INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

Interlexical Effects of Word
Frequency in English-French Bilinguals.

by

Adrien Pitrat, B.A.

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of

Master of Arts
Department of Psychology

Carleton University

Ottawa, Ontario

September / 1997

© copyright

1997, Adrien Pitrat

Running head: INTERLEXICAL WORD FREQUENCY EFFECT

National Library
of Canada

Acquisitions and
Bibliographic Services

395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque nationale
du Canada

Acquisitions et
services bibliographiques

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence

Our file Notre référence

The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

0-612-26937-X

The Undersigned recommended to the Faculty of Graduate
Studies and Research acceptance of the thesis,

Interlexical Effects of Word Frequency in English-French Bilinguals.

Submitted by

Adrien Pitrat, B.A.

in partial fulfilment of the requirements for the degree of Master of Arts

Handwritten signature of John Dye, written in black ink over a horizontal line.

Thesis Supervisor

Handwritten signature of Kim, written in black ink over a horizontal line.

Chair, Department of Psychology

Carleton University

September, 1997

Education is what survives after what has been learned has been forgotten.

B. F. Skinner

I have never let my schooling interfere with my education.

Mark Twain

ABSTRACT

The present research examined the interlexical effect of word frequency using English-French cognates. 108 participants (72 English [mother tongue, or L1]-French [second language, or L2] bilinguals and 36 English monolinguals) were randomly assigned to a Lexical Decision Task (Experiment 1) or a Naming Task (Experiment 2). Within each experiment the bilingual participants were randomly assigned to one of two groups: performing the task in English or performing the task in French. The same stimuli were used in the two tasks: 72 nonwords and 72 cognates. The cognates were separated into four groups of 18 stimuli: High frequency in both languages (H/H), high English frequency and Low French frequency (H/L), low English frequency and high French frequency (L/H), and low frequency in both languages (L/L). Classical findings were replicated for both experiments (Intralingual word frequency effect, lexical status effect). The main hypothesis was that in the L/H condition the participants would benefit from the high frequency of the non-target language (i.e., the language not used during the experiment) and therefore be faster than in the L/L condition. This pattern of results was found for the bilingual participants in Experiment 1. However, contrary to the predictions, similar results were found for the control group. Different results were found in Experiment 2 as none of the groups performed faster under the L/H condition than the L/L one. These findings partially support a model of bilingual lexical representation where cross-language facilitation can occur. The mediating effect of the task as well as some proposals for further research are discussed.

ACKNOWLEDGMENTS

A poursuivre des études, on finit bien un jour par les rattraper. Ma longue course ne se fit pas seule mais avec l'aide de plusieurs personnes que je tiens à remercier ici.

My first thank you will go to the late Dr. Alan Moffitt whose kindness and humour made my first year in Ottawa a much more bearable experience. I would like to express my profound gratitude to my advisor Dr. John Logan who offered me the support, guidance, and understanding necessary to complete this work as well as shared with me a strong taste for those apples made of silicone.

Un grand merci à ma mère, mon père et toute ma famille pour leur confiance et leur amour... un foyer ne doit pas être un lieu où l'on séjourne, mais un lieu où l'on revient.

I would also like to thanks the following people who helped me directly or just made my every day experience during these three years a better one. My most sincere thanks to Dr. Webster, Dr. Junker, Dr. Forth, Dr. Herdman , Dr. Lefevre, Lynn Giff, Dr. Carroll, Dr. Fried, Stan Lee, Frederick Lichacz, Dr. Gick, and André Marcoux.

Merci enfin à toute l'équipe du "Boulangier Français", pour m'avoir apporté beaucoup plus que de simples nourritures terrestres.

TABLE OF CONTENTS

1. Introduction	1
2. Studying the bilingual lexicon(s)	2
2.1. The Stroop task	2
2.2. Priming	4
3. The Lexical Decision Task and Naming task	5
4. Monolingual lexical models	7
4.1. Lexical instance models	7
4.1.1. The Logogen Model	7
4.1.2. The Serial Search Model	8
4.1.3. The Verification model	8
4.2. Parallel distributed processing models	9
4.2.1. The Interactive Activation model	9
4.2.2. Seidenberg and McClelland's PDP model	10
4.3. Dual-route models	10
4.3.1. Coltheart	10
4.3.2. Paap's dual-route model	11
5. Bilingual lexical models	11
5.1. Dual-code models	12
5.1.1. Language-selective Access Hypothesis	12
5.1.2. The independence hypothesis	12
5.2. Single-code models	13
5.2.1. The interdependence hypothesis	14

5.2.2. Bilingual Activation Verification model	14
5.2.3. Bilingual Interactive Activation model	14
6. Present study	15
7. General design	18
7.1. Participants	18
7.2. Equipment	18
7.3. Stimuli	19
7.4. Procedure	23
8. Experiment 1	24
8.1. Method	24
8.1.1. Participants	24
8.1.2. Equipment	24
8.1.3. Stimuli	24
8.1.4. Procedure	24
8.2. Results	24
8.2.1. Participants	24
8.2.2. Error data and Outliers	25
8.2.3. RT data	27
8.3. Discussion	31
9. Experiment 2	33
9.1. Method	34
9.1.1. Participants	34
9.1.2. Equipment	34
9.1.2. Stimuli	34

9.1.3. Procedure	34
9.2. Results	34
9.2.1. Participants	34
9.2.2. Stimuli	35
9.2.3. Error data and Outliers	35
9.2.4. RT data	37
9.3. Discussion	39
10. General Discussion	41
10.1. Bilingualism assesment	42
10.2. Median split	43
10.3. The French groups	45
10.4. Monolingual lexical models	45
10.5. Bilingual lexical models	49
10.6. Future work	51
10.7. Conclusion	52
11. Tables	53
12. Figures	56
13. Appendixes	68
14. References	76

Interlexical Effects of Word Frequency in English-French Bilinguals.

Understanding language is one of these seemingly effortless everyday acts that is so pervasive that we often fail to grasp the elaborated mechanisms it involves. However, humans are amazingly good at comprehending language as the accomplished reader can recognize nearly 500 words per minute (Crystal, 1987, p. 211). To realize this task an internal lexicon that contains all the words known to the reader must be accessed. What makes this task a real tour de force is that humans have between 55,000 and 90,000 words in their lexicon (Oldfield, 1966). In order to appreciate fully the demands of language comprehension, consider the following: If we were to print the contents of an average English lexicon using the same format as the page you are reading, which contains approximately 370 words, it would require no less than 240 pages. Of course, the goal of every database, be it a dictionary or a library, is not to accumulate information but to organize it so that it can be retrieved in an efficient and rapid way. Likewise, a mental lexicon that would store tens of thousands of words without an adequate search engine would be virtually useless. Therefore the central questions that are to be answered when studying the lexicon concern its structure as well as the way it is accessed.

For the most part psychology has dealt with the structure of the lexicon of monolinguals. However the last 15 years have seen increased interest in the structure of the bilingual lexicon. To stress the importance of bilingualism in the world consider that the number of languages currently being used in the world is about 4,500 (Crystal, 1987, p. 284). If we compare this figure with the count of countries and territories in the world (225) we find that, on average, twenty languages are being spoken in each of them. Even when taking a conservative estimate of 1,000 languages (number of languages spoken by more than 10,000 people) we arrive at 4.4 languages per country. The purpose of this

mathematical diversion was not to depict an accurate portrait of bilingualism in the world but rather to illustrate its magnitude and pervasiveness. Yet, despite the undeniable breadth of bilingualism less than a quarter of the world's countries are officially bilingual (Crystal, 1987, p. 360). In a situation where bilingualism is both ubiquitous and understated, increasing our knowledge of bilingualism can only benefit institutions as well as individuals. Specifically, expanding our understanding of the way bilinguals access their lexicon(s) would have both conceptual as well as applied implications. To know whether one language can influence lexical processes in the other language is of interest both to the psychologist and the teacher as it would better our comprehension of language representation while giving us insight into how new languages are learned. If a bilingual's languages can interact then it might point to the possibility of the existence of either links between the lexicons or of a single amodal lexicon. However, if no such interaction is to be found then the two languages might have functionally separated mental representational systems. Evaluation of the bilingual lexicon requires the use of specific psychological methods. I will now review two paradigms that have been utilized to study the bilingual lexicon¹: the Stroop-task and the lexical priming task.

Studying the bilingual lexicon

The Stroop Task

The Stroop task has been extensively used to investigate the nature of the bilingual lexicon. In the original task (Stroop, 1935), participants were presented with a color word printed in either a congruently colored ink (e.g., "red" printed in red ink) or an incongruently colored ink (e.g., "red" printed in blue ink). The participants were then asked to name the ink color while ignoring the color word. Participants were slower when

¹For ease of exposition I will refer to both a unitary bilingual lexicon and language specific lexicons as "the bilingual lexicon".

responding to incongruent displays compared to congruent displays, an effect which has come to be known as the "Stroop effect". In the case of bilingual studies, the Stroop task has been extended to include both languages. In this task the participants have to name the ink color in one language while the color name is displayed in their other language. In the case of French-English bilinguals, participants might have to name the ink color in English (e.g., "blue") while ignoring the color word being displayed in French (e.g., "rouge"). Most bilingual studies using the Stroop task report between-language interference as well as within-language interference, the latter being more important than the former. Preston and Lambert (1969) were the first to report interlingual interference using the Stroop task. In their experiment the name of the color was either printed in the participants' dominant language (English) or in their second language (French or Hungarian). After having replicated the classical intra-lingual Stroop effect, Preston and Lambert found that participants were also slowed in their responses when the response language differed from the language in which the color words were printed. However, the intra-language interference was found to be larger than that of inter-language interference. This differential effect was also reported by Tzelgov, Henik, and Leiser (1990) in Hebrew-Arabic bilinguals. Chen and Ho (1986) performed a similar study using Chinese-English bilingual participants. When the participants had to respond in Chinese, the expected slower responses to incongruent displays were observed. However, when they were asked to respond in English a developmental shift from greater between-language interference to greater within language interference was observed as a function of second language proficiency. As a result, Chen and Ho proposed a mixed model of bilingual language representation which evolves as proficiency progresses. The authors proposed a model in which words are translated from one language to another for the less proficient bilinguals whereas more adept bilinguals rely on an amodal system linking the two

representational systems. Mägiste (1984) also reported that the amount of interference observed with second language color words was related to the proficiency in the second language. What can we make of these studies? The fact that words in one language can influence decisions made about words in another language seems to suggest that bilinguals either operate with a single amodal lexicon or with two lexicons that share common links which permit the exchange of information. However, the use of the Stroop task to investigate the bilingual lexicon has its limits, the most obvious one being that only color words can be used as stimuli. The implication of this restriction to colour terms is that word characteristics such as frequency, neighborhood density or concreteness cannot be easily manipulated, therefore other tasks are therefore needed to examine the nature and depth of the link between the two lexicons.

Lexical Priming

Another widely used method for studying lexical access in bilinguals is priming. Typically, priming refers to the effect of a specific word (prime) on the recognition of a subsequently presented word (probe). A word is said to "prime" another word when it facilitates its recognition. For example, the presentation of the word "doctor" (prime) followed by the presentation of the word "nurse" (probe) makes the recognition of the word "nurse" faster than if the latter were presented alone or following an unrelated prime word, such as "car". Predictably, studies in bilingualism have added a twist to the classic priming studies by displaying the prime in one language and the probe in another. Schwanenflugel and Rey (1986) tested English-Spanish inter-language priming by priming words from each language by their respective categories (e.g., the word "arm" cued by the category "Body"). In the first condition the prime and the probe were written in different languages (e.g., "body-mano [hand]") whereas in the second condition both prime and probe were in the same language (e.g., "cuerpo[body]-mano"). In the control condition the

prime was replaced by a neutral warning cue (e.g., "ready-mano" or "listo[ready]-hand"). Results showed that the benefit from the category prime was the same regardless of the target language, thus "body" primed "mano" as much as it primed "hand", therefore supporting the idea that the bilinguals's two languages can influence each other.

Both the Stroop Task and the Priming experiments described above point to the permeable nature of the bilingual's lexicons. However, these experiments focus on inter-language interference that might arise because of conflicting meaning between words in two languages. The Stroop task works because the participant is affected by the color name in his or her second language whereas priming occurs because reading a word in one language activates conceptually related words in the other language. The results described above indicate that a word's meaning has cross-language effects both in the Stroop Task as well as Priming experiments. Could other word characteristics have similar inter-language effects? Words are often classified using other parameters including: length (in number of letters, syllables, phonemes), frequency (how often does the word appear in the language? Is it rare or common?), number of neighbors (how many other words can be formed by changing, deleting, or adding one letter from the target word?), as well as the numbers of meanings. In the next section I review the two tasks that have been most widely used to investigate these variables in the context of lexical organization and processing.

The Lexical Decision Task and the Naming Task

In a classical Lexical Decision Task (LDT) participants are asked to make a decision as whether a string of letters presented to them (generally on a computer screen) is a word (e.g., "cat") or a nonword (e.g., "melp"). This task does not involve the identification of the letter string per se but only its classification as a word or a nonword. Here, the RT to correctly identify words is assumed to reflect the time needed to retrieve information from the lexicon. In a Naming Task (NT) participants read aloud a letter string. As participants

are not in a forced choice condition. NTs do not usually include nonwords. The advantages and disadvantages of the LDT and NT will be examined later. Over the years the LDT and the NT have been used to collect a variety of robust results. If the goal of a model is to predict behavior then the lexical models should be able to account for these results. The most important effects, such as the lexical status effect and the word frequency effect will be briefly described. Other lexical decision findings such as the nonword legality effect (Rubenstein, Lewis, & Rubenstein, 1971), the word similarity effect (O'Connor, & Forster, 1981), the repetition priming effect (i.e., when a word is presented a second time it is recognized faster than the first time), the semantic priming effect (i.e., when a word is preceded by a semantically related prime it is recognized faster), and the word similarity effect (i.e., nonwords that look like words are classified as such more slowly than other nonwords) will not be described as they are not directly relevant to the present investigation.

The lexical status effect refers to the finding that participants are on average faster at classifying a letter string that is a word than a string that is a nonword (Rubenstein, Garfield, & Milikan, 1970). The broad explanation for the lexical status effect is that when confronted with a nonword participants have to perform an exhaustive search in their lexicon while words only necessitate a self-terminating one (i.e., a search which ends when a match is found). This effect has been replicated so reliably with LDTs that a failure to reproduce it would only point to a potential problem with either the experimental design or the apparatus. This is why for the present study this effect will be considered more as a way to check for the coherence of the experimental design rather than as finding relevant to specific hypothesis.

Another reliable effect is the word frequency effect. In a LDT high frequency words (e.g., "car") are generally classified as words faster than low frequency words

(e.g., "emu"). Both because of its ease of manipulation (i.e., great variation in range) and the robustness of its effect, word frequency will be used as the major experimental variable in the present experiment. However, because different lexical models (monolingual and bilingual) account for the word frequency effect in different ways I will first review these models before describing the present study.

As background for description of bilingual lexical models, I will first review several monolingual lexical models. These models can be grouped in three different categories: lexical instance models, parallel distributed processing models, and dual-route models. Predictions made by these models concerning the word frequency effect will also be discussed.

Monolingual lexical models

Lexical instance models

Lexical instance models assume that each word is represented as a discrete unit in long term memory (LTM). As describing all existing models is not feasible I will only review the Logogen Model, the Serial Search Model, and the Verification Model as representative of this class of models.

The Logogen Model. Morton's (1969) Logogen Model relies on basic units called Logogens (from Latin *logos*, "word", and *genus*, "birth", p. 165). A logogen is a mental representation of a word which includes its semantic, visual and acoustic information. Word recognition takes place when sufficient information has allowed the word's logogen to reach a threshold level. Therefore logogens can be conceptualized as counting devices (or detectors) which accumulate sensory as well as contextual information (i.e., visual, acoustic, and semantic). The Logogen Model accounts for the word frequency effect by proposing that the logogens' threshold levels are affected by the number of times a word is recognized or spoken/written. Specifically, the threshold of a given logogen is lowered as

the number of instances a word is encountered or produced increases. Thus, high-frequency words will have lower threshold logogens than low-frequency words.

The Serial Search model. The Serial Search model (also known as "Lexical Search model", "table lookup" theory or "bin" model) was first described by Forster (1976). According to this model, words in the lexicon are looked up serially for a match with the target word. However, as scanning through the whole lexicon would be too time consuming the search is limited to specific subsets of lexical entries called "bins" (e.g., there could be such a bin for words beginning with the letter b) . This model has both an orthographic access file for written words as well as a phonological access file for spoken words. Each word is represented in both files, which are in turn linked to a Master File (or "lexicon proper"; Taft, 1991). Because words are classified in the Master file according to their frequency of occurrence, high frequency words are accessed faster than low frequency words as the former are at the beginning of the file. Also, the search will pause every time a orthographically similar word (neighbor) is activated. For example, if the word to be recognized is "cat" the search will also check the neighbors "rat", "bat", "hat", "cut", and "cap" (among others) against the target word. Here the serial search model predicts that high neighborhood densities will slow down access to the lexicon. Therefore, the larger the number of neighbors, the longer the search (O'Connor & Forster, 1981).

The Verification model. Rather than generating only one match as in the Serial Search model, the Verification model (Becker, 1976; Becker & Killion, 1977; Becker, 1979) generates a set of candidates that are then checked against the stimulus. Specifically, the Verification model relies on two processes (feature extraction and verification) as well as two information stores (sensory and lexical). The sensory store is a memory store that holds the features of the stimuli for a brief period of time. The lexical store holds three types of information: sensory-properties (sensory features), sensory representations ("a

prototypical representation of what the stimulus should look like", Becker, 1976, p. 564), and semantic information. In the first stage of word recognition candidates are extracted from the sensory-property list by a counting device that accumulates the features matched between the sensory store and the sensory-property list (this stage is similar to the one proposed by the Logogen model). The verification stage acts on the candidates' features (other than the sensory) by checking them against the sensory representation store. According to the Verification model, frequency information is accessed once a set of candidates has been activated, then high frequency words are verified before low frequency words. Because high frequency word recognition happens after fewer rejections of candidates than low frequency words, high frequency words are identified faster.

Parallel distributed processing models

Parallel distributed processing (PDP) models are another instance of single-route models. Examples of PDP models include the Interactive Activation model and Seidenberg and McLelland's developmental PDP model which will be reviewed here.

The Interactive Activation model. The Interactive Activation model proposed by McLelland and Rumelhart (1981) posits that word recognition calls upon increasingly higher levels of linguistic features. As an example, recognition of printed words is assumed to be achieved through the following stages: visual feature level, letter level, word level, and syntactic level (Taft, 1991). According to this model as a letter string is being recognized its features (i.e., letters features and then letters) are activated. These features activate words with similar features as potential candidates. However, as the selection process proceeds, the correct candidate word feeds back activation to the letter level, which in turn increases the probability of the correct word-level candidate to be selected. The model is parallel in two ways: spatially (letter strings of at least 4 letters can be processed at the same time) and temporally (processing the visual information at different levels

simultaneously). The word frequency effect is explained in terms of connective strength between units. Taft (1991) gives the example of the letter H having a greater connective strength with the word HOUSE rather than HOUND as the former appears more often than the latter.

Seidenberg and McClelland's (1989) developmental PDP model. This model includes grapheme units connected to hidden units, which in turn are connected to phoneme units. The orthography of the stimuli are encoded in the grapheme units whereas the phonological information is coded in the phoneme units. The system works using both bottom-up (letter-to-word) as well as top-down (word-to-letter) processes. The word frequency effect is explained by the plasticity of the connective weights. The more a word is encountered the stronger the connections between the appropriate nodes and the faster the response.

Dual-route models

Contrary to lexical instance and PDP models, in dual-route models access to the lexicon can be achieved through two different paths, a graphemic one (lexical) and a phonological one (sublexical). In the first case it is the word's orthography which is used whereas the second path rely on the pronunciation of the word. Coltheart's and Paap's dual-route models are examples of this type of model.

Coltheart's model. Coltheart was the first to propose a dual-route model of lexical access (Marlsen-Wilson, 1992, p.49). In his view the lexicon can either be accessed through a word's orthography or by using grapheme-phoneme conversion rules. The former strategy applies to regular words whereas the latter concerns irregular words (or nonwords). The first strategy is also faster than the second. The word frequency effect is accounted for by the frequency-ordered lexical search that is performed subsequent to the feature extraction stage. This frequency effect will only be found when lexical access is

performed using the word's orthography.

Paap's dual-route model. Instead of proposing that the two routes are used as a function of the type of stimuli encountered (i.e., word vs. nonword), Paap and Noel (1991) opted for a model in which the two strategies compete. In this "horse race" model, word recognition follows both a lexical and nonlexical route (following a spelling-to-sound rule, or orthographic to phonological conversion [OPC]).

All of the lexical models described above focus solely on the monolingual lexicon. Because of the unique characteristics of the bilingual lexicon, it is not immediately obvious whether models designed to explain the monolingual lexicon can be extended without modification to bilinguals. Nevertheless, several variations on the basic models of lexical organization in monolinguals have been proposed for bilinguals.

Bilingual lexical models

Early models of bilingual lexical organization envisioned three different possibilities (De Groot, 1993). In (1) coordinate organization the two languages are completely separated. This view proposes that words from the two languages each have their own representation in their corresponding lexicon. As an example, the word "car" and "voiture", even if having the same meaning, would be represented twice, once in the English lexicon and once in the French lexicon. Conversely, the (2) compound approach to bilingual lexical organization posits the existence of a unique lexicon. Here the words "car" and "voiture" would share a common amodal representation. Finally, the (3) subordinative approach to the bilingual lexicon postulates that access to the lexicon is mediated by the dominant language. In this model, for a native English bilingual individual access to the lexical representation of the word "voiture" will be accomplished 'through' its English equivalent "car". This model can be contrasted with the Concept Mediation Model (similar to the compound approach) in which "there are no direct connections between the

parallel words in the different languages [but] parallel words are connected via an amodal conceptual system (i.e., the semantic level of representation)" (Tzelgov, Henik, & Leiser, 1990, p. 761).

With the first two models mentioned above, coordinate and compound, in mind it is possible to come up with two broad categories of models of bilingual lexical organization. The first one includes those models who postulate separate and independent lexicons (dual-code models) and follow the coordinate approach. The second group contains the models which assume some communication between the two languages by postulating the existence of a supralinguistic amodal lexicon (single-code models) which conforms with a compound conceptualization.

Dual-code models

Language-selective access hypothesis. According to Macnamara (1967), linguistic independence is "the ability to keep languages functionally distinct" (p. 729) and is obtained by forming stronger lexical links within each language than between languages. Discrimination between languages is achieved through the use of an automatic "input switch" which is driven by contextual information such as orthographic peculiarities (e.g., accents). Support for this hypothesis is to be found in experiments where bilingual participants are asked to perform unilingual and bilingual tasks (e.g., mixed-sentences). The finding that participants are slower in the latter task (Macnamara, 1967; Macnamara & Kushnir, 1971) supports a model of the bilingual lexicon in which the two languages are separated.

Independence hypothesis. This model assumes that processing in one language does not affect processing in the other language and therefore the two languages are functionally separated. According to this approach contextual information plays an important role as distinctive language instructions induce a corresponding language set

which in turns activates the appropriate language store. Gerard and Scarborough (1989) designed an experiment in which monolinguals, Spanish-English bilinguals and English-Spanish² bilinguals were tested in a LDT using cognates (words with the same orthographies and meaning in both languages), homographic noncognates (words with the same orthographies but different meanings in both languages), and noncognates (words with different orthographies and different meanings in both languages). Because no inter-language facilitation was found for cognates or homographic noncognates between the two languages (e.g., English bilinguals performed as if they had no knowledge of the cognates as Spanish words) the authors concluded that bilinguals have two separate lexicons which can be accessed selectively. The independence model of bilingual word representation is comparable to the Coordinate hypothesis which posits that the two languages are completely separated (each word has its own meaning attached to it). According to this model cognates are represented twice as they have one conceptual form in each language.

Single-code models

Single-code models are also known as the interdependence models or shared (or common) storage hypothesis models. An example of this category would be the Word Association model in which "comprehension of a word is always mediated by access to units of the more proficient language. That is, access to and from a word in the less proficient language is always mediated by the activation of the parallel word in the more proficient language" (Tzelgov et al., 1990, p. 761). It should be noted that this model was designed to explain the performance of less than proficient bilinguals (e.g., when the second language is being learned). Caramazza and Brones (1979) have suggested a similar distinction between bilingual lexical models as they proposed that information from one

²The first language listed is the native language.

language is either kept in "separate" memory stores or in a single or "shared" memory store which may be accessed through language specific tags. The common thread between these models is a hypothetical representational system that mediates between lexicons.

Interdependence hypothesis. This hypothesis is a direct reply to the "independence hypothesis" described earlier as it posit the existence of a single integrated memory. Papaioannou and Padilla (1982) asked English-Greek bilinguals to form English or Greek words. The words had to begin, end, or include target trigrams. For example, if participants were presented with the consonant-vowel-consonant trigram "PON" they could propose the English words "PONy", "uPON", or "opPONent". The performance of the participants was the same regardless of instruction language (English, Greek, or both languages). The authors propose a model in which the instructions are coded at the semantic level and which therefore does not influence performance.

Whereas most models of bilingual lexical organization describe the way the words from the two languages are stored and accessed, the BIA and the BAV models are the only models which focus on the word recognition level.

The Bilingual Interactive Activation (BIA) model (Grainger, 1993). In this model the visual stimuli activates the two languages by activating nodes of higher and higher complexity until language nodes are reached (Figure 1). The disambiguation of which language the stimuli belongs to is achieved by back propagation from the language nodes (Grainger, 1993). As in the Interactive Activation model, the Word Frequency effect is explained by the fact that high frequency words have stronger connections.

Insert Figure 1 about here

The Bilingual Activation Verification (BAV) model (Grainger, 1993). This model

is based on the Activation Verification monolingual model of lexical representation (Becker, 1976; Paap, Newsome, McDonald, & Schvaneveldt, 1982). According to Grainger (1993), although incoming visual stimuli first activate potential candidates in the two languages (Figure 1), it is only during the verification stage that context helps to pick the appropriate candidate. Even if language context directs the search to the appropriate language, "nontarget lexical representations can be activated during target language processing" (p. 19). Once the language-appropriate set of candidates is selected, the candidates are checked in decreasing order of frequency.

Because divergent tasks underscore different processes it is no surprise that both the dual-code models as well as the single-code models have been supported by distinctive categories of experiments. On the one hand dual-code hypotheses are often supported by the following tasks: free-recall, language specific transfer effects, lexical decision task, recognition memory, release from proactive interference, repetition priming, word association, and word fragment completion task (Durgunoglu & Roediger, 1987; Gerard & Scarborough, 1989). On the other hand, Single-code hypotheses are backed by free recall, paired associate experiments, sentence memory, Stroop-task, and word categorization experiments (Durgunoglu & Roediger, 1987; Gerard & Scarborough, 1989).

Present Study

As noted above most research concerning the structure of the bilingual lexicon has dealt mainly with a possible semantic cross-language effect. The present investigation focuses on the recognition of language form by examining the frequency effect and its potential cross-language variations in both a LDT (Experiment 1) as well as a NT (Experiment 2). These two tasks were used because various researchers (e.g., Balota & Chumbley, 1984; Gerard & Scarborough, 1989; Taft, 1991) have argued that they call upon different processes. According to Balota and Chumbley (1984), the frequency effect

found in LDTs may not be solely due to lexical access per se but rather to decision processes at the post-access stage. However, the NT has also been criticized as it could be possible for participants to read aloud the stimuli using a grapheme-to-phoneme strategy (Taft, 1991). The differences between these two tasks will be discussed more in depth in the general discussion section in the light of the results. As stated by Hino and Lupker (1996), using both the LDT as well as the NT allows to look for parallel or divergent effects and therefore determinate with more accuracy the locus of the observed process, either lexical or post-lexical (e.g., speech production). In the present study the same experimental stimuli were used with a LDT and a NT.

To investigate both the possibility of an inter-language frequency effect four types of English/French cognates were used. The cognates were either high frequency in both languages (H/H³), high English frequency and Low French frequency (H/L), low English frequency and high French frequency (L/H), or low frequency in both languages (L/L). The term "cognate" is used to refer to words which share the same orthography (with the exception of accentuation) and meaning in the two languages (e.g., "table"). Within each experiment three groups of participants were used, a control monolingual group, a bilingual group (English-L1, French-L2) performing the task in English as well as a bilingual group (English-L1, French-L2) performing the task in French. I will now review each experiment and its hypotheses.

In order to clarify the categorization of the different groups in Experiment 1 the following coding will be used. The task name (LDT) will be followed by a lower-case letter representing one of the three conditions: "e" for bilinguals performing the task in English, "f" for bilinguals doing the task in French, and "c" for the control condition.

³This notation will be used to refer to the four different cognate conditions. The first letter will always refer to the English frequency whereas the second letter will refer to the French frequency. For example the H/L condition includes cognates which have a high English frequency and a low French frequency.

Therefore, LDTc will refer to the monolingual participants in the control group, LDTe will represent the bilingual group performing the task in English whereas LDTf will be used to refer to the bilingual participants performing the task in French.

Based on previous research specific results were expected in Experiment 1. An effect of lexical status should be found. Namely, when collapsed across conditions cognates should be responded to faster than nonwords. A main effect of word frequency should be found both for English and French frequency. Specifically, high English frequency cognates (H/H and H/L) should be responded to faster than low English frequency cognates (L/H and L/L). Participants should also respond to high French frequency cognates (H/H and L/H) faster than to low French frequency cognates (H/L and L/L). The main hypothesis of interest lies in the comparison of the L/H condition with the L/L condition for the LDTe group. If word frequency has a cross language effect then L/H cognates should be responded to faster than L/L cognates for the bilingual groups doing the task in English. Participants should benefit from the high frequency of words from their second language whereas L/L words should not offer such advantage as their frequencies are low in both languages. This effect, however, should not be found with the control group. Similarly H/L cognates should be responded to faster than L/L ones for the LDTf group. As no control group exist to provide a baseline for the LDTf group (because of participant selection limitations), its performance will only be used for descriptive purposes. When comparing LDTe performance in the H/H condition to the H/L condition no difference should be found as a ceiling effect should prevent any cross-language facilitation to already high frequency cognates.

The convention used to describe the conditions associated with the NT in Experiment 2 parallel those associated with the LDT. NTc will refer to the monolingual participants in the control Naming Task group, NTe will represent the bilingual group

performing the task in English whereas NTf will be used to refer to the bilingual participants performing the task in French. Results similar to those in Experiment 1 are expected in Experiment 2. As the design of the two experiments is very similar I will first discuss the general design of the experiments and then describe both experiments in details afterwards.

General design

The general design applies to both experiments. The LDT and the NT experiments were run in parallel which means that each participant was randomly assigned to either experiment.

Participants

The participants were 141 students from Carleton University. Most participants were recruited through introductory psychology classes and received one experimental credit for their participation. All participants were English native speaker. As the requirements of the experiment were high (i.e., be proficiently bilingual or monolingual), additional participants were recruited by posters, the university internet newsgroup (carleton.general), and the university newspaper. These participants entered a \$100 cash draw for their participation as they could not benefit from the experimental credit. All participants were required to have normal or corrected to normal vision. The data of 33 participants was not included in the analysis (this figure is cumulative for both experiments, see result section for details as well as Table 1 for participants' descriptive statistics).

Insert Table 1 about here

Equipment.

All participants were individually tested on a Macintosh LCIII computer equipped with a Macintosh Color Display CRT (12 inches). PsyScope v1.0.2b4 (Cohen &

MacWhinney, 1994) was used to present the stimuli and collect the data. The participants' responses were entered using the PsyScope CMU button box (allowing one ms RT accuracy). The intensity of the screen was set at its minimum level whereas the contrast was set at its maximum level. The experiment took place in a brightly lit room. Bilingualism and monolingualism were assessed by a paper-and-pencil questionnaire administered after the completion of the experiment to avoid providing cues about the nature of the experiment. Bilingual participants were additionally asked to answer a few questions in French. Twenty to thirty seconds of their French utterances were recorded on a Marantz PM221 portable cassette recorder for further assessment of their bilingualism.

Stimuli

3127 cognates were collected from the Brulex database (Content, Moutsy, & Radeau, 1990a, 1990b) as well as from a database created from the Kučera and Francis (1967) frequency analysis. The Kučera and Francis listing is based on 1,014,232 words (taken from texts first printed in 1961) whereas the Brulex database, created from the "Trésor de la langue française" (Imbs, 1971), is based on a pool of 23,505,451 words (from French literature published between 1919 and 1964). In establishing criteria for choosing the stimuli accentuation was not taken into account ("caméra" was a valid cognate even if its English counterpart does not have an "accent aigu"). These cognates were then separated into four frequency categories.

Cognates with a high frequency in both languages (H/H) were defined as those having a frequency of 80 or more in English and of 2000 or more in French. The low frequency cognates (L/L) were defined as those having a frequency of 20 or less in English and of 200 or less in French. Cognates with a high frequency in English and low frequency in French (H/L, where the first letter represents the frequency in English and the second letter the frequency in French) were defined as those having a frequency of 80 or

higher in English and of 200 or lower in French. Finally, cognates with a low frequency in English and a high frequency in French (L/H) were defined as those having a frequency of 20 or lower in English and of 2000 or higher in French. Twenty cognates were selected from each of the four groups, yielding a total of 80 cognates. The cognates' characteristics, other than Frequency, were controlled for (See Table 2 and 3). The log frequencies for the each cognate of the four groups are plotted in Figure 2.

Insert Table 2 about here

Insert Figure 2 about here

The cognates used in the control condition and English conditions in the NT and LDT had no accents whereas the cognates presented in the French conditions had accents. The nonwords were constructed by changing a few letters from the French and English cognates. This method was preferred over creating original nonwords as it allowed control for some other characteristics such as word length to match these of the cognates. Moreover this method has been widely used in the past (e.g., Balota & Chumbley, 1984). None of the nonwords had accents (see Appendix B for list of Nonwords).

After completion of the experiment two cognates per condition were removed, yielding to a total of 18 cognates per condition. This was necessary as some cognates were not recognized as words by a large number of participants (e.g., 59.5% of the LDT participants did not recognize the cognate "cession" as being a word). In order to have an equal number of stimuli per condition, some cognates and nonwords were randomly removed from the analysis to reach a balanced number of 72 cognates (i.e., 18 cognates in four conditions) and 72 nonwords (see Appendix A). The same cognates and nonwords were removed prior to the statistical analyses for both experiments.

Insert Table 3 about here

In order to check for the equality of frequencies between similar frequency conditions one way ANOVAs were performed within each language on the mean frequencies of the stimuli (see Table 3 for mean frequencies). Because of the difference between the number of words sampled in the two corpora used to calculate the frequencies (23,505,451 for the French cognates versus 1,014,232 for the English cognates), no comparisons were made across languages. A significant effect of English frequency was found, $F(3,68) = 40.016$, $p = .001$. The first contrast was aimed at comparing the H/H condition against the H/L one (as the assumption of homogeneity was not met, separate variance of estimate was used). The English frequency for the H/H cognates was found to be no different than the frequency of the H/L stimuli. Similarly, the English frequency complement of the L/H cognates was no different than the frequency of the L/L cognates. However, both high English frequency conditions (H/H and H/L) were significantly higher than both low English frequency conditions (L/H and L/L), $t(32.2) = 10.92$, $p = .001$. Comparable results were found with French frequency. An overall ANOVA comparing French frequencies was significant, $F(3,68) = 11.41$, $p = .001$. As with English frequency, similar French frequency conditions were not significantly different. The high frequency conditions (H/H and L/H) did not differ from one another, and nor did the low frequency conditions (H/L and L/L). Taken together the mean of the two high French frequency conditions was found to be significantly higher than the mean of the two low frequency conditions, $t(34) = 5.72$, $p = .001$. Plotting each stimulus according to its French and English log frequencies also illustrates the clear separation between the four cognate conditions (see Figure 2).

Because it has been shown by some researchers (Rubenstein et al., 1970; Hino & Lupker, 1996) that words with more meanings were recognized faster than words with fewer meanings this variable could have been confounded with the frequency effect. Therefore a similar set of analyses as the one described above were performed to check for the equality of number of meanings between similar frequency conditions. The number of meanings were counted using the Petit Robert (1972) dictionary as well as the Oxford Advanced Learner's Dictionary of Current English (Hornby, Cowie, & Gimson, 1985). One way ANOVAs were performed within each language on the mean number of meaning of the stimuli. No comparisons were made across languages. The ANOVA for the mean number of meanings for English words was significant, $F(3,68) = 6.5377$, $p = .0006$. As the assumption of homogeneity was not met separate variance of estimate was used for all contrasts. The H/H condition was found to be no different from the H/L condition in the mean number of meanings. Similarly, the L/H condition did not differ significantly from the L/L condition. However, both high English frequency condition (H/H and H/L) were significantly higher than both low English frequency conditions (L/H and L/L), $t(27.5) = 4.251$, $p = .001$ (see Table 2 for mean number of meanings as well as standard deviation scores). Comparable results were found with French frequency, $F(3,68) = 10.56$, $p = .001$. Separate variance of estimate was also used for the contrasts for the French mean number of meanings as the assumption for homogeneity of variance was not met. Both high French frequency conditions (H/H and L/H) did not differ from one another on the number of meanings. Also, the two low French frequency conditions (H/L and L/L) were not statistically different. However, the two high French frequency conditions were found to have a greater number of meanings than the two low frequency conditions, $t(47) = 5.627$, $p = .001$.

Stimulus length, English ND, and French ND were also evaluated across the words

in each condition. The results of individual one-way ANOVAs indicated that the four different conditions are comparable in terms of stimuli length, English ND, and French ND (see Table 2).

Procedure

The French experimental groups differed from the English ones in that the instructions were in French and some cognates had accents (e.g., conférence, hôtel). All participants were seated at a viewing distance of approximately 60 cm from the screen. After reading the instructions all participants were instructed to make their response as quickly and accurately as possible. The participants were not told that the stimuli included cognates.

Each trial began by the presentation of a fixation cross (displayed for 1000 ms) followed by the stimulus which stayed on screen until the participant spoke the word (NT) or pressed either button (LDT). The stimuli were presented in black on a white background in the center of the screen. The experiment began with 20 practice trials consisting of items not used in the experimental trials (10 cognates and 10 nonwords). The experiment consisted of 160 randomized trials (80 cognates and 80 nonwords). All the stimuli were displayed in bold lowercase 12 point Geneva type font in black-on-white (e.g., **this sentence is in bold lowercase 12 point Geneva type**).

At the end of the experimental session the participants were given the paper-and-pencil questionnaire (see Appendix B). The bilingual participants were also recorded answering French questions in French for 20 to 30 seconds (i.e., "Que pensez-vous des nouvelles lois anti-tabac de Toronto?", "Etes-vous dérangé(e) par la fumée des cigarettes dans les restaurants?", "Etes-vous fumeur(-euse) vous-même?")⁴. The participants were

⁴"What do you think about Toronto's new anti-tobacco laws?", "Are you disturbed by cigarette smoke in restaurants?", "Are you a smoker yourself?"

then debriefed as to the nature of the experiment (see Appendix C).

Experiment 1

Because the main variable of interest was word frequency and the LDT task has been used on numerous occasions to study this variable in the past it was decided to rely on this task for the first experiment.

Method

Participants. 54 of the 141 participants were randomly assigned to the LDT experiment.

Equipment. The participants used the two of the three buttons of the button box to enter their response. For the LDTf group the buttons were labelled "mot" and "non-mot" whereas they were named "word" and "nonword" for the LDTe and LDTc groups.

Stimuli. The stimuli were the same as those described in the 'general' section.

Procedure. The participants were randomly allocated to an experimental group (i.e., LDTe or LDTf) whereas the monolingual participants were assigned to the control group (LDTc). The participants were prompted to use the index and middle finger of their dominant hand to enter their response. The stimulus stayed on screen until the participant pressed either button.

Results

Participants. The data from 15 participants were not used⁵ (two from the LDTe group, nine from the LDTc group, and four from the LDTf group): participants who had overall error rates and/or response times exceeding two standard deviations from the group means for these measures or who were randomly removed in order to obtain an equal number of participants per group. After data selection the total number of participants was

⁵Data from six participants from Experiment 1 and 2 were also not used as four data files were lost due to a file management error and two participants showed too severe a cognitive/physical impairment for their data to be used.

54 (i.e., three groups each containing 18 participants).

An ANOVA verified that the participants in Experiment 1 who had been categorized as bilingual according to the questionnaire differed from those who had been classified as monolingual (see Figure 3), $F(2,51) = 188.84, p < .01$. A subsequent contrast analysis using separate variance of estimate (as the assumption of homogeneity of variance was not met) revealed that both bilingual groups (LDTe and LDTf) were not significantly different (LDTe, $M = 2.24$; LDTf, $M = 2.36$). However, the monolingual group (LDTc, $M = 5.57$) differed significantly from both bilingual groups taken together ($M = 2.30$), $t(43.6) = 25.98, p = .001$.

Insert Figure 3 about here

An ANOVA was also ran on the number of years participant had spent in University. This extraneous variable was examined as it might have been a nuisance variable (the control group had been recruited mainly through the introductory Psychology class whereas the experimental groups had been recruited via posters and an internet newsgroup). However, the participants did not differ in the numbers of year they spent in university. Participants' age did not differ significantly either (see Table 1).

Error data and Outliers. The percentage error rate is shown in Figure 4. For the LDT an error was defined as a wrong response (i.e., pressing the button "Word" instead of "Nonword" and vice-versa). Outliers were defined as those RTs being two standard deviations above or below the mean. It is important to keep in mind that the H/L condition for the LDTf participants is really their "L/H" condition as the H/L condition refers to the condition where the cognates have a high English frequency and low French frequency. Therefore, Figure 4 clearly shows that the error rate increases as frequency decreases, with the smallest error rate being found in the H/H condition whereas the L/L condition

demonstrates the highest error rate.

In order to check if the error rate for the cognates collapsed together was smaller than the error rate for the nonwords three paired-samples *t* tests were performed (with $\alpha = 0.017$). For the LDTc group the difference between the cognates (7.18%) and the nonwords (10.34%) was not significant. Similar results were obtained for the LDTf group (cognates: 7.56%, nonwords: 11.50%) and for the LDTe group (cognates: 4.79%, nonwords: 5.79%).

A repeated measures ANOVA was performed on the error rate of the cognates. The within subjects variable was Cognates and had four levels (H/H, H/L, L/H, & L/L). The between variable was Group and had three levels (LDTe, LDTc, & LDTf). No significant effect of Group was found, $F(51,2) = 2$, $p = .073$. The main effect of Condition was significant, $F(4,204) = 17.14$, $p = .001$, as well as the two way interaction between Group and Condition, $F(8,204) = 17.14$, $p = .009$.

Three contrasts were performed for each group (H/H vs. H/L, L/H vs. L/L, and H/H & H/L vs. L/H & L/L). The first contrasts were done for the LDTe group. The contrast between the H/H condition (1.23%) and the H/L condition (3.09%) was not significant. However, the LDTe participants made significantly fewer errors in the L/H condition (3.4%) than in the L/L condition (11.42), $F(53,1) = 6.31$, $p = .015$. The combined error rate for the H/H and the H/L conditions (2.16%) was significantly lower than for the L/H and L/L conditions (16.4%), $F(53,1) = 4.78$, $p = .032$.

For the LDTc participants there was no significant difference in the percentage of error between the H/H condition (1.23%) and the H/L condition (3.09%). The difference between the L/H condition (8.95%) and the L/L (15.43%) condition was only marginally nonsignificant ($p = 0.052$). However, a significant difference was found between the H/H and H/L conditions collapsed together (2.16%) and the combined L/H and L/L conditions

(12.19%), $F(53,1) = 23.55, p = .001$.

The LDTf participants error rate in the H/H condition (1.23%) was statistically equivalent to their error rate in the L/H condition (1.54%). Similarly, no difference was found between the H/L condition (12.53%) and the L/L condition (15.43%). The LDTf participants made fewer errors in both high French frequency conditions combined together (H/H and L/H, 1.74%) than in both low French frequency conditioned (H/L and L/L, 13.42%), $F(53,1) = 32.33, p = .001$.

Insert Figure 4 about here

RT data. All analyses on RTs used average median RTs. As RTs to nonwords were of little interest beyond the replication of the lexical status effect three paired-samples t tests were performed (with $\alpha = 0.017$) to check that cognates collapsed accross conditions were classified faster than nonwords. All the t tests were significant. Within the LDTc group the cognates ($M = 566$ ms) were classified faster than the nonwords ($M = 708$ ms), $t(17) = -5.23, p = .001$. The LDTf participants also categorized the cognates ($M = 614$ ms) faster than nonwords ($M = 767$ ms), $t(17) = -6.33, p = .001$. The participants in the LDTe group recognized the cognates ($M = 543$ ms) faster than the nonwords ($M = 681$ ms), $t(17) = -7.74, p = .001$. These effects can be seen on Figure 5.

Insert Figure 5 about here

A repeated measures ANOVA was then performed with one within and one between subjects variable. The within subjects variable was Cognates and had four levels (H/H, H/L, L/H, & L/L). The between variable was Group and had three levels (LDTe, LDTc, & LDTf). This approach using one within variable was favored over using two

within variables with two levels each (i.e., English frequency, high and low; French frequency, high and low) as the interactions between the English and French frequencies was of less importance than the planned comparison outlined in the hypotheses. A main effect of Group was obtained, $F(2,51) = 8.22$, $p = .001$. The main effect of Cognates was also significant, $F(3,153) = 95.59$, $p = .001$, as was the two way interaction between Group and Cognates, $F(6,153) = 3.59$, $p = .002$.

Three contrasts were performed for each group (yielding to a total of 9 contrasts). The three first contrasts were done for the LDTe group. As expected the contrast between the H/H and the H/L conditions turned out non significant as the LDTe participants were not significantly faster in the H/H condition ($M = 504$ ms) than in the H/L one ($M = 523$ ms). As this result was only marginally non-significant ($p = .063$) a power analysis was performed which revealed a low power (.460). However, as ETA square was also small (.063), increasing N would have only enabled reaching significance for a somewhat trivial difference. The contrast between the L/H and the L/L condition was significant, $F(53,1) = 10.47$, $p = .002$. The LDTe participants were faster in the L/H condition ($M = 554$ ms) than in the L/L condition ($M = 613$ ms). The last contrast between both high English frequency cognates conditions (H/H and H/L averaged together) and the two low English frequency cognates conditions (L/H and L/L averaged together) was significant, $F(53,1) = 17.85$, $p = .001$. The LDTe participants were faster at correctly classifying the high English frequency cognates ($M = 513$ ms) than they were at identifying the low English frequency cognates as words ($M = 584$ ms)(see Figure 6).

Insert Figure 6 about here

Similar contrasts were performed on the LDTc group data. The average median RTs for the H/H and H/L conditions were not significantly different (H/H, $M = 536$ ms;

H/L, $\underline{M}$ = 526 ms). However, a significant difference was found between the L/H and the L/L condition as the LDTc participants were faster at classifying L/H cognates ($\underline{M}$ = 588 ms) than they were at classifying L/L cognates ($\underline{M}$ = 649 ms), $F(53,1) = 11.40$, $p = .001$. Finally, words from the two high English frequency cognate conditions (H/H and H/L, $\underline{M}$ = 531 ms) were identified faster than in the two low English frequency cognate conditions (L/H and L/L, $\underline{M}$ = 619 ms), $F(53,1) = 34.49$, $p = .001$ (see Figure 7).

Insert Figure 7 about here

The LDTf participants did not respond differently in the H/H condition ($\underline{M}$ = 582 ms) compared to the L/H condition ($\underline{M}$ = 607 ms). Because this result was marginally non-significant ($p = .093$) a power analysis was performed. Power was found to be low (.389) but as ETA square was also low (.052) it can be concluded that a greater N would have only help reach a statistically significant result for a rather unimportant difference. A significant difference was found between the H/L and L/L conditions, $F(53,1) = 6.98$, $p = .011$. The LDTf participants responded more quickly to the H/L cognates ($\underline{M}$ = 617 ms) than to the L/L cognates ($\underline{M}$ = 682 ms). The LDTf participants classified high French frequency cognates (H/H and L/H, $\underline{M}$ = 594 ms) more quickly than low French frequency cognates (H/L and L/L, $\underline{M}$ = 649 ms), $F(53,1) = 29.33$, $p = .001$ (see Figure 8).

Insert Figure 8 about here

Insert Figure 9 about here

A median split was performed on the overall RT (cognates and nonwords) to check if the difference found between the control and experimental group (see Figure 9) would

maintain itself in both fast and slow participants. The median split resulted in four groups out of the LDTe and LDTc groups: LDTe fast, LDTe slow, LDTc fast, and LDTc slow. A two-way ANOVA was performed with Language (monlingual, bilingual) and Speed (fast, slow) as the two variables. The main effect of Speed was significant, $F(1,32) = 37.74$, $p < .001$. Almost 100 ms separated the fast participants (LDTe fast and LDTc fast, $M = 544$ ms) from the slow ones (LDTe slow and LDTc slow, $M = 639$ ms). Neither the main effect of language nor the two-way interaction (Speed x Language) were significant. Similarly, none of the t-tests were significant. Therefore the LDTe slow group ($M = 629$ ms) did not differ significantly from the LDTc slow group ($M = 650$ ms). The LDTe fast group ($M = 525$ ms) was also not significantly different from the LDTc fast group ($M = 563$ ms).

Insert Figure 10 about here

To check if slower participants differed from the faster ones on bilingualism a median split was also done on the bilingualism scores. The participants were separated into two groups: more bilingual and less monolingual (LDTe more bilingual, LDTe less bilingual, LDTc more monolingual, and LDTc less monolingual). A two-way ANOVA was performed with Language (monlingual, bilingual) and Bilingualism (more or less bilingual, more or less monolingual) as the two variables. None of the effects of the ANOVA were found to be significant. Two t-tests were done in order to compare those participants who scored at the extreme of the bilingualism questionnaire (more bilingual and more monolingual) as well as those who scored low on the same questionnaire (less bilingual and less monolingual). The average median RT of the more bilingual LDTe participants ($M = 583$ ms) were not significantly different from those of the more monolingual LDTc participants ($M = 611$ ms). The less bilingual LDTe group ($M = 571$

ms) was also not found to behave differently than the less monolingual LDTc group ($M = 602$ ms) (see Figure 11).

Insert Figure 11 about here

Discussion

A summary of the results can be found in Table 4. The LDT replicated some robust monolingual effects: cognates were responded to faster than nonwords (replication of the Lexical status effect) and high frequency cognates were responded to faster than low frequency cognates within each language (replication of the Frequency effect) for all groups. Also, high frequency cognates within one language (i.e., H/H and H/L cognates are both High frequency in English) were not responded to differently. These results were found for all three groups (LDTc, LDTe, & LDTf).

Unexpected results were found with the LDTc group as these monolingual participants responded to L/H cognates faster than L/L cognates. According to the hypothesis only the bilingual participants should have benefited from the high frequency counterpart in the second language.

Insert Table 4 about here

Moreover, when comparing the LDTe group with the LDTc group it appears that the former is faster in almost every condition except the H/L one (see Figure 9). At first it was thought that the experimental groups might have been different from the control group in the number of years spent in University as both group were recruited through different method; Psychology 100 credits for most of the control participants, posters and ads for most of the bilingual participants. Statistical analysis reported in the result section revealed no such difference. However, the pen-and-paper questionnaire given to the participants at

the end of the experiment revealed that most control participants had had some French education early in their life. Even if the monolingual participants ranked themselves low in French proficiency on the second part of the questionnaire it appears that most of them attended French classes. Eight participants reported the grades during which they took French. The average beginning year was grade 5 ($M = 5.5$) and the average finishing year was grade 9 ($M = 8.87$). Five participants out of 18 were involved in an immersion program whereas 10 attended a French class "several times a week". Only three LDTc participants reported having no French education at all. However, most participants also reported never having to speak French (83%) nor having to read it or understand it (77%). Monolingual participants also reported never watching French TV nor reading French books (100%). Even if 38% of the control group confirmed that some family members spoke French, none ever lived in a francophone country or region.

An important assumption of the present experiment was that the language in which the instruction set was given as well as the presence of language specific cues (i.e., accentuation) would be enough to lead the participants to perform the experiment without realizing that the stimuli were all cognates. Did the instructions really activate the language set? To the question "Did you notice some non-congruent words (i.e., French words for English tasks and English words for the French tasks)?" the great majority of the participants answered positively (61% for the control group (LDTc) and 100% for the two experimental groups). When asked to report some of the non-congruent stimuli 44% of the participants could do so. Some stimuli were reported as non-congruent more often than others (e.g., "boutique" and "milieu" were reported five times each whereas "cinema" was only mentioned once). However, only a very small portion of the participants noticed that all stimuli were cognates (LDTe: 5%; LDTc: 11%; LDTf: 5%). Even if most participants mistook some cognates for non-congruent words, by and large they did not clue into the

fact that all stimuli were cognates. This seems to suggest that the use of language specific instructions as well as orthographic languages cues were effective in inducing the participants to rely on one language.

The comparisons of the error rate for the cognates (collapsed accross conditions) and the nonwords yielded a pattern of somewhat unexpected results. Generally the error rate for words would be expected to be lower than that of nonwords. However, in the present experiment no such difference was found. As can be seen in Figure 4 it seems that the L/H condition and the L/L condition might be responsible for the lack of statistical difference. Because low frequency words are not encountered as often as high frequency words it might be that some participants responded to some of the L/H and L/L cognates as if they were nonwords.

In general the differences found in the error rate between the different cognate conditions are what would be expected from a LDT. The participants did not made more errors in either of the high frequency conditions (H/H and H/L for the LDTc and LDTe groups and H/H and L/H for the LDTf group). Except for the LDTe group, where the participants made fewer errors in the L/H condition than in the L/L condition, participants made as many errors in the two low frequency conditions. As anticipated the high frequency conditions collapsed together had a lower error rate than the two low frequency conditions combined. These results show that the higher word frequency corresponds to a low error rate, a pattern commonly found in LDTs.

In conclusion, the main hypothesis that bilingual participants performing the task in English would be faster at classifying the L/H cognates than the L/L cognates was partially supported. The fact that similar results were found with the control group may be imputed to the monolingual participants' knowledge of French which was better than expected.

Experiment 2

Because of the possibility that the I.D.T involved some task specific processes a second experiment using a NT was ran. Experiment 2 uses exactly the same design and stimuli as Experiment 1.

Method

Participants. 53 participants were randomly selected from the 141 Carleton University student pool (see Table 1 for descriptive statistics).

Equipment. The equipment was the same as the one described in "General design" except that instead of using the button box directly the participants had to use a Genexxa HPM 010 headset with built-in microphone (plugged in the button box). The headset was used to ensure the microphone remained at a consistent distance from the participants' mouths (the headset was not used to present auditory stimuli). All of the participants utterances were recorded on a Marantz PM221 portable cassette recorder.

Stimuli. The stimuli were the same as described in "General design" and included both the cognates as well as the nonwords. Nonwords are generally not used in NT; however, so as to make the two experiments as similar as possible, nonwords were included in Experiment 2.

Procedure. The bilingual participants were randomly assigned to either experimental group (i.e., NTe or NTf) and the monolinguals to the control group (NTc). The participants were asked to speak clearly in the microphone and to name each word aloud as fast as they could while maintaining a low error rate for pronunciation. Otherwise, the procedure was similar to that described in the "General design" section.

Results

Participants. The data from 12 participants were not used for the statistical analysis (two from the NTe group, eight from the NTc group, and two from the NTf group). As in Experiment 1 some participants were more than two standard deviations from the group

means for these measures. To reach an equal number of 18 participants per group some were randomly removed from the analysis.

A one-way ANOVA performed to determine if the participants differed significantly on their bilingualism score (as assessed by the bilingual questionnaire) yielded a significant effect, $F(2,51) = 140.28$, $p < .01$. Contrast analysis (using separate variance of estimate) showed that the two bilingual groups did not significantly differ from one another (NTe, $M = 2.81$; NTf, $M = 2.30$). The monolingual group (NTc, $M = 5.56$) was significantly different from the two merged bilingual groups ($M = 2.55$), $t(40.1) = 22.51$, $p = .001$. As in Experiment 1 an ANOVA was performed on the number of years spent in university as well as the participants' age. The results showed no significant differences between the groups.

Stimuli. To ensure that the analyses in the two experiments were as similar as possible the stimuli discarded in Experiment 1 were also removed from Experiment 2 and vice versa. For example, some nonwords were removed from the list because participants in Experiment 2 mispronounced them (e.g., 27.5% of the NT participants mispronounced the nonword "modiolion"). These stimuli were also removed from the analysis in Experiment 1 (see Appendix A).

Error data and Outliers. The NT error rate incorporates wrong pronunciations, speaking out a word different from the one displayed, and repetition (i.e., the participant repeats the stimulus twice because of mispronunciation or hesitation). The errors were counted by the experimenter after the experiment by listening to the taped utterances of the participants. Outliers were defined as those RTs being two standard deviations above or below the mean.

As in Experiment 1, in order to compare the error rate for the cognates collapsed across condition with the error rate for the nonwords three paired-samples t tests were

performed (with $\alpha = 0.017$). All the t tests were significant. For the NTc group the percentage of errors for the cognates (2.48%) was significantly lower than for the nonwords (12.57%), $t(17) = -6.32$, $p = .001$. Similarly, the NTf participants made fewer errors when responding to cognates (2.95%) than to nonwords (8.10%), $t(17) = -4.67$, $p = .001$. The percentage of errors for the NTe group was also lower for the cognates (2.79%) than for the nonwords (9.03%), $t(17) = -5.36$, $p = .001$.

A repeated measures ANOVA was performed on the error rate using a design similar to the one for the LDT. No significant main effect of Group was found. The main effect of Condition was significant, $F(4,204) = 40.80$, $p = .001$. The two-way interaction was also significant, $F(8,204) = 3.43$, $p = .001$. As seen in Figure 4, the error rate for the NT data is much less than for the LDT. The low error rate might explain why it does not look as if there is a direct relationship between condition and error rate as in Experiment 1. Contrasts similar to those completed in Experiment 1 were performed on the error data from the NT experiment. The NTe participants' error rate in the H/H condition (2.47%) was statistically equivalent to their error rate in the H/L condition (1.85%). However, they made significantly more errors in the L/H condition (5.56%) compared to the L/L condition (1.23%), $F(53,1) = 13.74$, $p = .001$. The difference between the H/H and H/L conditions (2.17%) and the L/H and L/L conditions (3.41%) was not significant.

None of the contrasts concerning the NTc participants were significant. The NTc participants' error rate in the H/H condition (1.54%) was statistically equivalent to their error rate in the H/L condition (2.47%). Similarly, there was no significant difference between the L/H condition (3.09%) and the L/L condition (2.78%). When collapsed together, both high English frequency conditions (H/H and H/L, 2.01%) were not different than both low English frequency conditions (L/H and L/L, 2.95%).

The NTf participants' error rate in the H/H condition (1.54%) was statistically

equivalent to their error rate in the L/H condition (3.4%). However, they made significantly more errors in the H/L condition (5.25%) than in the L/L condition (1.54%), $F(53,1) = .012$, $p = .040$. There was no difference between the H/H and L/H condition collapsed together (2.48%) and the H/L and L/L conditions collapsed together (3.41%).

RT data. All RTs analyses were performed on average median RT. As in Experiment 1 three paired-samples t-tests were performed (with $\alpha = 0.017$) to check that cognates collapsed across conditions were classified faster than nonwords. All the t-tests yielded significant effects. The NTc participants responded to cognates ($M = 554$ ms) faster than they responded to nonwords ($M = 656$ ms), $t(17) = -6.42$, $p = .001$. Similarly, the NTf participants classified cognates ($M = 556$ ms) faster than nonwords ($M = 613$ ms), $t(17) = -8.04$, $p = .001$. Cognates were also responded to faster ($M = 527$ ms) than nonwords ($M = 608$ ms) in the NTe group, $t(17) = -7.67$, $p = .001$ (see Figure 5).

Paralleling the LDT experiment, a 4x3 repeated measures ANOVA was performed to compare cognate conditions and groups. The within subjects variable Cognates had four levels (H/H, H/L, L/H, & L/L) whereas the between subjects variable Group had three levels (NTe, NTc, & NTf). The main effect of Group was not significant. However, there was a significant main effect of Cognates, $F(3,153) = 23.70$, $p = .001$, as well as a significant two way interaction between Group and Cognates, $F(6,153) = 5.22$, $p = .001$.

Planned comparison indicated no significant difference between the RTs of the NTe group for the H/H ($M = 512$ ms) and H/L ($M = 517$ ms) conditions. Similarly, the contrast between the L/H and the L/L condition was not significant. The NTe group response to the L/H condition ($M = 539$ ms) was virtually identical to the one of the L/L condition ($M = 542$ ms). The NTe participants, however, were faster at classifying high English frequency cognates (H/H and H/L, $M = 515$ ms) than low English frequency

cognates (L/H and L/L, $\underline{M}$ = 540 ms), $F(53, 1) = 8.53$, $p = .005$ (see Figure 6).

The NTc group named the H/H cognates ($\underline{M}$ = 531 ms) at the same speed as the H/L cognates ($\underline{M}$ = 544 ms). Likewise, no significant difference was found between the RTs to L/H cognates ($\underline{M}$ = 577 ms) and L/L cognates ($\underline{M}$ = 582 ms). The NTc participants classified high English frequency cognates (H/H and H/L, $\underline{M}$ = 537 ms) faster than low English frequency cognates (L/H and L/L, $\underline{M}$ = 580 ms), $F(53, 1) = 30.85$, $p = .001$ (see Figure 6). Finally, no significant difference was found for the NTf group response to H/H cognates ($\underline{M}$ = 542 ms) compared to L/H ones ($\underline{M}$ = 550 ms). The RT for H/L cognates ($\underline{M}$ = 571 ms) was identical to the one for L/L cognates ($\underline{M}$ = 571 ms). The NTf participants were significantly faster when classifying high French frequency cognates (H/H and L/H, $\underline{M}$ = 546 ms) than when responding to low French frequency cognates (H/L and L/L, $\underline{M}$ = 571 ms).

As in Experiment 1, a two-way ANOVA was performed on the NT RTs after a median-split. The main effect of Speed was significant, $F(1,32) = 42.75$, $p < .001$. More than 100 ms separated the fast NT participants (NTe fast and NTc fast, $\underline{M}$ = 507 ms) from the slow ones (NTe slow and NTc slow, $\underline{M}$ = 618 ms). The main effect of Language was also significant, $F(1,32) = 4.574$, $p = .040$. The NTc group was significantly slower ($\underline{M}$ = 580 ms) than the NTe group ($\underline{M}$ = 544 ms). The two-way interaction (Speed x Language) was not significant. In order to compare the two slow groups and the two fast groups two t-tests were performed. A significant difference was found between the NTe slow group ($\underline{M}$ = 585 ms) and the NTc slow group ($\underline{M}$ = 650 ms), $t(16) = 2.20$, $p = .043$. No significant difference was found between the NTe fast group ($\underline{M}$ = 503 ms) and the NTc fast group ($\underline{M}$ = 511 ms). It seems that the effect obtained in the NT experiment between the NTe group and the NTc group is mainly due to the slow respondents. Indeed, the fast participants are indistinguishable from one another (see Figure 10).

As in Experiment 1, to check if slower participants differed from the faster ones on bilingualism, a median split was also done on the bilingualism scores. The participants were separated into two groups: more bilingual and less monolingual (N_{Te} more bilingual, N_{Te} less bilingual, N_{Tc} more monolingual, and N_{Tc} less monolingual). A two-way ANOVA was performed with Language (monolingual, bilingual) and Bilingualism (more or less bilingual, more or less monolingual) as the two variables. The main effect of Bilingualism was not significant. The more bilingual participants ($M = 580\text{ms}$) did not answer differently than the more monolingual participants ($M = 543\text{ ms}$). The main effect of Language nor the two-way interaction (Speed x Language) were significant. As in Experiment 1 two t-tests were performed in order to compare the participants who scored at the extreme of the bilingualism questionnaire (more bilingual and more monolingual) as well as the participants who scored low on the same questionnaire (less bilingual and less monolingual). A significant difference in RT was found between the two "more bilingual" groups, $t(16) = 2.57$, $p = .020$. The N_{Te} participants with higher bilingualism scores named the cognates faster ($M = 532\text{ ms}$) than the N_{Tc} participant with higher scores on monolingualism ($M = 630\text{ ms}$). However, the less bilingual N_{Te} group did not differ from the less monolingual N_{Tc} group (see Figure 12).

Insert Figure 12 about here

Discussion

Several of the basic findings obtained in the LDT experiment were also observed with the NT. The lexical status effect was replicated as cognates were vocalized faster than nonwords in all conditions. The word frequency effect was also replicated as high frequency cognates were responded to faster than low frequency cognates. This effect applies to the N_{Te} and N_{Tc} groups where H/H and H/L cognates collapsed together (high

English frequency cognates) were responded to faster than L/H and L/L cognates (low English frequency cognates). Similarly, for the NTf group the high French frequency cognates (H/H and L/H averaged together) were named faster than the low French frequency cognates (H/L and L/L averaged together). As expected no difference was found between the L/H cognates and the L/L cognates for the control group. However, contrary to the hypotheses, no difference were found between L/H and L/L cognates in the NTe group, where the former were hypothesized to be named faster than the latter. Similarly, with the NTf group the H/L cognates were not named significantly faster than the L/L cognates, a result contradicting the predictions for this group.

As in Experiment 1, it seems that the control participants received more French education than expected from the bilingualism questionnaire. In NTc group 16 participants out of 18 received French education "several times a week" at some point in their lives whereas the two remaining were involved in an immersion program. Twelve participants reported the grades during which they learned French. The mean grade for beginning French classes was grade 5 ($M = 5$) and the average last grade was grade 9 ($M = 9$). However, 94% of these participants reported having to speak and understand French once a month or less. These participants also never read French books and only one out of 18 reported watching French television 30 minutes per week. Participants in the NTc group had some family members who speak French (4 out of 18) but never lived in a francophone country or region (94%).

To the question "Did you notice some non-congruent words?" the participants answered positively in the same proportion as in Experiment 1 (61% for the control group (NTc) and 100% for all four experimental groups). When asked to report some of the non-congruent stimuli 50% of the NT participants could do so. Also, as in the LDT experiment only a very small portion of the participants noticed that all stimuli were

cognates (NTE: 11%; NTc: 0%; NTf: 0%).

The pattern of errors for the NT experiment is radically different from the one reported in Experiment 1. For all three groups, and as could be expected, there was no difference in the percentage of errors between the H/H and the H/L conditions (H/H and L/H for the NTf group). Contrary to our expectations, the NTc group made more errors in the L/H condition than in the L/L condition. The same result can be found with the NTf group where participants made more errors in the H/L condition than in the L/L condition. The NTE group is the only one where the percentage of errors between the L/H and the L/L conditions did not differ. When the high frequency cognates were collapsed together and compared to the low frequency cognates no difference in the error rate could be found in any of the three groups. These results could be explained by the way the error rate was collected for the NT experiment. In Experiment 1 the error data was automatically collected by the computer as the task was being performed. However, in the case of the NT it is the experimenter who collected the error data by listening to the audio tapes of the participants' utterances recorded during each session. The fact that the experimenter's first language was French rather than English may partially explain the pattern of results.

As in Experiment 1, the fact that the NTc group did not differ from the NTE group may be attributed to the NTc group's knowledge of French. However, because Experiment 2 results differ radically from those of Experiment 1 it is necessary to explore the differences between the two tasks and their possible effect on the participants' performance.

General Discussion

The pattern of results for the two experiments are quite distinct. In the LDT the L/H cognates were responded to faster than the L/L cognates regardless of the language group. Specifically, L/H cognates were responded to faster than L/L cognates for both the LDTE

and LDTc groups and H/L cognates were named faster than L/L ones in the LDTf group. Conversely, the NT showed no interlingual facilitation effect as the L/H condition was not responded to faster than the L/L condition for the NTe or the NTc group and the NTf group in the H/L condition was not faster than the L/L condition. Because participants were randomly assigned to either experiment we can assume that it is the task (LDT vs. NT) which is responsible for the differences in RT for the L/H and L/L condition within each group. To better understand these results several issues will be reviewed.

Because testing for bilingualism and monolingualism was a central issue in the present experiments, I will first review some problems that might have arisen because of the participants' selection process. A related issue is individual differences in experimental performances and bilingualism. Therefore, I will next consider the results of the median split on RT and bilingualism. Following this I discuss the case of the French groups in both experiments (LDTf and NTf). Finally, the results will then be discussed in the light of several monolingual and bilingual models of lexical organization followed by some concluding remarks regarding potential future work.

Bilingualism assessment

As mentioned in the discussion section of both experiments the control groups had substantial French education. Analysis of the language questionnaire data indicates that the control groups for both experiments (LDTc and NTc) were probably not different enough from the experimental groups as far as their knowledge of the second language was concerned. More specifically, the control groups might not have been monolingual enough thus explaining why these participants' responses to L/H cognates were faster to L/L ones in Experiment 1. In the end, the control groups might have been suffering from a double handicap as it seems that the monolingual participants also responded more slowly than the experimental groups for all types of cognates, including nonwords (except in the H/L

condition of the LDT experiment, see Figure 9). Specifically, it appears that the control group's performance was very similar to that of the bilingual participants performing the tasks in English with the only difference being that the control groups were always slower.

As reading skills was not assessed in the questionnaire it cannot be concluded for certain that this variable is responsible for the difference between the two groups.

However, making sure that the control group is truly monolingual as well as assessing its reading skills (so that they match those of the experimental groups) should be a high priority in further research. The median splits performed on the data revealed some important characteristics related to this issue.

Median split

Two median splits were performed to check if faster/more bilingual participants performed the tasks differently than slower/less bilingual participants. The median split performed on the LDT data did not reveal any effect of speed or proficiency beyond the expected effect of speed itself. However, the NT split demonstrated a very specific pattern of results in which the fast NTc and NTe are almost indistinguishable from one another (see Figure 10). However, when the slow participants are considered, the NTc group is always slower than the NTe group, regardless of the condition. Therefore, it could be concluded that the results plotted on Figure 9 are likely primarily due to the slow participants. When the NT groups created by the RT median split are compared to the ones created by the Bilingualism median split some striking similarities appear. As can be seen in the table below, the fast groups (NTc fast, NTe fast) are more bilingual than the slower groups. Six out of nine participants in the NTc fast group rated themselves as less monolingual whereas six out of nine participants in the NTe fast group rated themselves as more bilingual. The exact opposite can be found with the two slower groups: In the NTc slow group six out of nine participants rated themselves as more monolingual whereas six

out of nine participants in the NTe slow group rated themselves as less bilingual.

Therefore, it seems that less fluent bilinguals were more likely to also have slower RTs.

	NTc fast	NTc slow	NTe fast	NTe slow
NTc less monolingual	6	3	-	-
NTc more monolingual	3	6	-	-
NTe less bilingual	-	-	3	6
NTe more bilingual	-	-	6	3

The distribution of the LDT participants among the two median splits appears to be different from that of the NT as far as the English groups are concerned. The participants in the two control groups (LDTc fast and LDTc slow) are scattered across the bilingual groups in the same way the participants from the NT control groups are. The fast monolingual participants have a tendency to be less monolingual (66%) than the slow monolinguals who in turn are more monolingual (66%). The difference between the NT and the LDT is most evident in the bilingual participants. In the NT faster participants were more likely to be more bilingual (in the LDT the opposite is true) as faster LDTe participants are less bilingual (55%) and slower LDTe participants are more bilingual (55%).

	LDTc fast	LDTc slow	LDTe fast	LDTe slow
LDTc less monolingual	6	3	-	-
LDTc more monolingual	3	6	-	-
LDTe less bilingual	-	-	5	4
LDTe more bilingual	-	-	4	5

In conclusion, the median split can partially explain the results for Experiment 2 as being primarily due to the RTs of the slow participants. However, the median split did not clarify the results for the LDT. Because of the small number of participants (nine per group after the median split) one must keep in mind that these results are only suggestive at best. So far, because of the lack of an appropriate control group consideration of the results from the French groups (LDTf and NTf) have been left aside. However, the absence of a control group does not exclude some general statements about the performances of these

two groups.

The French groups

The main result concerning the French groups (LDTf, NTf) is that they are constantly slower than the English groups (LDTe, NTe). In Experiment 1 the LDTf participants are on average 75 ms slower than the LDTe participants. The LDTf participants are also slower than the LDTc participants by 49 ms. In Experiment 2 the difference is also present but of a smaller magnitude as the NTf group is only 26 ms slower than the NTe group. However, in the NT experiment it is interesting to note that the NTf participants are faster than the control group in the L/H, L/L, and nonword conditions. When the overall average median RT is taken into consideration the NTf group is only 8 ms faster than the NTc group. Yet, when the H/H and H/L conditions are excluded the difference between the NTf group and the control group reaches 27 ms in favor of the NTf participants. The NTf participants seem faster at naming cognates that do not have a high English frequency (L/H, L/L) as well as nonwords that are the NTc participants.

In this experiment even having a French monolingual control group would not have permitted a true comparison with the NTf and LDTf groups. Indeed, a French monolingual group could only serve as a control group for participants whose mother tongue would be French. That design would have allowed an investigation of the effect of L2 (English) on L1 (French) as it is dubious that monolingual French participants could be compared to participants with English as a mother tongue and French as their second language. In order to better explain these results the monolingual lexical models as well as the bilingual models of lexical organization will now be reexamined.

Monolingual lexical models

Five types of models will be reviewed in the light of the results: the Logogen model, the Verification model, the Serial Search model, PDP model, and dual-route

models.

According to the Logogen model (Morton, 1969) the frequency of a word increases as a function of the number of times it is encountered. If some words in two languages have a similar graphemic structure (such as cognates) then reading such a word in one language might also raise the "word counter" in the other language. For example, encountering the French word "accent" (a L/H cognate) might increment its frequency both in French and English. Therefore, cognates that have a high frequency in one language and a low frequency in the other language could be treated as high frequency in both languages by bilinguals. During Experiment 1 the LDTe participants might have responded faster to the L/H cognates than to the L/L cognates not because of the high frequency of the former in French but rather because the latter had become high frequency words in English. If this approach is correct then the results in Experiment 1 need not be explained by a facilitatory effect of French because the LDTe participants only had to access their English lexicon language to respond faster to L/H cognates than to L/L ones. However, the NTe group did not respond faster to L/H cognates than to L/L ones. Since there was a significant main effect of English frequency (i.e., high English frequency cognates were responded to faster than low frequency cognates) we could have expected L/H cognates to be responded to as fast as high frequency English cognates. Because no such result was found it is doubtful that the L/H cognates became high frequency words in both languages. Rather, the two frequencies of a cognate seem to be distinct and limited to one language.

According to the Verification model (Becker, 1976; Becker & Killian, 1977; Becker, 1979), frequency information is accessed once a set of candidates has been activated. However, it is in the first stage of word recognition (feature extraction) that candidates are extracted from the sensory-property list. In the case of bilinguals, the question is whether cognates will activate both languages so that the sensory-property list

from which the list of potential candidates is created contains both versions of the cognates. Because no interlingual effects were found in the NT the conclusion will be the same as with the Logogen model, namely that the frequencies of cognates in two languages do not influence each other. However, early versions of the Logogen model as well as the Verification model only propose the use of a graphemic route. Because it suggests that a phonological route can also be used the Serial Search model might be able to explain the NT results.

The Serial Search model (Forster, 1976) has both an orthographic access file for written words as well as a phonological access file for spoken words. Cognates share the same orthography but have a different phonology. The word "image" for example is pronounced very differently in English (imɪdʒ) and French (ɪma:ʒ). Therefore, it might be that bilinguals performing a LDT (including cognates from their two languages) are more easily influenced by the non-target language frequencies than during a NT where they have to pronounce the cognates. In the NT, the fact that the participants have to speak aloud the words may reinforce access to the phonological file and because cognates' phonology differs the carry over effect from one language to another may be less than during a LDT where bilinguals might rely more on the orthographic file. The results from the present experiments show that this might indeed be the case. In the LDT the LDTe participants were faster at identifying L/H cognates than L/L one, which might point at a possible interlexical effect. However, during the NT the NTe participants named the L/H cognates as fast as the L/L ones.

PDP models such as the Interactive Activation model or Seidenberg and McClelland's PDP model explain the word frequency effect by the strength of the connection between nodes. The more a word is encountered, the stronger its connections and the faster it will be subsequently recognized. If the two languages of a bilingual are

separately stored then the question becomes whether or not a cognates can activate potential candidates in both languages. However, if cognates can indeed activate candidates in both languages a problem arises when the word frequency effect is taken into account. As the word frequency effect is explained by connective strength then cognate recognition should always result in the cognate with the highest frequency being selected regardless of the language. For example, when presented with the cognate "obscure" (L/H), NTe participants should have recognized the French word faster than the English word. However, this does not seem to be the case since the recording of the NTe utterances shows that the participants pronounced the L/H cognates as English words.

According to the Dual-route model, word recognition uses either a graphemic path (lexical) or a phonological one (sublexical). As described earlier, the lexical path is generally faster because the phonological route calls upon an additional stage in which the graphemic structure is translated into a phonological one. In Coltheart's model the route used is a function of the type of stimulus encountered: regular words will follow an orthographic path whereas irregular words will follow grapheme-phoneme conversion rules. In the present experiment the NT may force the use of a spelling-to-sound strategy. As was discussed earlier, such strategy might in turn prevent interlingual interference as language specific pronunciation may direct the search in one language only. The same is true of Paap's dual-route model which proposes a horse-race analogy to the dual-route model; because participants in a NT have to speak aloud the stimuli it may be that the race is biased in favor of the phonological route from the start.

Monolingual lexical models, for obvious reasons, are very limited in explaining the performance of bilinguals in LDTs and NTs. I will now turn to bilingual lexical models to see how they might account for the results obtained in Experiment 1 and 2.

Bilingual lexical models

Based on monolingual lexical models, bilingual models of lexical organization describe the relationship (or lack of it) between two languages' representational systems. I will review some of the models defined earlier in order to interpret the experiments' results. Yet, one should keep in mind that the purpose of the present experiments was not to prove the existence of a single or dual-lexicon system in bilinguals but rather to explore the possibility of an interlexical frequency effect. Moreover, most bilingual models (with the exception of the BIA and the BAV) deal with the semantic liaisons between the two languages but do not describe the word recognition processes itself. I will therefore only briefly review some bilingual models and focus on the BIA and the BAV.

Because they do not suppose links between languages, dual-code models cannot readily account for the effect found in Experiment 1. The language-selective hypothesis, for example, posit that certain cues (e.g., accents) will lead the word recognition process to one language rather than another. Because cognates minimize these cues they might activate both languages. However, even if two languages are activated it does not necessarily imply that they can interact.

The Word Association model can account for the LDT results as it postulates that comprehension of L2 is mediated by L1. Again, even though this model deals with the meaning of the words it can be hypothesized that a low frequency word in L2 would benefit in terms of speed of recognition from its mediation through L1 when it is a high frequency word in the latter language. Results supporting this view were found in Experiment 1 as LDTf participants classified H/L cognates faster than L/L cognates. However, when performing a LDT in L1 bilinguals should not benefit from the frequency of words in L2. Experiment 1 does not back this assumption as LDTe participants categorized L/H cognates faster than L/L cognates.

Both the BIA and the BAV models rely on contextual information to direct the search to the relevant language. In the case of the BAV, context will guide the search to the appropriate language list of candidates. For the BIA, context will activate the language node which will in turn facilitate similar language links while inhibiting the other language links.

The results obtained in Experiment 1 point to the fact that the high frequency of cognates in one language can facilitate their categorization in the other language in which they are low frequency. The problem with the BAV is that the frequency effect is supposed to take place after the activation of the appropriate language. This is why Grainger (1993) proposes an accommodation to the BAV when he considered the effect of ND between two languages. As with cognates and frequency, words in one language can have varying number of neighbors attached to them in each language. Grainger defines three such cases: patriots (more neighbors in their own language), neutral words (equal number of neighbors in each language), and traitors (more neighbors in the other language). To account for the ND effect across languages Grainger proposed that verification be "initiated as a function of the relative activation levels in each lexicon" (Grainger, 1993, p. 21). Grainger then expects that traitors would be recognized more slowly than patriots as verification would first start with the non-target language. A similar stand could be taken with frequency and cognates in which verification would begin in the language in which the cognate would have the higher frequency. However, if this is the case then bilinguals should always recognize cognates as words from the language in which they have the higher frequency, a position that is not upheld by the results and noted in the previous section. Specifically, it is possible that during the LDT the LDTe participants effectively responded to the L/H cognates as if they were French words. In this case there is no need of interlexical interference to explain the results obtained with the LDT; The participants merely classify

the cognates in the language with the highest frequency. The reason the NT did not demonstrated the same results as the LDT might be explained by the fact that speaking aloud each cognate reinforced the use of only one language. Yet, when the post-experimental questionnaire is taken into account it appears that as many NT participants than LDT participants could report that the experiment contained non-congruent words (61% of the control groups, 100% of the English groups). The same problem arises when the BIA is altered to account for the effect of ND. Here the language with more nodes activated (i.e., with the more neighbors activated) would in turn activate more corresponding language nodes while inhibiting the other language. If this theory is applied to the word frequency effect, then once again cognates should always be recognized as words from the language in which they have the highest frequency. As the present experiment did not directly test for these hypotheses the preceding remarks are to be taken more as conjectures rather than deductions.

Future work

The present experiment examined the effect of L2 experience on L1 word recognition. However, in priming experiments the effects of L2 on L1 are not as important as the effects of L1 on L2 (Altarribam, 1991, cited in Kroll, 1991). Therefore, extensions of the present experiments should look more closely at the effect of L1 on L2 by testing more thoroughly the bilingual participants for their reading skills as well as to find a reliable control group with very little knowledge of English. Thus, to fully investigate the interaction between English and French one should look at the effect of French (L2) on English (L1), as was done in the present experiment, but also at the effects of English (L2) on French (L1).

One way to verify that the differences between the participants' performances on the LDT compared to the NT are due to a difference in what type of information is processed

would be to make the LDT more similar to the NT. According to Hino and Lupker (1996) using degraded stimuli can make the discrimination of words and nonwords using orthographic information harder. If the stimuli are degraded the participants might have to rely more heavily on phonological information, making the LDT more similar to the NT. Replicating the present experiment using degraded stimuli in the LDT might therefore be helpful to determine which kind of information, orthographic or phonological, that the participants relied on in each task.

Hino and Lupker (1996) also found that controlling for frequency by using counts from printed text does not necessarily correspond to using a familiarity rating which would be more true to an "everyday experience" of frequency (p. 1333). Testing for familiarity would also prevent the inclusion of stimuli totally unknown to most of the participants (such as the cognate "cession" in this experiment).

Conclusion

In conclusion, Experiment 1 presents some support for the idea that word characteristics such as frequency can have inter-language effects. However, because of the lack of similar results with the NT it may be that task specific processes mediate the effect of the inter-language word frequency effect. It also remains to be seen if the effect found for the control group in Experiment 1 can be attenuated by recruiting more appropriate monolingual participants.

	Experiment 1 Lexical decision task			Experiment 2 Naming task		
	English	French	Control	English	French	Control
Mean age	19.3	20.9	21.4	20	21	19.9
Age SD	1.63	3.46	3.77	3.11	5.19	1.96
Male/female	5/13	7/11	12/6	7/11	7/11	8/10
% right handed	72.2	94.4	100	NA	NA	NA
Subject mortality	2	6	7	4	2	7

Each cell based on 18 participants (i.e., the means and SD do not include the participants who were discarded).

Table 1: Participants' Summary Descriptive Statistics.

	Average Number of Letters	Average English Neighborhood Density	Average French Neighborhood Density	Average English Number of Meanings	Average French Number of Meanings
H/H	6.61 (1.77)	5.33 (8.89)	1.50 (2.93)	6.61 (1.77)	5.50 (3.67)
H/L	6.83 (1.95)	3.22 (3.95)	0.44 (0.90)	7.27 (7.58)	2.44 (2.67)
L/H	6.33 (1.41)	3.67 (5.69)	0.50 (1.01)	2.00 (1.50)	6.94 (4.73)
L/L	6.89 (1.59)	2.50 (3.35)	0.83 (1.01)	1.67 (1.29)	2.33 (1.25)

Each cell based on 18 participants (i.e., the means and SD do not include the participants who were discarded).

Table 2: Stimuli Descriptive Statistics by condition (standard deviations between parentheses).

		English Frequency	
		High	Low
French Frequency	High	147.00 (71.03)	5.77 (4.16)
	Low	162.38 (91.56)	4.77 (3.94)

Based on a corpus of 1,014,232 words.

		English Frequency	
		High	Low
French Frequency	High	16974.66 (15570)	12593.44 (14987)
	Low	197.55 (147.27)	216.94 (141.73)

Based on a corpus of 23,505,451 words.

Table 3: Mean Stimuli Frequencies (standard deviations between brackets).

Top panel - English Frequency

Bottom panel - French frequency

	LDTc	LDTe	LDTf *
Nonwords vs. Cognates	Cognates responded to faster than nonwords.	Cognates responded to faster than nonwords.	Cognates responded to faster than nonwords.
H/H & H/L vs. L/H & L/L	H/H & H/L responded to faster than L/H & L/L	H/H & H/L responded to faster than L/H & L/L	H/H & L/H responded to faster than H/L & L/L
H/H vs. H/L	No difference between H/H and H/L	No difference between H/H and H/L	No difference between H/H and L/H
L/H vs. L/L	L/H responded to faster than L/L	L/H responded to faster than L/L	H/L responded to faster than L/L

	NTc	NTe	NTf *
Nonwords vs. Cognates	Cognates responded to faster than nonwords.	Cognates responded to faster than nonwords.	Cognates responded to faster than nonwords.
H/H & H/L vs. L/H & L/L	H/H & H/L responded to faster than L/H & L/L	H/H & H/L responded to faster than L/H & L/L	H/H & L/H responded to faster than H/L & L/L
H/H vs. H/L	No difference between H/H and H/L	No difference between H/H and H/L	No difference between H/H and L/H
L/H vs. L/L	No difference between L/H and L/L	No difference between L/H and L/L	No difference between H/L and L/L

▲ = Results predicted by the hypotheses.

◻ = Results opposite to hypotheses.

* = For the LDTf and the NTf groups the H/L and L/H conditions are inverted.

Table 4: Summary Results
Top panel - LDT
Bottom panel - NT

Figure 1: The Bilingual Activation Verification (BAV) model (top) and the Bilingual Interactive Activation (BIA) model (bottom)(Grainger, 1993, p. 18-20).

Figure 2: Cognates log frequencies.

Figure 3: Average score on the bilingualism questionnaire.

Top panel - LDT

Bottom panel - NT

Figure 4: Percent error.

Top panel - LDT

Bottom panel - NT

Figure 5: Cognates vs. Nonwords average median RT for correct responses.

Top panel - LDT

Bottom panel - NT

Figure 6: Average median RT for correct responses as a Function of Condition.

Top panel - LDT

Bottom panel - NT

Figure 7: Effect of English frequency.

Top panel - LDT

Bottom panel - NT

Figure 8: Effect of French frequency.

Top panel - LDT

Bottom panel - NT

Figure 9: Control group versus English group as a function of condition.

Top panel - LDT

Bottom panel - NT

Figure 10: RT median split.
Top panel - LDT
Bottom panel - NT

Figure 11: LDT bilingualism median split.

Top panel - more bilingual / more monolingual

Bottom panel - less bilingual / less monolingual

Figure 12: NT bilingualism median split.

Top panel - more bilingual / more monolingual

Bottom panel - less bilingual / less monolingual

Appendix A

Cognates

H/H	H/L	L/H	L/L
attention	business	accent	amoral
base	cession*	banal*	cargo
close*	corporation	boutique	catalogue
concept	district	brutal	chrome
condition	fédéral	champ*	coma
conférence	fiscal	chef	dynamo
front	jazz	cinéma	guttural*
hôtel	manager	confuse	illégal
image	meeting	critique	indolent
justice	performance	dîner	jovial*
moment	plant*	disciple	malaria
opinion	présent	esprit	migration
question	radiation	immobile	narration
race	record	milieu	nomination
service	round	obscure	outrage
situation	short	offensive	pastel
source	staff	regret	pétition
train	stage	robe	potion
trouble*	stand	trait	purge
volume	western	unité	turban

* Cognates dropped from the statistical analysis. Accents were used only in the NTf and LDTF groups.

Appendix B

Nonwords

affuntion	ajarol	asment	balion
baso	bilema*	bozz	bramp
canpution*	chouble	clatal	cloin
cluve	comperance*	danol	derlarmance
dervide	destol	dodent	domule
duniness	elsrit	fland	flont*
flort*	fobe	fobiul	frouf
fuleram	fysavo	gudration	hadel
illapile	invelant*	ippernal	irage
larno	lonfupe	lorge	lource
maporia	mesdern	mituasion	modiolion*
mustice	mustrict	nessoun	olscupe
oppendime	ouslage	ovidion	palager
parcoration	plitique	prail*	rabe
rancept	rouff	roustion	rubron
rullumal	scoge	stedent	talamogue
tecord	tedition*	terlet	thrume
tiscol	toda	tonilation	toulique
toutang	tref	udibe	valletion
vinor	viscidle	zlaff	zolieu

* Nonwords dropped from the statistical analysis.

Appendix C

The following questionnaire is aimed at evaluating your knowledge of the French language. Please remember that all data collected will be coded for confidentiality (i.e., your name will NOT appear on these sheet or on the computer data files).

Participant number: _____

PART 1

This first set of question relates to your personal experience with French (schooling, trips...). Please answer all questions carefully.

- Do you speak any other language than English? (if yes, please specify): _____
_____
- Have you ever had a hearing, reading, or speech disorder? (if yes, please specify): _____
_____
- At what age did you begin to learn French?: _____
- Did you learn French in a formal school setting or other? (If "other", please briefly explain): _____
_____
- What is your mother tongue? _____
- How intensive was your French instruction?
 ___ immersion   ___ several hours/day   ___ 1 hr/day   ___ several times a week
- Please indicate the focus of your French instruction (by estimating the percentage of time spent on each items, e.g., 50%/50%):
  - a) Written and spoken language: _____ % and _____ %
  - b) Comprehension and production: _____ % and _____ %
- For how long have you been living in Canada? _____
- Would you label your French as "Québécois" French ___ or as French "from France" ___

- How often do you currently speak or hear French?
 ___ once a month   ___ once a week   ___ once a day   ___ several times a day
- For how long have you been speaking French? _____
- Do you watch French television? (if yes, please estimate how many hours per day or week): _____
- Do you read French books (if yes, please estimate how many per months or year): _____
- Have you ever lived in a Francophone region/country? (if yes, please specify): _____
- Do other members of your family speak French? (if yes, please specify): _____

PART 2

This questionnaire is designed to assess your proficiency in French. Please answer ALL questions. Read each statement carefully. Even though you might never have been in some of the situations described below, try to imagine how well you think you could do. Please circle only ONE answer.

- I can follow dialogues in a French film with no subtitles.

1.....I can do this perfectly	4.....I can do this, but not always well
2.....I can do this well	5.....I can do this, but poorly
3.....I can do this reasonably well	6.....I cannot do this at all
- I can understand puns, sarcasm or irony in French.

1.....I can do this perfectly	4.....I can do this, but not always well
2.....I can do this well	5.....I can do this, but poorly
3.....I can do this reasonably well	6.....I cannot do this at all
- I understand most of the lyrics of a French song.

1.....I can do this perfectly	4.....I can do this, but not always well
2.....I can do this well	5.....I can do this, but poorly
3.....I can do this reasonably well	6.....I cannot do this at all
- I can write a letter of employment in French.

1.....I can do this perfectly	4.....I can do this, but not always well
2.....I can do this well	5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I understand French "slang" as well as standard French.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I can express my opinions in French.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I can talk in French about the pros and cons of a subject.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I could follow a first year lecture in a French University.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I can understand French written poetry.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I can understand a research paper written in French in my field.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I can understand a novel in French.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I could work in a French-only speaking environment.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I can read French newspaper easily.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• I can write an essay in French in which I can express my opinions.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

• If I watch a discussion between two people on an interview show on French TV, I can understand all the arguments presented by each participant.

1.....I can do this perfectly

4.....I can do this, but not always well

2.....I can do this well

5.....I can do this, but poorly

3.....I can do this reasonably well

6.....I cannot do this at all

Appendix D

Informed consent form**Guideline**

The purpose of an informed consent is to insure that you understand the purpose of the study and the nature of your involvement. The informed consent must provide sufficient information such that you have the opportunity to determine whether you wish to participate in the study. This form must be completed prior to beginning the experiment.

Present study: Bilingual study**Research Personnel**

The following people are involved in this research project and may be contacted at any time. Adrien Pitrat (home phone number 230-0549) and Dr. John Logan (faculty sponsor, 788-2600, ext. 2690). Should you have any ethical concerns about this study please contact Dr. Lise Paquet (Chair, Department of Psychology Ethics Committee) or Dr. W. Jones (Chair, Department of Psychology, 788-2600, ext. 2648).

Purpose

The purpose of this study is to learn more about the 'mental dictionary' (also known as the lexicon) of bilinguals and non bilinguals.

Duration and locale.

The experimental session will last approximately 45 minutes. Testing will take place at the university.

Potential risk / discomfort.

There are no potential physical or psychological risks in this experiment.

Anonymity / Confidentiality

The data collected in this experiment are confidential. All data are coded such that your name is not associated with the data. The coded data are made available only to the researchers associated with this project.

Right to withdraw

You may refuse to participate at any time during the course of the experiment and will be immediately excused.

I have read the above description of the 'Lexicon study' study and understand the conditions of the participation. My signature indicates that I agree to participate in the experiment.

Participant's name: _____

Researcher name: Adrien Pitrat

Researcher signature: _____ Date: _____

Appendix E

Debriefing

The purpose of this study was to examine the nature of the 'mental dictionary' (or lexicon) in bilinguals. A lot of research has already been performed on the lexicon of monolinguals. However, the bilingual lexicon offers some unique and intriguing problems for investigation. The goal of the experiment that you just took part in was to investigate the way words in French and English lexicons are linked. Are words in the bilingual lexicon linked through a non linguistic representation or are they directly linked? Can characteristics of words in one language influence the recognition of words in the second language?

In order to investigate this question I used cognates. Cognates are words that are written the same way in both languages and that have the same meaning (e.g., "table" in French and English). What I manipulated was the frequency of these words. It has been known for a long time that words that appear more frequently in our language (i.e., high-frequency words) are recognized faster than words that appear rarely (i.e., low-frequency words). If words are linked between lexicons of different languages then characteristics of similar words (such as frequency) might have an additional effect if the words are similar (cognates). The hypothesis of the experiment are graphed below. As you can see, the main hypothesis is that cognates that have low frequency in one language and a high frequency in the other language should be recognized faster than cognates that have a low frequency in both languages. As an example, a bilingual person should recognize the English word "regret" faster than "coma" as the former has a high frequency French (but a low one in English) whereas the latter has a low frequency in both languages.

If you have any comments about this research, then please feel free to contact Adrien Pitrat (home phone number 230-0549) or Dr. John Logan (faculty sponsor, 788-2600, ext. 2690). Should you have any ethical concerns about this study please contact Dr. Lise Paquet (Chair, Department of Psychology Ethics Committee, 788-2600, ext.2692) or Dr. W. Jones (Chair, Department of Psychology, 788-2600, ext. 2648).

References

- Balota, D. A., & Chumbley, J. I. (1984). Are lexical decisions a good measure of lexical access? The role of word frequency in the neglected decision stage. Journal of Experimental Psychology: Human Perception and Performance, 10, 340-357.
- Becker, C. A. (1976). Allocation of attention during visual word recognition. Journal of Experimental Psychology: Human Perception and Performance, 2, 556-566.
- Becker, C. A. (1979). Semantic context and word frequency effects in visual word recognition. Journal of Experimental Psychology: Human Perception and Performance, 5, 252-259.
- Becker, C. A., & Killion, T. H. (1977). Interaction of visual and cognitive effects in word recognition. Journal of Experimental Psychology: Human Perception and Performance, 3, 389-401.
- Caramazza, A., & Brones, I. (1979). Lexical access in bilinguals. Bulletin of the Psychonomic Society, 13, 212-214.
- Chen, H., & Ho, C. (1986). Development of Stroop interference in Chinese-English bilinguals. Journal of Experimental Psychology: Learning, Memory, and Cognition, 12, 397-401.
- Cohen, D. J., & MacWhinney, B. (1994). Psyscope [Computer program]. Carnegie Mellon University, Department of Psychology (version 1.0.2b4).
- Content, A., Moutsy, P., & Radeau, M. (1990a). Brulex: Une base de données lexicales informatisée pour le français écrit et parlé. L'Année Psychologique, 90, 551-566.
- Content, A., Moutsy, P., & Radeau, M. (1990b). Brulex [machine readable data

- file]. Content, A., Moutsy, P., & Radeau, M.: Université Libre de Bruxelles, Laboratoire de Psychologie Expérimentale (Producer and Distributor).
- Crystal, D. (1987). The Cambridge encyclopedia of language. Cambridge University Press. Cambridge.
- De Groot, A. M. B. (1993). Word-type effects in bilingual processing tasks. In Schreuder, R., & Weltens, B. (Eds.), The Bilingual Lexicon. Amsterdam: John Benjamins Publishing Co.
- Durgunoglu, A. Y., & Roediger, H. L. (1987). Test differences in accessing bilingual memory. Journal of Memory and Language, 26, 377-391.
- Forster, K. I. (1976). Accessing the mental lexicon. In R. J. Wales & E. Walkers (Eds.), New approaches to language mechanisms (pp. 257-287).
- Gerard, L. D., & Scarborough, D. L. (1989). Language specific lexical access of homographs by bilinguals. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 305-315.
- Grainger, J. (1993). Visual word recognition in bilinguals. In Schreuder, R., & Weltens, B. (Eds.), The Bilingual Lexicon. Amsterdam: John Benjamins Publishing Co.
- Hino, Y., & Lupker, S. J. (1996). Effects of polysemy in lexical decision and naming: An alternative to lexical access accounts. Journal of Experimental Psychology: Human Perception and Performance, 22, 1331-1356.
- Hornby, A. S., Cowie, A. P., & Gimson, A. C. (Eds.). (1985). Oxford advanced learner's dictionary of current English. Oxford: University Press.
- Imbs, P. (1971). Etudes statistiques sur le vocabulaire français. Dictionnaire des fréquences. Vocabulaire littéraire des XIXe et XXe siècles. Centre de Recherche pour un Trésor de la Langue française (CNRS), Paris: Librairie

Marcel-Didier.

- Kroll, J. F. (1993). Accessing conceptual representations for words in a second language. In Schreuder, R., & Weltens, B. (Eds.), The Bilingual Lexicon. Amsterdam: John Benjamins Publishing Co.
- Kučera, H., & Francis, W. N. (1967). Computational analysis of present-day american english (2nd ed.). Providence, Rhode Island: Brown University Press.
- Macnamara, J. (1967). The linguistic independence of bilinguals. Journal of Verbal Learning and Verbal Behavior, 6, 729-736.
- Macnamara, J., & Kushnir, S. L. (1971). Linguistic independence of bilinguals: The input switch. Journal of Verbal Learning and Verbal Behavior, 10, 480-487.
- Mägiste, E. (1984). Stroop tasks and dichotic translation: The development of interference patterns in bilinguals. Journal of Experimental Psychology: Learning, Memory, and Cognition, 10, 304-315.
- Marslen-Wilson, W. D. (Eds.). (1992). Lexical representation and process. Bradford Book: Cambridge, Massachusetts.
- McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. Psychological Review, 88, 357-407.
- Morton, J. (1969). Interaction of information in word recognition. Psychological Review, 76, 165-178.
- O'Connor, R. E. & Forster, K. I. (1981). Criterion bias and search sequences bias in word recognition. Memory and Cognition, 9, 78-92.
- Oldfield, R. C. (1966). Things, words and the brain. Quarterly Journal of Experimental Psychology, 18, 340-353.

- Paap, K. R., Newsome, S. L., McDonald, J. E., & Schvaneveldt, R. W. (1982). An Activation-Verification model for letter and word recognition: The word superiority effect. Psychological Review, 89, 573-594.
- Paap, K. R., & Noel, R. W. (1991). Dual-route models of print to sound: Still a good horse race. Psychological Research, 53, 13-24.
- Papaioannou, C., & Padilla, A. M. (1982). Bilingual memory of Greek-English bilinguals. Psychological Reports, 50, 1047-1054.
- Petit Robert. (1972). Paris: Société du Nouveau Littré.
- Preston, M. S., & Lambert, W. E. (1969). Interlingual interference in a bilingual version of the Stroop color word task. Journal of Verbal Learning and Verbal Behavior, 8, 295-301.
- Rubenstein, H., Garfield, L., & Milikan, J. A. (1970). Homographic entries in the internal lexicon. Journal of Verbal Learning and Verbal Behavior, 9, 487-494.
- Rubenstein, H., Lewis, S. S., & Rubenstein, M. A. (1971). Evidence for phonemic recoding in visual word recognition. Journal of Verbal Learning and Verbal Behavior, 10, 645-657.
- Schwanenflugel, P. J., & Rey, M. (1986). Interlingual semantic facilitation: Evidence for a common representation system in the bilingual lexicon. Journal of Memory and Language, 25, 605-618.
- Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming. Psychological Review, 96, 523-568.
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 18, 643-662.
- Taft, M. (1991). Reading and the mental lexicon. Hillsdale: Laurence Erlbaum Associates.

Tzelgov, J., Henik, A., & Leiser, D. (1990). Controlling Stroop interference: Evidence from a bilingual task. Journal of Experimental Psychology: Learning, Memory, and Cognition, 16, 760-771.

IMAGE EVALUATION TEST TARGET (QA-3)

APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989

© 1993, Applied Image, Inc., All Rights Reserved