was discussed in relation to the issue of L2 semantic development.

Chapter 5 also examined the proposal with respect to the asymmetrical weight of the conceptual involvement between translation directions (Kroll and Stewart, 1994), using a bidirectional (L1→L2 and L2→L1) translation task; however, the study did not yield the results that this model predicted. All the participants evinced approximately equal RTs for both translation directions. An exception was the lowest-proficiency participants who produced slightly slower RTs for backward translation than for forward translation ($p<.07$). It was discussed that this outcome might be related to the fact that for Japanese learners of English, English word recognition in backward translation tends to be less efficient than Japanese word recognition in forward translation. This seems to be due to their lack of experience in computational analysis of phonemic components of a word, which is regarded as important in English word recognition (Akamatsu, 1999, 2003; Koda, 1999).

Kroll and Stewart's (1994) proposal was re-examined in Chapter 6 by observing the size of concreteness effects. No statistically significant differences were found in the size of concreteness effects in both forward and backward translation for participants at the three developmental stages. This result did not support Kroll and Stewart's (1994) proposal; it suggested that the concepts were involved equally in both translation directions and in all three developmental stages. This outcome was in line with the findings of De Groot and Poot's (1997) study and Duyck and Brysbaert's (2004) study. By observing the concreteness effects, this study also supplied additional evidence of the structural differences in bilingual semantics depending on the word types (De Groot, 1993). In relation to this, the limitation of the Revised Hierarchical model was discussed; the model is not able to predict the different degree of semantic involvement depending on the level of concreteness of a word.

Overall, the focus of the Hierarchical Model and the Revised Hierarchical Model is on whether or not the concepts are involved in the certain condition of translation processing. De Groot (1993) discusses the case where the degree of conceptual overlap differs between translation equivalents depending on the word types such as concrete/abstract words. In such a case, what matters is an issue of *what kind of* concepts are involved in the bilingual processing. When an L2 word is processed, the conceptual components involved may vary between a novice L2 learner and a proficient L2 user due to the difference in the level of their knowledge with regard to the semantic information of the word in question. Thus, as L2 acquisition progresses, the issue regarding the development of the L2 lexicon might be more appropriately accounted for by the extent to which L2 semantics has developed rather than in terms of whether concepts are mediated or not. Therefore, it appears that the phase where the concept is not mediated (i.e. the word association stage) is best represented as a phenomenon whereby L2 semantics is completely parasitic on L1 semantics. In this phase, when an L2 word is processed, since there is no semantics to refer to in the L2 lexicon, the concept is also not accessed via this lexicon. As L2 acquisition progresses, semantic information is installed in the L2 lexicon and accordingly the concepts are mediated via L2 semantics. After the installation of L2 semantics in the L2 lexicon begins, L2 semantic development further continues to the phase where the L2-specific semantics is set up for words whose meanings do not share the concepts with those of the translation equivalents (i.e. co-ordinate system, De Groot, 1993).

Development of L2 semantics was directly explored in Chapter 7 by means of a semantic priming task. The aim of this experiment was to investigate the question of how the semantic interconnectivity between L1 and L2 can be correlated to the developmental stage of L2 semantics. In other words, if L2 semantics is associated with L1 semantics in a parasitic fashion, does this facilitate the semantic link from L2 to L1? If L2 semantics has developed enough to establish L2-specific semantics independent of L1 semantics, does it block the cross-linguistic semantic link? The results of this experiment supplied evidence that this postulation is not true. In fact, the RT data of the most proficient bilinguals exhibited the largest L1 collocation effect on L2 processing. The results indicated that as L2 semantics develops, the interactive connectivity across languages becomes more efficient. The findings of this study suggest that in the case of the proficient bilinguals, semantic activation may spread simultaneously from an L2 word, via neighbouring nodes, to various related words not only in L2 but also in L1. This may occur as a result of the establishment of interlinks across the L1 and L2 semantic networks, rather than a one-to-one translation link, which may reflect their sensitivity with regard to the semantic differences between languages.

It seems necessary to reconsider the results of the word association test discussed in Chapter 3 (3.2.1). The Japanese college-level participants produced various irrelevant associates in response to L2 stimulus items (Ueno, 2003). This result prompted the conclusion that the L2 semantics of bilinguals at this level may be parasitic on L1 semantics. Indeed, in the case of the stimulus item *admit*, these participants did not produce any associates related to the primary concept of this word "to accept a truth (unwillingly)/ to accept responsibility for doing/saying something wrong/illegal." The earlier-mentioned conclusion was based on the fact that such associates constituted the majority of responses from the native speakers of English. However, the results in Chapter 7 indicate that bilinguals automatically access L1 when processing L2, given initial language-non-selectivity. The word association task tells us about the productive semantic associations of bilinguals, but it does not reveal the interactive bilingual semantic link at the unconscious level. Thus, L1-related associates in a word association test simply indicate that bilinguals' two semantic systems are associated across languages, which is fairly natural. In respect of the investigation of dynamic mechanisms involved in bilingual processing, it appears that online experiments which are able to elicit the unconscious responses offer the most fruitful evidence.

In the experiment in Chapter 7, stimulus items were presented in a monolingual context — that is to say, only L2 orthography was presented to the participants. Furthermore, no information was provided to them concerning any relations between these L2 stimuli and the L1. The previous bilingual semantic studies typically used interlingual prime-target pairs—i.e. L1 prime-L2 target and L2 prime-L1 target (De Groot and Nas, 1991; Gollan, Forster and Frost, 1997; Jin, 1991; Fox, 1996). Therefore, it may be possible to say that this study examined the purely semantic aspect of bilingual processing.

The findings with respect to semantic connectivity between languages in relation to the developmental stage of L2 semantics appear to offer a scaffold for further exploration of this issue. Relative to further study of this matter, three questions were proposed at the end of Chapter 7. These questions suggest investigation of facilitation and control mechanisms with regard to bilingual semantic processing in various developmental stages. This would provide us with more evidence of the development of L2 semantics and the semantic interconnectivity between languages. This study focused on semantic access from L2 to L1; however, the issue of semantic access in the opposite direction (i.e. L1→L2) would also be worth investigating. This might reveal how bilinguals' L2 processing affects their L1 processing.

As far as the experimental paradigm of a bidirectional translation task (Chapter 5 and 6) is concerned, this task has commonly been used to investigate the asymmetrical conceptual link with the L1 and with the L2 lexicon (Kroll and Stewart, 1994). It was also argued by Kroll and Tokowicz (2001) that productive translation, in contrast with receptive translation, is most appropriate to examine the Revised Hierarchical model. However, this seems to be limited to the case where the two languages used for the examination share the orthographic systems. Some experimental studies on writing systems report that lack of L2 intraword structural sensitivity for the participants with non-alphabetic L1 background had a negative impact on their English word recognition performance (Akamatsu, 1999, 2003; Koda, 1999). This might be related to the unexpected results obtained in the examination of the Revised Hierarchical model in Chapter 5.

It has to be noted that there are some limitations in controlling the number of letters/characters in stimulus items. It is desirable to match the word length of the stimulus items between languages. Despite some inconsistent results depending on the number of letters and task types (e.g. Balota et al, 2002; New, Ferrand, Pallier and Brysbaert, 2006; Yamada, Imai and Ikebe, 1990; Weekers, 1997), enough evidence of word length effects is available in various writing systems. In general, longer words require larger latencies to process than shorter words in alphabetic languages (e.g. French: O'Regan and Jacobs, 1992; English and German: Ziegler, Perry, Jacobs and Braun, 2001), in syllabic languages (e.g. Japanese *Kana*: Yamada, et al., 1990), and in logographic languages (e.g. Japanese

*Kanji*: Morton, Sasanuma, Patterson and Sakuma, 1992). However, due to the difference of the nature of the structures and mechanisms across orthographic types (see 2.4.1 for detailed explanation), it is inevitable that the average length of the stimulus items varies across languages. For instance, in Ellis et al.'s (2004) cross-linguistic study on orthographies using a naming task, the average length of the test items in English was 5.25; in *Hiragana*, 3.13; in *Kanji*, 2.04. It also seems that the magnitude of the effect of word length differs among the writing systems. Ellis et al. (2004) found that the word length effects correlated with orthographic transparency. The more transparent the orthography was, the larger the length effects became: *Hiragana* had the largest effect; English, less effect; and *Kanji*, the least effect. Therefore, it appears that the degree of the word length impact on lexical processing tends to be inconsistent among the languages with various writing systems.

The problems concerning mixed orthographies between *Kana* and *Kanji* in the Japanese word list were discussed earlier in Chapter 5 (see the discussion in p.168). However, the analysis of the RT data for *Kana* and *Kanji* in Chapter 5 and 6 elicited no statistically significant difference (see p.168 and p.175 respectively). Nevertheless, the use of a single writing system in the stimulus word list would have been desirable in order to eliminate the possibilities of the unpredicted effects. This issue should be taken into account in the experimental design of future studies.

# Conclusion

In this thesis, I have investigated the relationship between semantic development and interactive semantic connectivity in the case of bilingualism. This matter was investigated both from a theoretical perspective (Part One) and from an empirical perspective (Part Two).

In Part One, I discussed theories concerning organisation and processing in the L1 lexicon (Chapter 1) and the bilingual lexicon (Chapter 2). Most merit was found in the interactive-activation model (Rumelhart and McClelland, 1981, 1982), which posits direct and parallel lexical access. According to this view, the lexicon, which consists of four properties, is characterised by single-level storage and direct access, and, whether the lexicon is used for comprehension or production, the four properties are processed, for the most part, in parallel. The unity of these four properties can also be understood by seeing them as categorisable into lexemes (phonology and orthography) and lemmas (semantics and syntax). On this view the lemma serves to access and retrieve conceptual information (Levelt, 1989, 1999). In the case of the bilingual lexicon, after five decades of controversy over whether the two lexicons are integrated or separated, the consensus tends now towards acceptance of the notion of 'interconnection' between them. This standpoint considers the two lexicons to be highly connected but also accepts that there is a certain degree of separation between them (Cook, 2002; Singleton, 2003b). Thus, the two lexicons are assumed to be simultaneously accessed at the initial stage, and it is the control system that is understood to determine which language is actually chosen for comprehension and production purposes (Green, 1986, 1993, 1998; Grosjean 1997, 1998, 2001).

In Chapter 3, I further discussed semantic organisation and processing in the L1 and bilingual lexicon. The outcome of the discussion with respect to L1 semantics favoured the spreading activation model (Collins and Loftus, 1975). This model suggests that semantics is organised according to the relatedness of meanings and further proposes that semantic activation spreads via neighbouring nodes in the sense network. This model was assessed by examining several pertinent experimental studies, which typically used a semantic priming task. Furthermore, on the basis of findings from the L1 semantic studies, I suggested how bilingual semantic networks might be interconnected. I discussed in particular the case of the collocational associations of the English words *admit* and *allow* and the Japanese word *yurusu* (see Figure 20). I also argued that, according to the results of a word association test with college-level Japanese-English bilinguals (Ueno, 2003), their semantics in respect of the L2 word *admit* was parasitic on that of the L1 word *yurusu* (see Figure 22). I defined 'parasitism' as an incomplete state of L2 semantics, owing to an absence of L2-specific concepts, which is supplemented by concepts from L1 semantics. As L2 acquisition proceeds, L2 semantics appears to develop in such a way that L2-specific concepts are established (Kroll, 1993; deBot, Paribakht and Wesche, 1997; Jiang, 2000). Given that L2 semantic development occurs in this way, I raised some questions bearing on how the degree of bilingual semantic interconnectivity may differ according to the developmental stage of L2 semantics. If L2 semantics is incomplete and parasitic on L1 semantics, does this then mean that in this situation bilingual semantic connectivity is greater? If L2 semantics develops to the level at which L2-specific concepts are established independently of L1 semantics, does this then sever the semantic link between L2 and L1? In other words, if the semantics of the L2 becomes independent of that of the L1, is L2 semantics processed without reference to L1 semantic information? These questions sought to probe why proficient bilinguals are able to comprehend and produce the appropriate meanings of messages in L2, while less proficient L2 learners often fail to do so. This is the fundamental question which was posed in my introduction.

This question was investigated in the empirical study (Part Two). The development of the bilingual lexicon was first explored using a picture-naming task and a translation task. Two developmental models—the Hierarchical model (Potter *et al.*, 1984) and the Revised Hierarchical Model (Kroll and Stewart, 1994)—were examined in the light of data from Japanese–English bilinguals

(Chapter 5). The results did not show what Potter *et al.*'s model exactly predicted with respect to the novice L2 learners' picture-naming and translation performances. No significant difference between these performances was found, possibly because in the case of the relatively easy words (high-frequency concrete words), these learners had already reached the transitional stage to concept mediation. For such words, this transition seems to occur comparatively soon after the onset of L2 acquisition. The results with regard to the highest-proficiency participants showed faster RTs for picture-naming than for forward translation, this difference approaching significance ($p<.06$). For this unexpected result, the discussion moved beyond the model's framework –the issue concerning semantic involvement in the language processing in question was considered. It was suggested that the result may reflect some degree of L2 semantic development for these participants.

As far as Kroll and Stewart's (1994) prediction is concerned, the tendency of translation asymmetries was tested in relation to the degree of concept mediation. However, their prediction was not confirmed; participants produced approximately equal RTs for two translation directions or the marginally significant level of asymmetry with longer RTs in backward translation (the lowest-proficiency participants, $p<.07$). It was discussed that the Japanese participants' lack of experience with the alphabetic orthography might have been responsible for the unexpected results.

Kroll and Stewart's (1994) prediction was re-examined via observation of Japanese–English bilinguals' concreteness effects (Chapter 6). This approach was used in order to avoid a direct comparison of the L1 and L2 orthographic recognition performances. Nevertheless, inconsistent results with Kroll and Stewart's prediction were obtained again. The equally strong concreteness effects in both translation directions and for the participants at three L2 developmental levels suggested approximately the same degree of concept involvement in both directions and at the three developmental stages. This outcome supported De Groot and Poot's (1997) and Duyck and Brysbaert's (2004) viewpoints. The concreteness effects also supplied additional evidence of the structural differences in bilingual semantics depending on the level of concreteness of a word (De Groot , 1993).

Discussion of the results obtained in the experimental studies in Chapter 5 and 6 implied that the exploration of the L2 development requires particular attention to a semantic factor. The two models focus on the conceptual link with the bilingual lexicon in various developmental stages; thus, they mainly investigate the issue of whether or not concepts are involved. However, we recall De Groot's (1993) proposal concerning the varying degree of conceptual overlap between translation equivalents depending on the word types. When we take this notion into account, it appears that the investigation of *what kind of* concepts—or more specifically, which semantic features of the L2 word—are involved in the processing of the L2 word provides more insightful perspectives in the study of L2 development. This is because the semantic features involved in the processing of an L2 word refer to the degree of the L2 learner's semantic development of the L2 word in question. For example, in the case of the high-proficiency L2 user, the presentation of an L2 word which consists of the L2-specific semantics (e.g. the word *admit* in contrast with the Japanese translation equivalent *yurusu*; see Figure 22 in Chapter 3 for the detailed illustration) would activate a rich value of the semantic features that the L2 word includes. On the other hand, in the case of the novice learner, it may activate only a part of the semantic features from what the L2 word has and possibly some semantic features also from the L1 translation equivalent.

The above stated issue was dealt with in Chapter 7 in the test of the hypothesis set out in Chapter 3. In this study, the interactive semantic connectivity between languages was investigated, using a lexical decision task in a semantic priming paradigm with language-specific collocations. The results, in fact, did not support the hypothesis. The L2 semantics of lower-proficiency learners tends to be underdeveloped and thus, dependent on L1 semantics. However, the results of their lexical decision performance in L2 did not prove to be strongly influenced by their knowledge of L1 collocations, when compared to that of highly proficient bilinguals. In contrast, in the case of the bilinguals whose L2 semantics was more likely to be independent of L1 semantics, their L2 collocation processing was strongly influenced by knowledge of L1 collocations, and a statistically significant outcome was observed. These results suggested that as L2 semantics develops, bilinguals' semantic activation may, in fact, spread more efficiently from L2 to L1. This assumption seemed to be supported by the fact that lower-proficiency L2 learners also produced large L1 collocation effects in the case of easier stimulus items. Such large effects may be the results of the fact that their semantics had somehow developed for easy L2 words. Therefore, the semantic processing mechanism of highly proficient bilinguals needed to be explained. Spreading semantic activation between languages may occur rapidly at the initial stage of processing, and it may be the control system which selects the appropriate lexicon for the semantic processing in question. This may be the reason why advanced bilinguals are able to retrieve the relevant meanings from messages in L2.

The importance of these findings is that the degree of strength with regard to interactive semantic connection between languages does not determine how the semantics in the relevant language is selected for the language processing in question. Therefore, the reason why the proficient bilinguals are able to extract the appropriate meanings in L2 seems not to be because their L2 semantics is stored separately in language memory from L1 semantics, with L1 semantics not being activated when L2 semantics is processed. The results of this study demonstrate that L1 semantics is highly active when L2 semantics is accessed. Bilingual semantics is interconnected and the semantic linkage does not weaken even after L2-specific semantics is acquired. Bilinguals' semantic processing seems to be more complex than was initially predicted—the dynamic mechanism of spreading activation and control seems to be involved in processing. On the other hand, less proficient L2 learners whose L2 semantics may be parasitically linked with L1 semantics tend to fail to retrieve appropriate meanings from an L2 message. This is not because their L1 semantics is more readily activated but because their L2 semantics is incomplete before the control system comes into play. In other words, their L2 processing is slow and inefficient.

Thus, I would like here to draw a conclusion with regard to the initial question which was posed in my introduction. Proficient bilinguals' ability to retrieve appropriate meanings in L2 is not the result of the bilingual lexicon being separated in a way that enables these bilinguals to recognise the subtle difference in meanings between translation equivalents and to exclude L1 semantics when L2 semantics is processed. Similarly, unsuccessful meaning retrieval in L2, typically found in less proficient learners' L2 processing, is not due to their easy access to L1 semantics. Proficient bilinguals' L2 semantic processing is efficient and accurate owing to the fact that their L2 semantics is comprised of the relevant information. On the other hand, less proficient learners' L2 semantic processing is sluggish and inaccurate because of their incomplete L2 semantics.

This thesis suggested three new perspectives in bilingual research. First, this study used an 'inter-lexical' approach to bilingual semantics. In order to investigate the mechanism of between-language spreading semantic activation, pairs of collocationally associated stimulus words were used in a semantic priming paradigm. As Heredia and Brown (2004) argue, we are now at the stage where we should be looking at bilinguals' language system beyond the isolated-word level (cf. the traditional approach using one-to-one translation equivalents). I suggested that collocational associations may represent inter-lexical relations in a semantic network and show semantic difference between languages. Thus, I argue that studying the bilinguals' processing of these collocational associations may reveal how their semantics from two languages is activated and then inhibited in order to comprehend the appropriate message. Second, this study also explored the developmental perspective of bilingual semantics. This is based on my assumption that the manner of bilingual semantic processing differs according to the level of L2 semantic acquisition. Francis (2005) pointed out that we know very little about how bilingual semantics develops. In particular, the developmental change in respect of *bilingual semantic processing* still remains relatively unexplored. I argue that investigation of this matter is very important for future bilingual research. Third, there is the question of how the experiment was designed. A total monolingual context was used for all the trials in this study—that is, participants were presented with only L2 words, whose orthography was utterly different from that of L1. Therefore, the L1 collocation effects elicited by participants were regarded as being caused purely by a semantic factor, owing to the fact that no orthographic or phonological clues were given. This suggests that recognition of an L2 word simply activated related L1 semantics without the mediation of orthographic or phonological information.

This thesis argues that L1 semantics is active when L2 semantics is processed and this tendency of language-non-selectivity in lexical access is particularly prominent for proficient bilinguals. The interactive connectivity may be greater and the semantic access from L1 to L2 may become more efficient, as the level of proficiency in L2 increases. However, further investigation is necessary in order to confirm the validity of this view. There seem to be two issues related to the fact that proficient bilinguals are able to retrieve and convey appropriate meanings in L2, whereas less proficient L2 learners tend to fail to do so. They are: i) proficient bilinguals' L2 semantic processing is fast and automatic; ii) L1 semantics is initially activated in parallel with L2 semantics but may be soon inhibited by means of the control system. If this is true, with SOAs longer than 250ms, the Japanese collocation effect would become smaller than in the case of an SOA of 250ms. On the other hand, less proficient learners' processing is slow; thus semantic access from L2 to L1 is also slow. If this is true, with SOAs longer than 250ms, these learners would exhibit greater Japanese collocation effects than they do with SOAs of 250ms. It is also interesting to investigate further whether or not their control system inhibits activation of non-target language (L1) semantics with even longer SOAs, as may happen in the case of proficient bilinguals. Furthermore, exploration of semantic access from L1 to L2 would also provide important insights with regard to how bilinguals' L1 processing may be different from monolinguals' processing. This thesis offers evidence with respect to the manner of L2 semantic processing in various developmental stages. I trust that its findings may, in some small way, contribute to encouraging others to pursue further this rich but as yet underexplored field of study.

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# Appendix A

## Stimulus items for the picture-naming task and the translation task reported in Chapter 5

BNC: words per million
JACET Basic Word List Level 1-8: 1 (high frequency), 8 (low frequency)
Name agree: percentage
Length: length of the words

| | English | Japanese | BNC | JACET | Name agree | Length (English) | Length (Kanji) | Length (Kana) |
|---|---|---|---|---|---|---|---|---|
| 1 | ant | アリ | 10 | 3 | 81 | 3 | | 2 |
| 2 | apple | りんご | 90 | 2 | 98 | 5 | | 3 |
| 3 | arm | 腕 | 202 | 1 | 90 | 3 | 1 | |
| 4 | balloon | 風船 | 10 | 3 | 100 | 6 | 2 | |
| 5 | bear | クマ | 18 | 1 | 88 | 4 | | 2 |
| 6 | bee | ハチ | 13 | 3 | 60 | 3 | | 2 |
| 7 | bicycle | 自転車 | 11 | 3 | 88 | 7 | 3 | |
| 8 | book | 本 | 374 | 1 | 100 | 4 | 1 | |
| 9 | bottle | ビン | 59 | 2 | 95 | 6 | | 2 |
| 10 | box | 箱 | 114 | 1 | 88 | 3 | 1 | |
| 11 | bread | パン | 38 | 2 | 83 | 5 | | 2 |
| 12 | butterfly | チョウ | 11 | 3 | 100 | 9 | | 3 |
| 13 | car | 車 | 353 | 1 | 81 | 3 | 1 | |
| 14 | cat | 猫 | 55 | 1 | 100 | 3 | 1 | |
| 15 | chair | いす | 97 | 1 | 100 | 5 | | 2 |
| 16 | cow | 牛 | 26 | 2 | 93 | 3 | 1 | |
| 17 | desk | 机 | 49 | 2 | 95 | 4 | 1 | |
| | | | | | MEAN | 4.5 | 1.3 | 2.3 |
| 18 | dog | 犬 | 124 | 1 | 100 | 3 | 1 | |
| 19 | ear | 耳 | 59 | 2 | 95 | 3 | 1 | |
| 20 | elephant | ゾウ | 15 | 2 | 100 | 8 | | 2 |
| 21 | eye | 目 | 392 | 1 | 98 | 3 | 1 | |
| 22 | finger | 指 | 90 | 1 | 71 | 6 | 1 | |
| 23 | flag | 旗 | 20 | 3 | 95 | 4 | 1 | |
| 24 | fly | ハエ | 10 | 1 | 76 | 3 | | 2 |
| 25 | foot | 足 | 214 | 1 | 95 | 4 | 1 | |
| 26 | glove | 手袋 | 14 | 3 | 98 | 5 | 2 | |
| 27 | gun | 銃 | 55 | 1 | 74 | 3 | 1 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 28 | hand | 手 | 54 | 1 | 93 | 4 | 1 | |
| 29 | horse | 馬 | 126 | 1 | 100 | 5 | 1 | |
| 30 | house | 家 | 49 | 1 | 95 | 5 | 1 | |
| 31 | key | カギ | 71 | 2 | 100 | 3 | | 2 |
| 32 | ladder | はしご | 16 | 3 | 98 | 6 | | 3 |
| 33 | mountain | 山 | 68 | 1 | 90 | 8 | 1 | |
| 34 | mouse | ネズミ | 28 | 2 | 79 | 5 | | 3 |
| | | | | | MEAN | 4.6 | 1.1 | 2.4 |
| 35 | needle | 針 | 23 | 3 | 81 | 6 | 1 | |
| 36 | nose | 鼻 | 48 | 2 | 98 | 4 | 1 | |
| 37 | onion | タマネギ | 12 | 3 | 95 | 5 | | 4 |
| 38 | pencil | 鉛筆 | 14 | 3 | 100 | 6 | 2 | |
| 39 | pig | 豚 | 25 | 3 | 90 | 3 | 1 | |
| 40 | potato | いも | 25 | 2 | 90 | 6 | | 2 |
| 41 | ruler | ものさし | 16 | 3 | 98 | 5 | | 4 |
| 42 | shoe | 靴 | 48 | 2 | 95 | 4 | 1 | |
| 43 | snake | ヘビ | 12 | 3 | 98 | 5 | | 2 |
| 44 | spider | クモ | 10 | 3 | 88 | 6 | | 2 |
| 45 | sun | 太陽 | 115 | 1 | 100 | 3 | 2 | |
| 46 | telephone | 電話 | 72 | 1 | 86 | 9 | 2 | |
| 47 | tiger | トラ | 13 | 3 | 93 | 5 | | 2 |
| 48 | train | 電車 | 84 | 1 | 86 | 5 | 2 | |
| 49 | tree | 木 | 147 | 1 | 100 | 4 | 1 | |
| 50 | watch | 腕時計 | 32 | 1 | 90 | 5 | 3 | |
| 51 | window | 窓 | 194 | 1 | 95 | 6 | 1 | |
| | | | | | MEAN | 5.1 | 1.5 | 2.7 |
| | TOTAL MEAN | | 74.7 | 1.9 | 90.2 | 4.7 | 1.3 | 2.4 |

**Pictures which demonstrated a high rate of error and omissions: balloon (left) and needle (right)**

# Appendix B

**Stimulus items for the bidirectional translation task reported in Chapter 6**

JACET Basic Word List Level 1-8: 1 (high frequency), 8 (low frequency)

Concreteness: from Paivio, Yuille and Madigan's (1968) concreteness list

**Forward translation:**

**High frequency, concrete words**

| | Japanese stimuli | English translation | JACET | Concrete | Word length Kanji |
|---|---|---|---|---|---|
| 1 | 山 | mountain | 1 | -- | 1 |
| 2 | 花 | flower | 1 | -- | 1 |
| 3 | 水 | water | 1 | -- | 1 |
| 4 | 庭 | garden | 1 | -- | 1 |
| 5 | 母 | mother | 1 | -- | 1 |
| 6 | 医者 | doctor | 1 | -- | 2 |
| 7 | 石 | stone | 1 | -- | 1 |
| 8 | 家 | house | 1 | -- | 1 |
| 9 | 女 | woman | 1 | -- | 1 |
| 10 | 会社 | company | 1 | -- | 2 |
| 11 | 電話 | telephone | 1 | -- | 2 |
| 12 | 戦争 | war | 1 | -- | 2 |
| 13 | 髪 | hair | 1 | -- | 1 |
| 14 | 昨日 | yesterday | 1 | -- | 2 |
| 15 | 新聞 | newspaper | 1 | 6.6 | 2 |
| 16 | 午後 | afternoon | 1 | -- | 2 |
| | | MEAN | 1 | 6.6 | 1.4 |

**Low frequency, concrete words**

| | Japanese stimuli | English translation | JACET | Concrete | Word length | |
|---|---|---|---|---|---|---|
| | | | | | Kanji | Kana |
| 17 | 怪物 | monster | 3 | -- | 2 | |
| 18 | 酸素 | oxygen | 3 | -- | 2 | |
| 19 | 矢 | arrow | 3 | -- | 1 | |
| 20 | せっけん | soap | 3 | -- | | 4 |
| 21 | はちみつ | honey | 3 | -- | | 4 |
| 22 | 奴隷 | slave | 3 | -- | 2 | |
| 23 | いとこ | cousin | 3 | -- | | 3 |
| 24 | 蝶 | butterfly | 3 | -- | 1 | |
| 25 | まくら | pillow | 5 | -- | | 3 |
| 26 | うさぎ | rabbit | 2 | -- | | 3 |
| 27 | キツネ | fox | 4 | -- | | 3 |
| 28 | 教室 | classroom | 3 | -- | 2 | |
| 29 | 猿 | monkey | 3 | -- | 1 | |
| 30 | 先祖 | ancester | 3 | 6.2 | 2 | |
| 31 | 辞書 | dictionary | 3 | -- | 2 | |
| 32 | 地震 | earthquake | 3 | 5.4 | 2 | |
| | | MEAN | 3.1 | 5.8 | 1.7 | 3.3 |

**High frequency, abstract words**

| | Japanese stimuli | English translation | JACET | Concrete | Word length Kanji |
|---|---|---|---|---|---|
| 33 | 名前 | name | 1 | -- | 2 |
| 34 | 例 | example | 1 | -- | 1 |
| 35 | 危険 | danger | 1 | -- | 2 |
| 36 | 影響 | influence | 1 | -- | 2 |
| 37 | 値段 | price | 1 | -- | 2 |
| 38 | 言語 | language | 1 | -- | 2 |
| 39 | 単語 | word | 1 | -- | 2 |
| 40 | 世紀 | century | 1 | -- | 2 |
| 41 | 科学 | science | 1 | -- | 2 |
| 42 | 違い | difference | 1 | -- | 1 |
| 43 | 約束 | promise | 1 | -- | 2 |
| 44 | 時間 | time | 1 | -- | 2 |
| 45 | 死 | death | 1 | -- | 1 |
| 46 | 質 | quality | 1 | 2.1 | 1 |
| 47 | 情報 | information | 1 | -- | 2 |
| 48 | 教育 | education | 1 | 2.5 | 2 |
| | | MEAN | 1 | 2.3 | 1.8 |

**Low frequency, abstract words**

| | Japanese stimuli | English translation | JACET | Concrete | Word length Kanji |
|---|---|---|---|---|---|
| 49 | 悪夢 | nightmare | 3 | -- | 2 |
| 50 | 招待 | invitation | 3 | -- | 2 |
| 51 | 幸福 | happiness | 3 | -- | 2 |
| 52 | 弱さ | weakness | 3 | -- | 1 |
| 53 | 創造 | creation | 3 | -- | 2 |
| 54 | 犠牲 | sacrifice | 3 | -- | 2 |
| 55 | 遅れ | delay | 3 | -- | 1 |
| 56 | 後悔 | regret | 3 | -- | 2 |
| 57 | 回復 | recovery | 4 | -- | 2 |
| 58 | 怒り | anger | 2 | -- | 1 |
| 59 | 犯罪 | crime | 2 | -- | 2 |
| 60 | 恥 | shame | 3 | 1.7 | 1 |
| 61 | 批判 | criticism | 3 | -- | 2 |
| 62 | 量 | quantity | 3 | 3.3 | 1 |
| 63 | 忍耐 | patience | 5 | -- | 2 |
| 64 | 福祉 | welfare | 3 | -- | 2 |
| | | MEAN | 3.1 | 2.5 | 1.7 |

**Backward translation:**

**High frequency, concrete words**

| | English stimuli | Japanese translation | JACET | Concrete | Word length English |
|---|---|---|---|---|---|
| 1 | animal | 動物 | 1 | 6.75 | 6 |
| 2 | building | 建物 | 1 | 6.94 | 8 |
| 3 | daughter | 娘 | 1 | -- | 8 |
| 4 | hospital | 病院 | 1 | 6.8 | 8 |
| 5 | school | 学校 | 1 | -- | 6 |
| 6 | station | 駅 | 1 | -- | 7 |
| 7 | university | 大学 | 1 | -- | 10 |
| 8 | hand | 手 | 1 | -- | 4 |
| 9 | village | 村 | 1 | 6.69 | 7 |
| 10 | student | 学生 | 1 | 6.38 | 7 |
| 11 | shoulder | 肩 | 1 | -- | 8 |
| 12 | police | 警察 | 1 | -- | 6 |
| 13 | husband | 夫 | 1 | -- | 7 |
| 14 | summer | 夏 | 1 | -- | 6 |
| 15 | country | 国 | 1 | -- | 7 |
| 16 | morning | 朝 | 1 | -- | 7 |
| | | MEAN | 1 | 6.5 | 7 |

**Low frequency, concrete words**

| | English stimuli | Japanese translation | JACET | Concrete | Word length English |
|---|---|---|---|---|---|
| 17 | ambassador | 大使 | 3 | 6.22 | 10 |
| 18 | balloon | 風船 | 3 | -- | 7 |
| 19 | landscape | 風景 | 3 | -- | 9 |
| 20 | thief | 泥棒 | 5 | -- | 5 |
| 21 | monkey | 猿 | 3 | -- | 6 |
| 22 | spider | クモ | 3 | -- | 6 |
| 23 | envelope | 封筒 | 3 | -- | 8 |
| 24 | bible | 聖書 | 3 | -- | 5 |
| 25 | airplane | 飛行機 | 3 | -- | 8 |
| 26 | furniture | 家具 | 3 | 6.83 | 9 |
| 27 | ladder | はしご | 3 | -- | 6 |
| 28 | thumb | 親指 | 3 | -- | 5 |
| 29 | funeral | 葬式 | 3 | -- | 7 |
| 30 | ceiling | 天井 | 3 | -- | 7 |
| 31 | umbrella | 傘 | 3 | 7 | 8 |
| 32 | whistle | 口笛 | 3 | -- | 7 |
| | | MEAN | 3.1 | 6.9 | 7.1 |

**High frequency, abstract words**

| | English stimuli | Japanese translation | JACET | Concrete | Word length English |
|---|---|---|---|---|---|
| 33 | ability | 能力 | 1 | 2.03 | 7 |
| 34 | culture | 文化 | 1 | -- | 7 |
| 35 | expression | 表現 | 1 | -- | 10 |
| 36 | distance | 距離 | 1 | -- | 8 |
| 37 | memory | 記憶 | 1 | -- | 6 |
| 38 | world | 世界 | 1 | -- | 5 |
| 39 | knowledge | 知識 | 1 | 1.56 | 9 |
| 40 | nature | 自然 | 1 | -- | 6 |
| 41 | experience | 経験 | 1 | -- | 10 |
| 42 | average | 平均 | 1 | -- | 7 |
| 43 | plan | 計画 | 1 | -- | 4 |
| 44 | opinion | 意見 | 1 | 2.29 | 7 |
| 45 | direction | 方向 | 1 | -- | 9 |
| 46 | result | 結果 | 1 | -- | 6 |
| 47 | secret | 秘密 | 1 | -- | 6 |
| 48 | success | 成功 | 1 | -- | 7 |
| | | MEAN | 1 | 2.3 | 7.1 |

**Low frequency, abstract words**

| | English stimuli | Japanese translation | JACET | Concrete | Word length English |
|---|---|---|---|---|---|
| 49 | ambition | 野望 | 3 | -- | 8 |
| 50 | warmth | 暖かさ | 3 | -- | 6 |
| 51 | comparison | 比較 | 3 | 2.69 | 10 |
| 52 | hell | 地獄 | 2 | -- | 4 |
| 53 | fever | 熱 | 5 | -- | 5 |
| 54 | depth | 深さ | 3 | -- | 5 |
| 55 | evolution | 進化 | 3 | -- | 9 |
| 56 | legend | 伝説 | 3 | -- | 6 |
| 57 | invention | 発明 | 3 | -- | 9 |
| 58 | confusion | 混乱 | 3 | -- | 9 |
| 59 | necessity | 必要 | 3 | 1.97 | 9 |
| 60 | passion | 情熱 | 3 | 1.66 | 7 |
| 61 | anxiety | 不安 | 3 | 1.63 | 7 |
| 62 | smell | 臭い | 2 | -- | 5 |
| 63 | tendency | 傾向 | 3 | 1.78 | 8 |
| 64 | proof | 証拠 | 3 | -- | 5 |
| | | MEAN | 3 | 1.8 | 7 |

# Appendix C

## Stimulus items for the priming task reported in Chapter 7

JACET Basic Word List Level 1-8: 1 (high frequency), 8 (low frequency)
Length: length of English words
Col-Freq: collocation frequency of prime and target pairs, obtained from British National Corpus computed by Word-Smith tool

**Japanese Collocations**

| | Prime | JACET | Length | Target | JACET | Length | Col-Freq |
|---|---|---|---|---|---|---|---|
| 1 | thin | 2 | 4 | tea | 1 | 3 | 0 |
| 2 | warm | 1 | 4 | mind | 1 | 4 | 0 |
| 3 | slim | 5 | 4 | style | 1 | 5 | 1 |
| 4 | heavy | 1 | 5 | disease | 1 | 7 | 0 |
| 5 | arm | 1 | 3 | clock | 2 | 5 | 0 |
| 6 | cat | 1 | 3 | cry | 1 | 3 | 1 |
| 7 | borrow | 2 | 6 | toilet | 3 | 6 | 0 |
| 8 | teach | 1 | 5 | road | 1 | 4 | 0 |
| 9 | write | 1 | 5 | picture | 1 | 7 | 0 |
| 10 | accept | 1 | 6 | test | 1 | 4 | 0 |
| 11 | allow | 1 | 5 | anger | 2 | 5 | 0 |
| 12 | forgive | 3 | 7 | marriage | 2 | 8 | 0 |
| 13 | stand | 1 | 5 | plan | 1 | 4 | 0 |
| 14 | ride | 1 | 4 | ship | 1 | 4 | 0 |
| 15 | laugh | 1 | 5 | kindly | 6 | 4 | 0 |
| 16 | hear | 1 | 4 | carefully | 1 | 9 | 0 |
| | MEAN | 1.5 | 4.69 | MEAN | 1.63 | 5.13 | 0.13 |

**English Collocations**

| | Prime | JACET | Length | Target | JACET | Length | Col-Freq |
|---|---|---|---|---|---|---|---|
| 1 | bus | 1 | 3 | fare | 5 | 4 | 44 |
| 2 | water | 1 | 5 | rate | 1 | 4 | 55 |
| 3 | air | 1 | 3 | force | 1 | 5 | 1150 |
| 4 | back | 1 | 4 | ache | 5 | 4 | 19 |
| 5 | large | 1 | 5 | population | 1 | 10 | 291 |
| 6 | little | 1 | 6 | money | 1 | 5 | 382 |
| 7 | admit | 2 | 5 | evidence | 2 | 8 | 42 |
| 8 | catch | 1 | 5 | sight | 1 | 5 | 60 |
| 9 | go | 1 | 2 | wrong | 1 | 5 | 633 |
| 10 | rent | 4 | 4 | house | 1 | 5 | 91 |
| 11 | leave | 1 | 5 | message | 1 | 7 | 95 |
| 12 | pay | 1 | 3 | fine | 1 | 4 | 91 |
| 13 | lay | 1 | 3 | egg | 2 | 3 | 25 |
| 14 | lose | 1 | 4 | weight | 2 | 6 | 255 |
| 15 | keep | 1 | 4 | dog | 1 | 3 | 30 |
| 16 | cool | 2 | 4 | shade | 3 | 5 | 16 |
| | MEAN | 1.31 | 4.06 | MEAN | 1.81 | 5.19 | 204.94 |

**Unrelated pairs**

| | Prime | JACET | Length | Target | JACET | Length | Col-Freq |
|---|---|---|---|---|---|---|---|
| 1 | juice | 2 | 5 | sky | 1 | 3 | 0 |
| 2 | far | 1 | 3 | orange | 2 | 6 | 0 |
| 3 | clever | 2 | 6 | skirt | 3 | 5 | 0 |
| 4 | help | 1 | 4 | tomato | 3 | 6 | 0 |
| 5 | milk | 1 | 4 | suggest | 1 | 7 | 0 |
| 6 | shy | 3 | 3 | candle | 3 | 6 | 0 |
| 7 | sad | 1 | 1 | firm | 2 | 4 | 0 |
| 8 | table | 1 | 5 | run | 1 | 3 | 0 |
| 9 | drink | 1 | 5 | horn | 3 | 4 | 0 |
| 10 | send | 1 | 4 | mouth | 1 | 5 | 0 |
| 11 | read | 1 | 4 | cage | 3 | 4 | 0 |
| 12 | window | 1 | 6 | phone | 1 | 5 | 0 |
| 13 | salt | 2 | 4 | football | 2 | 8 | 0 |
| 14 | warn | 2 | 4 | tree | 1 | 4 | 0 |
| 15 | potato | 2 | 6 | decide | 1 | 6 | 0 |
| 16 | close | 1 | 5 | dancer | 3 | 6 | 0 |
| | MEAN | 1.44 | 4.31 | MEAN | 1.94 | 5.13 | 0 |

**Word—non-word pairs**

| | Prime | JACET | Length | Target | JACET | Length | Col-Freq |
|---|---|---|---|---|---|---|---|
| 1 | nature | 1 | 6 | moge | * | 4 | * |
| 2 | dozen | 3 | 5 | yere | * | 4 | * |
| 3 | murder | 2 | 6 | dejet | * | 5 | * |
| 4 | college | 1 | 7 | keign | * | 4 | * |
| 5 | income | 2 | 6 | wation | * | 6 | * |
| 6 | add | 1 | 3 | ebter | * | 5 | * |
| 7 | hot | 1 | 3 | yax | * | 3 | * |
| 8 | coin | 3 | 4 | huth | * | 4 | * |
| 9 | cheese | 2 | 6 | buem | * | 4 | * |
| 10 | any | 1 | 3 | exot | * | 4 | * |
| 11 | focus | 2 | 5 | skite | * | 5 | * |
| 12 | ball | 1 | 4 | kopew | * | 5 | * |
| 13 | rain | 1 | 4 | hodry | * | 5 | * |
| 14 | attend | 2 | 6 | femtain | * | 7 | * |
| 15 | lunch | 2 | 5 | veirgon | * | 7 | * |
| 16 | grow | 1 | 4 | gofy | * | 4 | * |
| 17 | pain | 1 | 4 | gure | * | 4 | * |
| 18 | adult | 1 | 5 | zanook | * | 6 | * |
| 19 | last | 1 | 4 | quove | * | 5 | * |
| 20 | try | 1 | 3 | glur | * | 4 | * |
| 21 | glad | 2 | 4 | fise | * | 4 | * |
| 22 | better | 1 | 6 | krewting | * | 8 | * |
| 23 | jump | 1 | 4 | quontial | * | 8 | * |
| 24 | tale | 2 | 4 | vitish | * | 6 | * |
| | MEAN | 1.5 | 4.63 | | MEAN | 5.04 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 25 | area | 1 | 4 | guseck | * | 6 | * |
| 26 | fit | 2 | 3 | jepper | * | 6 | * |
| 27 | hate | 2 | 4 | whioss | * | 6 | * |
| 28 | improve | 1 | 7 | somerd | * | 6 | * |
| 29 | sorry | 1 | 5 | rement | * | 6 | * |
| 30 | inner | 2 | 4 | caum | * | 4 | * |
| 31 | flag | 3 | 4 | oppic | * | 5 | * |
| 32 | beat | 1 | 4 | socing | * | 6 | * |
| 33 | kiss | 2 | 4 | jeard | * | 5 | * |
| 34 | hope | 1 | 4 | azso | * | 4 | * |
| 35 | inform | 2 | 6 | wheck | * | 5 | * |
| 36 | red | 1 | 3 | doffly | * | 6 | * |
| 37 | brush | 2 | 5 | ronx | * | 4 | * |
| 38 | talk | 1 | 4 | atibe | * | 5 | * |
| 39 | fly | 1 | 3 | canpend | * | 7 | * |
| 40 | weapon | 2 | 6 | neft | * | 4 | * |
| 41 | group | 1 | 5 | molade | * | 6 | * |
| 42 | again | 1 | 5 | jodtic | * | 6 | * |
| 43 | just | 1 | 4 | queed | * | 5 | * |
| 44 | people | 1 | 6 | huce | * | 4 | * |
| 45 | mask | 3 | 4 | rokent | * | 6 | * |
| 46 | vast | 2 | 4 | thep | * | 4 | * |
| 47 | know | 1 | 4 | kairm | * | 5 | * |
| 48 | over | 1 | 4 | dighs | * | 5 | * |
| | MEAN | 1.5 | 4.41 | | MEAN | 5.25 | |

**Word recognition test**

| | | JACET | Length | | | JACET | Length |
|---|---|---|---|---|---|---|---|
| 1 | increase | 1 | 8 | 17 | coffee | 1 | 6 |
| 2 | answer | 1 | 6 | 18 | winter | 1 | 6 |
| 3 | slight | 3 | 6 | 19 | play | 1 | 4 |
| 4 | already | 1 | 7 | 20 | basic | 1 | 5 |
| 5 | peak | 3 | 4 | 21 | frog | 3 | 4 |
| 6 | middle | 1 | 6 | 22 | cope | 3 | 4 |
| 7 | sure | 1 | 4 | | MEAN | 1.64 | 5.41 |
| 8 | quit | 3 | 4 | | | | |
| 9 | dry | 1 | 3 | | | | |
| 10 | sometimes | 1 | 9 | | | | |
| 11 | west | 1 | 4 | | | | |
| 12 | nervous | 2 | 7 | | | | |
| 13 | package | 2 | 7 | | | | |
| 14 | golden | 2 | 6 | | | | |
| 15 | pink | 2 | 4 | | | | |
| 16 | cream | 1 | 5 | | | | |

## Appendix D

### Transcript of instructions

For Japanese-English bilinguals, instructions were given in Japanese. The equivalent English instructions are shown below each original instruction.

**<u>A picture naming task reported in Chapter 5</u>**

**Instruction 1**

この実験では、絵が画面上に出てきます。その絵の名前を英語で、マイクに向かってすばやく、そしてはっきりと言ってください。コンピュータが本当の答えと誤って認識するおそれがあるので、名前を言う前に、「うーん」などの声を出すことは避けてください。もし、名前が分からなければ、静かに次の絵が出てくるのを待って下さい。準備ができたら、スペース・キーを押してください。

(English translation)

In this experiment you will be presented with pictures on the computer screen. Your task is to name pictures in English clearly and as soon as possible. Please avoid saying "umm..." or anything before your answer, as this would be mistaken as your real answer by the computer. If you do not know the answer, please keep silence. PRESS THE SPACEBAR TO BEGIN!

**Instruction 2**

これから練習を始めます。絵の名前を英語で、すばやく、そしてはっきり言ってください。準備ができたら、スペース・キーを押して始めてください。

You will have some practice. Please name pictures in English clearly and as soon as possible. PRESS THE SPACEBAR TO BEGIN!

**Instruction 3**

これから、まもなく本実験を始めます。絵の名前を英語で、すばやく、そしてはっきり言ってください。準備ができたら、スペース・キーを押して始めてください。

Now, you will shortly start a real experiment. Please name pictures in English clearly and as soon as possible. PRESS THE SPACEBAR TO BEGIN!

**<u>A forward translation task (Japanese→English) reported in Chapter 5 and 6</u>**

**Instruction 4**

この実験では、日本語の単語が画面上に出てきます。その日本語の単語を英語に直して、マイクに向かってすばやく、そしてはっきりと言ってください。コンピュータが本当の答えと誤って認識するおそれがあるので、英語に直した単語を言う前に、「うーん」などの声を出すことは避けてください。もし、その英語が分からなければ、静かに次の単語が出てくるのを待って下さい。準備ができたら、スペース・キーを押してください。

(English translation)

In this experiment you will be presented with Japanese words on the computer screen. Your task is to translate these Japanese words into English clearly and as soon as possible. Please avoid saying "umm..." or anything before your answer, as this would be mistaken as your real answer by the computer. If you do not know the answer, please keep silence. PRESS THE SPACEBAR TO BEGIN!

**Instruction 5**

これから練習を始めます。日本語の単語を英語に直して、マイクに向かってすばやく、そしてはっきりと言ってください。準備ができたら、スペース・キーを押して始めてください。

You will have some practice. Please translate Japanese words into English clearly and as soon as possible. PRESS THE SPACEBAR TO BEGIN!

**Instruction 6**

これから、まもなく本実験を始めます。日本語の単語を英語に直して、マイクに向かってすばやく、そしてはっきりと言ってください。準備ができたら、スペース・キーを押して始めてください。

Now, you will shortly start a real experiment. Please translate Japanese words into English clearly and as soon as possible. PRESS THE SPACEBAR TO BEGIN!

**A backward translation task (English→Japanese) reported in Chapter 5 and 6**

**Instruction 7**

この実験では、英語の単語が画面上に出てきます。その英単語を日本語に直して、マイクに向かってすばやく、そしてはっきりと言ってください。コンピュータが本当の答えと誤って認識するおそれがあるので、日本語に直した単語を言う前に、「うーん」などの声を出すことは避けてください。もし、その日本語の名前が分からなければ、静かに次の単語が出てくるのを待って下さい。準備ができたら、スペース・キーを押してください。

(English translation)

In this experiment you will be presented with English words on the computer screen. Your task is to translate these English words into Japanese clearly and as soon as possible. Please avoid saying "umm..." or anything before your answer, as this would be mistaken as your real answer by the computer. If you do not know the answer, please keep silence. PRESS THE SPACEBAR TO BEGIN!

**Instruction 8**

これから練習を始めます。英単語を日本語に直して、マイクに向かってすばやく、そしてはっきりと言ってください。準備ができたら、スペース・キーを押して始めてください。

You will have some practice. Please translate English words into Japanese clearly and as soon as possible. PRESS THE SPACEBAR TO BEGIN!

**Instruction 9**

これから、まもなく本実験を始めます。英単語を日本語に直して、マイクに向かってすばやく、そしてはっきりと言ってください。準備ができたら、スペース・キーを押して始めてください。

Now, you will shortly start a real experiment. Please translate English words into Japanese clearly and as soon as possible. PRESS THE SPACEBAR TO BEGIN!

**<u>A priming task reported in Chapter 7 (for right-handed participants)</u>**

**Instruction 10**

Japanese instructions:

この実験では一連のアルファベット文字の組み合わせが画面上に出てきます。

まず######のサイン、続けて一つ目の文字のつながり、そして二つ目の文字のつながりが出てきます。二つ目の文字のつながりが英単語かどうかを判断してください。なお、一つ目の文字のつながりは、二つ目の文字のつながりを認識するのに役立つかもしれないので、よく注意して見てください。二つ目の文字のつながりが英単語だと思ったら　6　のキーを、英単語ではないと思ったら　5　のキーを押してください。準備ができたら、Enter キーを押して始めてください。

English instructions:

In this experiment, you will see ######.　Then a word is shown.　After this, another item appears.　This may or may not be a real word.　If it is a real word, press "6"; if not, press "5."　The first word appears for a short time. Look at it carefully.　It may help you to decide about the second item.　Press either key strongly as soon as you find your answer.　PRESS ENTER KEY TO BEGIN!

**Instruction 11**

これから練習を始めます。二つ目の文字のつながりが英単語だと思ったら　6　のキーを、英単語ではないと思ったら　5　のキーを押してください。準備ができたら、Enter キーを押して始めてください。

You will have some practice.　If it is a real word, press "6"; if not, press "5." Press either key strongly as soon as you find your answer. PRESS ENTER KEY TO BEGIN!

**Instruction 12**

これから、まもなく本実験を始めます。二つ目の文字のつながりが英単語だと思ったら　6　のキーを、英単語ではないと思ったら　5　のキーを押してください。準備ができたら、Enter キーを押して始めてください。

You will shortly start a real experiment again.　If it is a real word, press "6"; if not, press "5."　Press either key strongly as soon as you find your answer.
PRESS ENTER KEY TO BEGIN!

**Instruction 13**

実験を再開する前に、少し休憩してください。準備ができたら、Enter キーを押して始めてください。

Please have a short break before you have the next trial.　PRESS ENTER KEY WHEN YOU ARE READY!

**Instruction 14**

これから、まもなく本実験を始めます。二つ目の文字のつながりが英単語だと思ったら　6　のキーを、英単語ではないと思ったら　5　のキーを押してください。準備ができたら、Enter キーを押して始めてください。

Now, you will shortly start a real experiment again without practice.　If it is a real word, press "6"; if not, press "5."　Press either key strongly as soon as you find your answer. PRESS ENTER KEY TO BEGIN!

**<u>A priming task reported in Chapter 7 (for left-handed participants)</u>**

**Instruction 15**

Japanese instructions:

この実験では一連のアルファベット文字の組み合わせが画面上に出てきます。
まず######のサイン、続けて一つ目の文字のつながり、そして二つ目の文字のつながりが出てきます。二つ目の文字のつながりが英単語かどうかを判断してください。なお、一つ目の文字のつながりは、二つ目の文字のつながりを認識するのに役立つかもしれないので、よく注意して見てください。二つ目の文字のつながりが英単語だと思ったら　5　のキーを、英単語ではないと思ったら　6　のキーを押してください。準備ができたら、Enter キーを押して始めてください。

English instructions:
In this experiment, you will see ######.　Then a word is shown.　After this, another item appears.　This may or may not be a real word.　If it is a real word, press "5"; if not, press "6."　The first word appears for a short time.　Look at it carefully.　It may help you to decide about the second item.　Press either key strongly as soon as you find your answer.　PRESS ENTER KEY TO BEGIN!

**Instruction 11**

これから練習を始めます。二つ目の文字のつながりが英単語だと思ったら　5　のキーを、英単語ではないと思ったら　6　のキーを押してください。準備ができたら、Enter キーを押して始めてください。

You will have some practice. If it is a real word, press "5"; if not, press "6." Press either key strongly as soon as you find your answer.　PRESS ENTER KEY TO BEGIN!

**Instruction 12**

これから、まもなく本実験を始めます。二つ目の文字のつながりが英単語だと思ったら　5　のキーを、英単語ではないと思ったら　6　のキーを押してください。準備ができたら、Enter キーを押して始めてください。

You will shortly start a real experiment again.　If it is a real word, press "5"; if not, press "6."　Press either key strongly as soon as you find your answer.
PRESS ENTER KEY TO BEGIN!

**Instruction 13**

実験を再開する前に、少し休憩してください。準備ができたら、Enter キーを押して始めてください。

Please have a short break before you have the next trial.　PRESS ENTER KEY WHEN YOU ARE READY!

**Instruction 14**

これから、まもなく本実験を始めます。二つ目の文字のつながりが英単語だと思ったら　5　のキーを、英単語ではないと思ったら　6　のキーを押してください。準備ができたら、Enter キーを押して始めてください。

Now, you will shortly start a real experiment again without practice.　If it is a real word, press "5"; if not, press "6."　Press either key strongly as soon as you find your answer. PRESS ENTER KEY TO BEGIN!