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Bilingual Lexical Organization in Compound vs. Subordinate Normal Subjects: An Examination of the Processing of Cognates vs. Noncognates

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Abstract

The present study investigated bilingual lexical organization in two groups of French-English bilinguals: 1) Compound bilinguals, who acquired both languages in early childhood and speak both with high proficiency; and 2) Subordinate bilinguals, who started speaking their second language during or after adolescence and have reduced L2 proficiency. Subjects were tested on a cross-language auditory primed lexical decision task containing translations and associated words with both cognate and noncognate equivalents. Both subject groups demonstrated significant translation and associative priming, indicating that both groups of subjects had access to a conceptual route of processing. However, no significant facilitation was found for cognates over noncognates in the auditory modality, contrary to previous studies using visual presentation. A general model of compound bilingual lexical organization is derived, and the results are discussed in terms of their implications for second language acquisition.

Résumé

La présente étude a pour but d'examiner l'organization du lexique bilingue chez deux groupes de personnes bilingues (Français-Anglais): 1) des bilingues qui ont acquis les deux langues pendant la petite enfance et qui ont une forte compétence linguistique dans les deux langues; et 2) des bilingues qui ont commencé à parler L2 pendant ou après l'adolescence et qui démontrent une compétence linguistique plus faible en L2. Lors d'une épreuve auditive de décision lexicale avec amorçage contenant des mots traduits et associés (avec équivalents phonologiquement semblables et non-semblables), les deux groupes de bilingues démontrent des effets d'amorçage de traduction et d'association significatifs, indiquant que les deux groupes ont accès à la route conceptuelle. Cependant, aucun amorçage n'a été découvert pour les mots phonologiquement semblables, contrairement à ce qui est rapporté dans les études utilisant une présentation visuelle. Un modèle plus général d'organization lexicale bilingue est présenté, et les résultats sont discutés selon leurs implications pour l'apprentissage d'une langue seconde.

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For centuries, the phenomenon of bilingualism has intrigued philosophers, educators, psychologists, and neurologists alike. With the relatively recent birth of psycholinguistics, new models and methods of studying bilingualism have been developed which now provide great insight into the bilingual brain. Studies of bilingual language processing shed much light not only on the structure and function of the bilingual language system, but also offer researchers the opportunity to study the various components of language from a different perspective than is usually offered by the unilingual brain. One issue in bilingual language research which has probably attracted the most attention in recent years is that of the representation and organization of two languages in one brain. The main question which arises is whether languages are represented together in the linguistic system, in some kind of a common store, or whether they are organized in separate, independent systems. Another important issue in the bilingual literature is that of second language acquisition: is second language learning like first language learning? Would we expect that different factors in second language learning--such as age, manner and context of acquisition--might also affect the representation and organization of languages, resulting in different bilingual "types"? The present study examines the relationship

between second language acquisition factors and the organization of languages in the bilingual linguistic system. In particular, we have chosen to study the bilingual lexical system, as lexical items are the building blocks of meaningful communication in all languages.

Evidence of Language Organization from Aphasia/Neuroanatomical Studies

For the most part, when a bilingual suffers brain damage which affects language functioning (aphasia), the effects are more or less equally distributed over both languages. Yet many cases of differential impairment and recovery in bilingual and polyglot aphasia have been documented over the past century where each of a patient's languages is affected to different degrees (e.g. Pitres, 1895; Lambert & Fillenbaum, 1959; Watamori & Sasanuma, 1978; Silverberg & Gordon, 1979; Paradis, Goldblum, & Abidi, 1982; Nilipour & Ashayeri, 1989; Junqué, Vendrell, Vendrell-Brucet & Tobeña, 1989; Gomez-Tortosa, Martin, Gaviria, Charbel, & Ausman, 1995; see Paradis, 1983 for a compilation of reports from 1843 to 1975). Paradis (1977) has studied case reports of bilingual aphasia and describes these effects in terms of five basic patterns of differential recovery: *synergistic* (equally corresponding progress in each language), *antagonistic* (progress in one language while the other regresses), *successive* (progress first in one language, then the other), *mixed* (use of the two languages simultaneously), and *selective* (one language recovers more than the other). The phenomenon of differential recovery

generates much discussion as to the nature of the organization of the normal bilingual's underlying representational system, as it would appear that there are two distinct systems in operation under these circumstances. Yet this explanation does not account for the normal bilingual's ability to translate with ease, as it should prove difficult to pass from one system to the other and find the appropriate corresponding representation. If languages are stored separately, how does a bilingual know which language to expect to hear? On the other hand, if the languages were not stored separately, how would it be possible for a bilingual to function in a monolingual mode without constant interference from the other language? Paradis (1983) has described the following possibilities when considering bilingual lexical organization: 1) a dual system in which there are two separately represented linguistic systems; 2) a common, extended allomorphic system which functions by the use of rules; or 3) a tripartite system in which identical items are represented only once, while others are represented separately, within their own language base. Support for each of these possibilities has come not only from studies of differential recovery in aphasia, but also from clinical neuroanatomical studies. Consistent with the phenomenon of differential recovery in aphasia which supports the hypothesis of a dual system, Berthier et al. (1990) recently found that injection of sodium Amytal into the left middle cerebral artery territory of the brain (language area) in a bilingual resulted in speech arrest, followed by recovery of one language before the

other. Paradis (1983) argues that our ability to borrow structures from one language and to incorporate them into the other (e.g. phonology, lexical items, phrases, syntax) would indicate the possibility of a common, extended system. Cases of language mixing in bilingual aphasia might also support the existence of such a common system. Evidence for the tripartite system comes from cortical stimulation studies (e.g. Ojemann & Whitaker, 1978; Rapport, Tan & Whitaker, 1983) that have demonstrated alterations in language performance when certain cortical areas are stimulated electrically. Stimulation of some sites in the left hemisphere affects both languages equally, while other sites show language-specificity.

Despite this evidence from clinical and neuroanatomical studies, Paradis (1980) cautions that we must make the distinction between neural substrates in the brain and the linguistic system itself; a one-to-one correspondence between neuroanatomical organization and structure of the linguistic system does not necessarily exist. This differentiation between functional anatomy and the psycholinguistic processing system has been discussed in the monolingual literature on linguistic representation by researchers in the field of aphasia. Studies of aphasia and lesion sites in monolinguals have revealed that language can be represented differently across individuals, that there is not always a correlation between lesion site and aphasia "syndromes" (e.g. Basso et al., 1985), suggesting that the representation of the various components of language in the brain is *not*

invariant. This finding can easily be extended to our discussion of bilingual representation, and for this reason we favor the *psycholinguistic* approach in our inquiry into the organization of the bilingual lexico-semantic system.

Priming: A Tool to Investigate Lexical Organization

It has been demonstrated in the monolingual literature that word recognition can be facilitated, or speeded, when preceded by a semantically related or associated word prime, an effect which has been replicated many times and which has been attributed to spreading activation in semantic memory (Meyer & Schvaneveldt, 1971; Collins & Loftus, 1975). The organization of semantic memory may be conceived as a network of nodes in which the activation of a node automatically "spreads excitation" to surrounding nodes. Thus, when a prime "excites" a node in semantic memory, a related target is recognized more quickly since it is contained in a neighbouring node which has already been activated. It has also been posited that these nodes are organized, or "localized" in terms of "typicality" (Collins & Quillian, 1969) or "relatedness" (Collins & Loftus, 1975), and that it takes time for activation to spread from one node to the next. It would follow that items closer to the prime in "relatedness" would be recognized more quickly than those further away. This assumption that "time is distance"[1] underlies

[1] The term "distance" in this case refers to the degree of semantic relatedness, and not physical distance within the brain.

these studies, allowing interpretation of differences in reaction times as a window on lexical organization.

Studies of repetition priming have also been used to examine lexical organization. In monolinguals, it has been demonstrated that recognition of a word is greatly facilitated when it is presented a second time, either immediately, across trials, or even across days (Scarborough, Gerard & Cortese, 1979). Humphreys, Quinlan and Besner (1988) noted that their subjects showed large qualitative and quantitative differences in repetition effects depending on whether they occurred within or across a "perceptual event" (trial). When Dannenbring and Briand (1982) compared repetition effects and semantic priming effects in a lexical decision task in monolinguals, they determined that repetition effects were very strong and persistent, while semantic priming effects proved much more transient. The exact nature of the repetition priming effect is still under examination, but the lack of effects under certain masking conditions and across modalities suggests that it may be perceptually based, that is, dependent upon the shared acoustic or visual properties of repeated stimuli (Scarborough et al., 1979; Kirsner et al., 1980; Humphreys et al., 1988).

Automatic and Controlled Processes in Priming Tasks

A distinction has been drawn in the literature between conscious (or controlled) and automatic processes. Within a model of human information

processing, *controlled* processes have been defined as those which are highly demanding of attention, and are easily established and altered by the subject through conscious effort (Shiffrin & Schneider, 1977; Neely, 1977). These conscious processes result in a "controlled search", usually very slow and limited in capacity, or load. On the other hand, *automatic* processes have been defined as those which operate in long-term memory, and are difficult to alter or suppress consciously by the subject. Unlike conscious processes, automatic processes are not affected by load, and are usually very fast-acting. Priming experiments generally seek to attribute effects to *spreading activation*, an automatic process. Conscious attentional processes have been documented to exhibit very different effects--both in quantity (size of effect) and in quality (type of stimuli to which they are sensitive)--from those resulting from automatic processing (Shiffrin & Schneider, 1977; Neely, 1977).

Conscious effects must be controlled in order to prevent interference with the automatic processes under examination when studying lexical organization. It has been demonstrated that automatic processes are fleeting compared to attention-demanding processes, so they can usually be isolated in a lexical decision task by using very short stimulus onset asynchronies (SOAs) of approximately 250 ms (Neely, 1977).

Models of Bilingual Lexical Representation

We will now turn our discussion to models of bilingual lexical

organization. Two main schools of thought are represented in the literature: 1) those who support a hypothesis that lexical items of each language are stored *separately* in linguistic memory, in a *language-specific* manner, much like Paradis' (1983) aforementioned dual code system; and 2) those who support the hypothesis that items of both languages are represented in one *common , language-independent* lexicon for all items, consistent with Paradis' common extended system. The "separate storage" (Kolers, 1963) hypothesis has also been called the "linguistic independence" hypothesis, and holds that storage and lexical access occur separately, in two language-specific lexical systems. Based on reports that bilinguals occasionally had difficulty comprehending a language they were not expecting to hear, a monitor theory of processing was proposed in which the appropriate language is "activated" by means of an input "switch" mechanism (Obler & Albert, 1978); this monitor system thus allows performance in one language without interference from the other. According to this hypothesis, it should take more time for a bilingual to process language when he/she functions in a bilingual language mode than in a monolingual mode, as this would require activation of the switch from one language to the other. The results of a phoneme-triggered lexical decision task by Soares & Grosjean (1984) support this notion. When bilingual and monolingual subjects were asked to listen for a particular phoneme in a sentence and make a lexical decision (*word/nonword*) about the word beginning with that phoneme in the

sentence, nonword reaction times (RTs) were significantly slower for bilinguals than for monolinguals when the target word was presented in the same language as its carrier sentence. The authors interpreted this result as evidence that the bilingual searches both lexical systems before terminating the search, whereas the monolingual searches only one. Furthermore, bilinguals had slower reaction times for code-switched targets than for monolingual targets, supporting the notion that the code-switch process is time consuming, in travelling from one system to the other (see also Macnamara & Kushnir, 1971). Independence of the two lexical systems may also be demonstrated when there is no interference or transfer of learning from one language to the other. Scarborough, Gerard and Cortese (1984; Expt 2) noted that when asked to make lexical decisions about words in one language, bilingual subjects processed words from the other language in the same manner as nonwords, suggesting that there was no interference between languages. When Kolers (1964) asked bilingual subjects to practise saying the alphabet backwards in one language, he noted that learning did not transfer from one language to the other, suggesting that perhaps each of the processes of encoding and storage is language-dependent. In an interlingual word association task, Kolers (1963) asked subjects to write down the first word that came to mind besides the stimulus or its translation. When he compared the two lists of responses for each of the language conditions, he found that only about one-third of responses were actually

translations of each other, even though the same stimulus (translated) had been used for both word association tasks. He interpreted this as evidence that the "experiences and memories", or concepts, that are linked to words are represented in a language-specific manner.

Similarly, the separate stores model is supported whenever facilitation is obtained in a unilingual (within-language) task, and this facilitation is significantly diminished or disappears altogether when the task is performed across languages. Grainger and Beauvillain (1988) found greater associative priming within than between languages in a lexical decision task at a long SOA (750 ms) and no associative priming effect at all across languages when a short SOA (150 ms) was employed to assess automatic processing. Similarly, Costermans and Galland (1980) found that bilinguals had slower latencies when naming pictures in a semantic priming task across languages than within (primes were words accompanied by pictures), and that the facilitation effect obtained across languages was significantly reduced to the point that it was barely existent.

Greater within-language than cross-language facilitation has also been found in "repetition" priming studies (Kirsner, Brown, Abrol, Chadha and Sharma, 1980; Kirsner, Smith, Lockhart, King and Jain, 1984; Scarborough, Gerard and Cortese, 1984). In each of these studies, subjects were presented words in one task, then in a later lexical decision task were tested for word recognition of exact repetitions and translations (cross-language

"repetitions"). Although bilingual subjects in all studies showed facilitation for within-language (exact) repetitions, very little or no facilitation was found for translation equivalents (cross-language "repetitions") of these words. In a brief literature review, Kirsner (1986) explained that, contrary to monolingual repetition studies, the trend in bilingual translation and monolingual synonym experiments was that so-called "repetition" effects were highly transient, effective only after one or two trials; this may have been in large part responsible for the limited effects of the studies mentioned above in which translations or synonyms were separated for the entire duration of the first task until they were repeated in the second task. As previously discussed, the "repetition" effect as described in the monolingual literature is believed to be mainly related to perceptual or lexical form-based processing (Scarborough, Gerard, & Cortese, 1979; Humphries, Quinlan & Besner, 1988); however, some researchers have generalized the application of this term to bilingual research, perhaps somewhat inappropriately, calling translations "cross-language repetitions". In fact, translations may be repetitions in meaning, but not necessarily in form. As such, any cross-language "repetition priming" of this type is most likely due to the semantic relationship between the words, and not perceptual or form-based features as in monolingual repetition priming. Since *semantic* priming effects--contrary to long-lasting *repetition* priming effects--have been found to be highly transient in monolinguals (Dannenbring & Briand, 1982, as

previously discussed), we would not expect semantically-based translation or synonym priming to occur at long lags. Moreover, the absence of such effects across languages counterindicates the presence of repetition, or perceptually-based processing mechanisms, as we would expect effects at long lags if this were the case. The reason that "repetition" (translation) priming across languages was found to be so transient by Kirsner et al. , then, was most likely due to the semantic nature of the effect under examination. To avoid any confusion in terminology and associated connotations, we shall henceforth refer to the relationship between cross-language equivalent words as "translations" rather than "repetitions".

Probably the most highly developed model of language-specific lexical organization is the dual coding model, proposed by Paivio and Desrochers (1980). Like the separate stores model, dual coding proposes that bilinguals possess two separate verbal (lexical) systems in which words in each language are stored separately, in two monolingual networks. On the other hand, this model differentiates between two complex verbal systems on one level, containing within-language associative networks, and a nonverbal image system on the other, with connections both between verbal and conceptual ("image") systems and between translations in the two verbal systems. It is hypothesized that the connections between systems vary in number and in strength, and that translations have stronger links across languages than association links within languages as "associations between words within a

language[...]are assumed to be generally more diffuse than between translation equivalents in two languages. That is, the associative hierarchy is flatter in the within-language case" (Paivio, 1991; p. 120). The dual coding theory differs from the separate storage hypothesis in that it predicts not only strong cross-language priming between translations, but also that cross-language translation priming would be greater than within-language associative priming. This distinction has caused much confusion in the literature, as separate storage models tend to predict that cross-language effects should prove insignificant compared to within-language priming. It is problematic in that these effects across languages might more accurately be explained by shared conceptual network models wherein items more similar in meaning (e.g. translations) would result in larger effects than words that are more distant in meaning (e.g. associated words) within the bilingual associative network (Collins & Loftus, 1975; de Groot 1992a; 1992b; 1993).

We will now turn to the "common storage", or "language-interdependence" model (McCormack, 1977) of lexical organization, which has also received much support in the bilingual literature. This model holds that both of a bilingual's languages are integrated via a common, conceptual store, which operates as an associative network in which language is transparent. As opposed to the language-independence model, this model predicts that experimental effects found within a language should also be found across languages, as connections between representations are

equivalent, regardless of language. Equivalent semantic interference between and across languages has been noted in bilingual versions of tasks such as the Stroop color-word (Preston & Lambert, 1969) task, where naming of an ink color in which a color word appears is affected by a conflict in meaning (e.g. "blue" printed in yellow ink), and the flanker task, in which the semantic content of words flanked above and below the target are processed unintentionally (Guttentag, Haith, Goodman and Hauch, 1984). Caramazza and Brones (1980) found no difference in subjects' rate in naming members of semantic categories when they compared task performance within and across languages. Similarly, Lambert, Ignatow and Krauthamer (1968) observed that categorization of words by semantic category facilitated recall not only for within-language lists, but also for mixed language lists to a greater extent than did categorization by language.

Probably the most convincing evidence for language-interdependence comes from studies of cross-language semantic priming. The semantic priming effect, well established in the monolingual literature, has been replicated in cross-language lexical decision tasks containing semantically related words (e.g. Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Chen & Ng, 1989; Tzelgov & Eben-Ezra, 1992), as well as associated words (e.g. Jin, 1990; de Groot & Nas, 1991). Facilitation across languages has been found at very short SOAs (Schwanenflugel & Rey, 1986; Chen & Ng, 1989; Jin, 1990; de Groot & Nas, 1991; Tzelgov & Eben-Ezra, 1992), allowing researchers to be

fairly certain that these effects are attributable to automatic processing. Moreover, all of the studies that have compared within- and cross-language effects have found equivalent semantic facilitation for both (Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Meyer & Ruddy, 1974 as cited in de Groot & Nas, 1991; Tzelgov & Eben-Ezra, 1992), demonstrating that processing languages in a bilingual mode takes no more time than in a monolingual mode, counter to the language-independence notions of a dual system lexical search or bilingual "switch" mechanism that takes time to re-route from one language to the other. Counter to Grainger & Beauvillain's study (1988) that found weak or absent cross-language priming at a short SOA, Tzelgov & Eben Ezra (1992) have found that the between-language semantic priming effect is robust enough not only to withstand changes in SOA at short lags, but also differences in language expectation and changes in task requirements (e.g. naming vs. lexical decision).

Although a common storage model does not predict *larger* priming effects across languages than within, evidence of this pattern (which has been interpreted as support for dual coding (Paivio & Desrochers, 1980)) is not inconsistent with the interdependence model. For example, a free recall study by Paivio, Clark and Lambert (1988) found stronger recall facilitation for translations than for synonyms overall. From a common bilingual associative network perspective, we might predict that synonyms do not share as much semantic information as do translations, and hence that more

semantic priming would be found for translations than for synonyms. Translations have also been observed to facilitate recall more than synonyms in studies by Kolers and Gonzalez (1980) and Vaid (1988).

We have reviewed data which may appear at first contradictory, in that there seems to be good evidence for both the linguistic independence and interdependence hypotheses. However, it has been suggested by some (Snodgrass, 1984; Kroll & Sholl, 1992; Kroll & Stewart, 1994) that both the linguistic interdependence *and* independence hypotheses are correct, in that each reflects the organization of a different level of a hierarchical bilingual lexical system, one on a lexical level, the other on a semantic, or conceptual level. A recent study by Durgunoglu and Roediger (1987) provides compelling evidence that this may indeed be the case. A group of Spanish-English bilingual subjects performed a number of different types of lexical tasks: 1) a fragment completion task, considered to be a data-driven (lexical, or form-based) task; 2) a free recall task, considered to be a conceptually-driven (semantic) task, and 3) a word recognition task which examined both lexical and semantic study strategies. Results from the three tasks differed: performance on the fragment completion task supported linguistic independence, performance on the free recall task supported linguistic interdependence, and support for both independence and interdependence was found on the word recognition task, depending on whether processing was form-based or semantic in nature. The authors interpreted the

divergent results as indicating that each of these tasks taps a different level of processing, either lexical or semantic (see also Kintsch, 1970). The dissociation between the results of data-driven and conceptually-driven tasks demonstrates not only that different tasks tap different levels of processing, but also that there is support for both the shared and separate stores models, depending on which level of processing (lexical vs. semantic) is demanded by the task (Taylor & Taylor, 1990).

It is also important at this point to reiterate the distinction between *automatic* and *controlled* processes, which may play a role in accounting for the controversial results. Tasks such as free recall, fragment completion, translation or priming studies where prime and target are separated by long lags are not likely to reflect automatic processes as would a word recognition task in which primes and targets are separated by a small stimulus onset asynchrony (SOA). It is the automatic activation of lexical entries that may provide the best clues to the nature of lexico-semantic organization in bilinguals (e.g. Chen & Ng, 1989; de Groot & Nas, 1991; Tzelgov & Eben-Ezra, 1992; Keatley & de Gelder, 1992). We will return to these issues toward the end of the introduction.

Are All Bilinguals Alike?

It is often surprising in bilingual research that, while so much care can be taken to assure that testing procedures and research designs are valid and

reliable, the language profile of the subjects--who are, indeed, the focus of this research--is often sadly neglected. It is impossible to generalize results from bilingual research when we do not know to whom it applies; unfortunately, subject selection criteria vary widely across studies and sometimes there is so little documentation about the subjects' language profiles that it is impossible to determine their status as bilinguals. It is important to know the linguistic profile of bilingual subjects, for the bilingual linguistic system is complex and may be organized differently depending on acquisitional factors and proficiency.

Along with the common, dual and tripartite hypotheses of bilingual linguistic organization reviewed at the beginning of this discussion, Paradis (1983) has proposed a further hypothesis: a bilingual-type dependent system in which a bilingual's context and manner of acquisition determine the organization of the system. In 1953, Weinreich introduced the notion of three "types" of bilinguals based on the presumed extent of semantic overlap between linguistic systems: "coordinative", "compound", and "subordinative", illustrated in figure 1. In Saussurian terms, he explained that within the coordinative system, each signifier (word form) has a corresponding signified (meaning), while within the compound (shared) system, one signified has two signifiers, one in each language. The subordinative system, on the other hand, would be one in which the second language signifier has no corresponding signified, but rather is indirectly

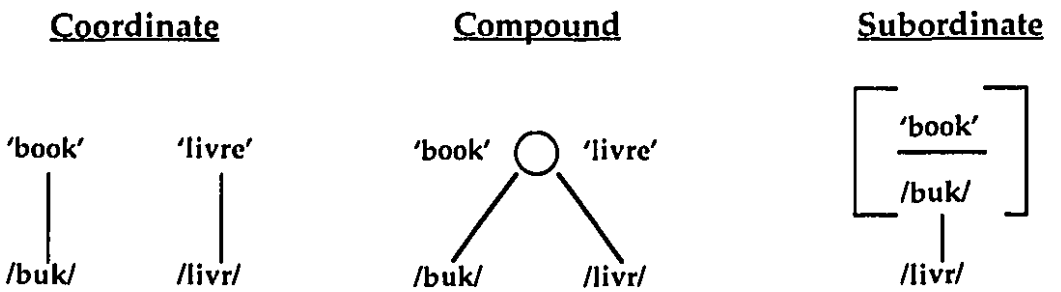


Fig. 1. Weinreich's (1953) bilingual types, adapted by Paradis (1978).

connected to the first language signified through a direct connection with its signifier. Weinreich described that the subordinative bilingual type

> ...is likely to apply when a new language is learned with the help of another (by the so-called 'indirect' method). The referents of the signs in the language being learned may then not be actual 'things', but 'equivalent' signs of the language already known. Thus, to an English speaker learning Russian, the signified of the form...may at first be not the object, but the English word...
>
> (p. 10)

A year later, Ervin and Osgood (1954) reiterated Weinreich's compound and coordinate types, yet chose to combine the subordinate type with the compound type. They describe coordinate bilingualism as being characteristic of the learning of two languages in separate contexts, for example one at home and the other at school or work. Their description of compound bilingualism, which has been widely accepted in the bilingual literature, described a language acquisition context "typical of learning a foreign language in a school situation", "fostered by learning vocabulary lists", or one where both languages are spoken in the home situation or in a context "by

the same people and in the same situations" (p. 140). However, the language backgrounds described here as typical of the compound bilingual are in fact very different, and might foster very different language processing or organization strategies. Paradis (1978) has countered that the compound-subordinate distinction is a useful one, and has attempted to "revive" and expand the definition of the subordinate bilingual type:

> ...subordinate bilingualism would be the outcome of learning the second language through an indirect method, as in the schools where the students would learn lists of words and their translation equivalents. Such a learner would constantly translate in his mind from his mother tongue into the second language whenever he wished to express something, and would likewise translate into his mother tongue before what he heard in the second language 'would make any sense'. (p. 166)

Another distinction concerning subject characteristics made in the bilingual literature is that of "early" versus "late" bilingualism. It has been hypothesized that there is a critical period for first language learning (Penfield & Roberts, 1959; Lenneberg, 1967), and that acquisition of language beyond that period, usually around the onset of puberty, becomes more difficult and effortful. According to Lenneberg's critical period hypothesis, language acquisition difficulties after this period are attributed to increased organizational rigidity of the brain upon maturation due to physiological and biochemical changes on the neuronal level, and to complete transfer of most language functions to the left hemisphere. In support of his hypothesis, Lenneberg (1967) has presented clinical studies of brain-damaged children who have shown the ability to transfer language functioning to other regions

of the brain and regain language functioning when insult occurs at a young age, while older children (adolescents) and adults are usually left with more permanent language deficits. Krashen (1973) has found evidence that this critical period may end much earlier than puberty, perhaps around the age of five. The question in bilingual research is whether the critical period can be extended to second language acquisition. While Lenneberg (1967) admits that adults are capable of "learning to communicate" in a second language, he explains that

> ...automatic acquisition from mere exposure to a given language seems to disappear after this age [the beginning of their second decade], and foreign languages have to be taught and learned through a conscious and labored effort. Foreign accents cannot be overcome easily after puberty. (p. 176)

Some developmental studies of second language acquisition support this notion, in that they find superior linguistic performance in younger second language learners in terms of phonology, or "accent" (Asher & Garcia, 1969; Oyama, 1976), as well as in comprehension ability (Oyama, 1978) and picture naming (Mägiste, 1992). But is second language learning really like first language learning? Ervin-Tripp (1974) asked this question and studied children of various ages learning a second language in a naturalistic context. She found that the developmental order of acquisition of second language structures was similar to that of first language acquirers, though older children showed an advantage for rate of learning over the younger children. Mayberry (1993) has provided evidence that L2 learning differs from L1

learning in a study of deaf adults with differing ages of acquisition of ASL (American Sign Language). She found an advantage in ASL performance for early childhood ASL learners over later ASL learners (subjects who essentially learned ASL as a first language, since prior spoken language acquisition had not been successful). Interestingly, when these older L1 ASL learners were compared to L2 ASL learners matched for age of acquisition, the L2 learners showed superior performance, indicating that L2 differs from L1 learning, and suggesting that some benefit is derived from L1 knowledge and skills. Similarly, Snow & Hoefnagel-Höhle (1978) found an increased efficiency of learning for older children and early adolescents, and Fathman (1975) found that older child learners outperformed younger ones in tests of morphology and syntax, while younger ones only showed superiority in terms of phonology (accent). This older learner advantage for rate of learning has been explained in terms of the onset of the formal operations stage of cognitive development (Krashen, 1982), in that the ability to use abstract thought allows for greater metalinguistic abilities in the acquisition of a second language. Genesee (1977) has argued that older learners are probably more efficient than younger learners because they approach the task of language learning with mature cognitive abilities unavailable to the younger learner. Although these data do not fully support the critical period hypothesis for second language development, studies of second language development over a longer term have revealed that while older learners are

superior to younger learners in terms of rate of progress, this rate levels off after a certain period of time, while younger learners usually continue to progress to higher levels of ultimate attainment in L2 (Krashen, Long & Scarcella, 1982). However, recent evidence has shown that it is possible for adult learners to achieve near-native proficiency in syntax , counter to the critical period hypothesis (White & Genesee, in press). Similarly, Scovel (1989) has argued that while childhood learners show superiority in ultimate attainment of L2 "accent", adults learners are able to produce linguistic structures other than phonology within near-native levels of ability.

To summarize, second language learning does not resemble first language learning in that it builds upon the skills and concepts acquired in the first language, and may reflect a different learning strategy altogether from first language learning. While first language learning during childhood is incidental, it appears that younger learners who begin second language acquisition near the time they are acquiring a first language (around the first five years of life) learn L2 through incidental means, as this is the only strategy available to them; on the other hand, later learners, having achieved a more mature state of cognitive development and armed with metalinguistic thought, undertake the task of language learning with a more conscious and explicit learning strategy. Paradis (1994) has recently discussed the role of implicit versus explicit memory with regard to second language learning (see Paradis, 1994). In this framework, a compound bilingual might

be described as a young second language learner who learns a second language before age five through incidental and implicit means (perhaps even acquiring two languages simultaneously as maternal languages); on the other hand, a subordinate bilingual would best be described as a late second language learner who must apply conscious knowledge to the language learning process, in an explicit and somewhat effortful manner.

Paradis (1994) argues that explicit language knowledge can never be transformed into implicit knowledge, as these two types of knowledge are qualitatively different: explicit memory contains knowledge *about* language structures and rules, while implicit memory contains knowledge about the actual *application* of these rules. As such, it would be incorrect to assume that an individual's extensive metalinguistic L2 education would necessarily result in the transfer of explicit knowledge to internalized procedural skills. Practice, or continuous application of this knowledge, on the other hand, might contribute to unconscious learned patterns of activation (e.g. internalizing L2 phonology through proprioception, among other things) and, eventually, implicit competence. While for an L1 learner lexical items are acquired unconsciously through the consistent association of lexical forms and semantic referents (concepts), one might hypothesize that an L2 learner discovers the arbitrary association between form and meaning through formal instruction and metalinguistic awareness. The learner then consciously associates the new L2 item with its known corresponding L1 item

(perhaps along with a perceptual, or form-related strategy for retrieval) until he has heard or used the L2 item in association with its semantic referent enough times that its retrieval then becomes unconscious and its linguistic representation internalized. Thus, if a bilingual possesses weaker implicit competence than explicit memory for L2 (as in an older second language learner), explicit memory may be more involved in a bilingual's language processing to compensate for a lack of internal, procedural L2 competence.

Support for this notion comes from recent studies by Segalowitz and colleagues. Favreau and Segalowitz (1982) compared the optimal reading rates of two groups of highly fluent bilinguals (who demonstrated near-native proficiency in communication tasks) and found that some of these bilinguals had a language "imbalance" in that they read more slowly in L2 than in L1. When they divided the highly fluent bilinguals into an equal reading rate group and an unequal rate group, they found that the unequal rate group also demonstrated slower L2 listening ability on an optimal listening task (where subjects could control the speed of input). Thus, although this group of bilinguals performed communication tasks with a near-native level of proficiency, they appeared to have underlying weaknesses on a more automatic level of L2 processing for both reading and listening. In order to explore this issue more directly, Favreau & Segalowitz (1983) tested these two groups on a semantically primed visual lexical decision task in which they varied the SOA, as well as the proportion of

related stimuli. The authors found that the unequal reading rate group did indeed demonstrate evidence of reduced automatic processing and increased conscious processing in their L2 (where they had shown automatic processing in L1), contrary to the equal reading rate group whose pattern of L2 reaction times were consistent with automatic processing. Favreau & Segalowitz (1983) noted that schooling experience in L2 was highly associated with unequal reading rates in their study; thus it is likely that amount of L2 reading experience may be a factor in acquiring automatic processing. A more recent paper by Segalowitz and Segalowitz (1993) reinforces this notion, in that it has provided evidence that controlled language processing in L2 word recognition becomes automatic with increased practice in L2.

Paradis' (1994) implicit versus explicit interpretation of lexical development may be extended to describe differences in lexical access strategies in bilinguals of differing *ages of acquisition*. Where lexical (or form-based) strategies of word access might be associated with the involvement of explicit memory in encoding processes in older learners, semantic (conceptually-based) strategies might correspond to incidental implicit encoding typical of younger learners. Results from a study by Genesee et al. (1978) have reinforced this idea. In this investigation, electroencephalographic (EEG) recordings of activity in the right and left hemispheres were gathered while fluent bilinguals with varying ages of L2 acquisition (infancy, childhood, and adolescence) performed a timed

language identification task (in which they pressed a button to convey their decision). Although there were no reaction time differences between the groups on the identification task, the adolescent L2 acquirers showed more right hemisphere activity, while the infant and childhood acquirers demonstrated greater left hemisphere reliance in processing these words. Genesee et al. (1978) interpreted these results as evidence that the adolescent bilinguals adopted a more holistic or perceptual strategy in responding to words, while the infant and childhood bilinguals tended to process these words with a more semantic-type strategy. A recent study by Wuillemin, Richardson and Lynch (1994) has corroborated these results, in that they found greater right hemisphere involvement for older acquirers on a divided visual field task than for early acquirers. These results support a hypothesis of second language development in which a critical period exists for implicit, or semantically-based acquisition of lexical items, after which explicit metalinguistic form-based encoding strategies are required. As noted earlier, practise, or proficiency may also play a role in the developing structure of the lexicon. Therefore, we might expect differences in the organization of the bilingual lexical system between subordinate bilinguals, who have learned a language during or after adolescence and have reduced L2 proficiency, and compound bilinguals who have learned a second language during childhood, perhaps even simultaneously with L1 acquisition, and who have become highly proficient in L2. The adolescent or adult learner with low L2

proficiency is most likely a subordinate type of bilingual who, with reduced implicit competency in L2, must consciously mediate L2 performance through L1 implicit knowledge; this bilingual type would then have to rely on a form-based or lexical route of L2 word access. A compound bilingual, on the other hand, might describe a bilingual who learned L1 and L2 in early childhood, at approximately the same time, within the same context, and who demonstrates equally high levels of proficiency in each of their two languages. L1 and L2 words would refer to conceptual representations common to both languages, and lexical access would be mediated through an implicitly encoded conceptual route of processing for each language (e.g. Potter et al., 1984).

A Developmental Model of Bilingual Lexical Organization

Now that we have determined that second language acquisitional factors seem to play an important role in the development of the bilingual lexical system, we will return to our discussion of psycholinguistic models. Two hierarchical models of linguistic representation have been proposed by Potter et al. (1984) which describe different connections between the components of the lexical system. They are considered "hierarchical" because they make a distinction between the lexical (form-based) and conceptual (or semantic) levels of representation. As illustrated in figure 2 below, the two languages are interconnected in both models; the only

difference lies in whether the two lexical stores are directly linked or linked indirectly through the conceptual system. The lexical system for L1 usually contains more representations than the L2 lexical system, which is indicated in this schema by different sized boxes. These have also been described as "three-code" models (e.g. Keatley et al, 1994), similar to Paradis' (1983) previously discussed "tripartite" system, in that they assume two separate codes, or representations, at the lexical level and one common code for representations at the conceptual level. The first of these is the "concept mediation" model, in which representations are stored separately at the lexical level, yet linked through a common conceptual store at the semantic level. This model is consistent with the common stores, or language interdependence hypothesis which was discussed earlier. The second is called the "word association" model, in which only first language words are

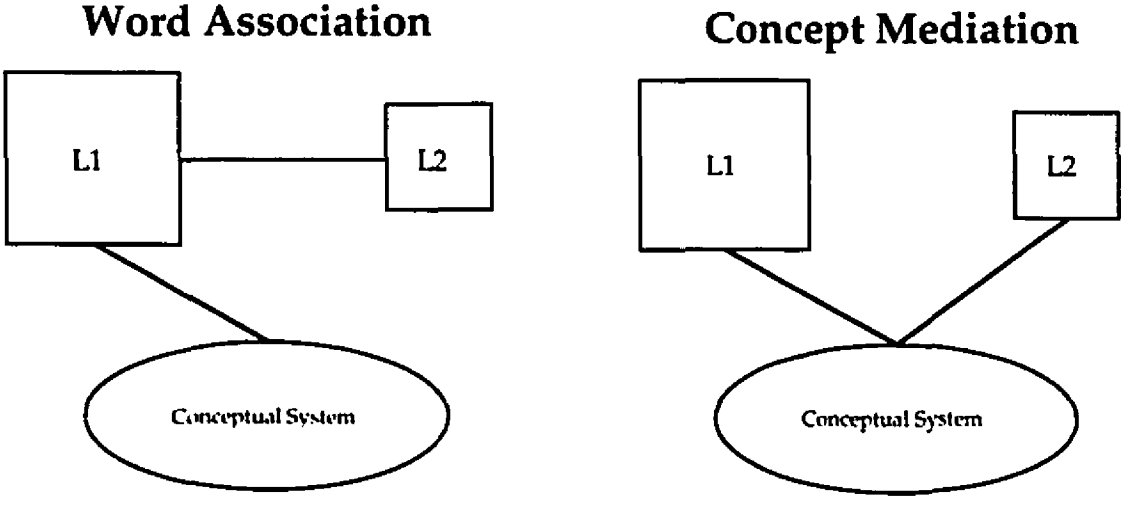


Fig. 2. Word Association and Concept Mediation Models (Potter et al., 1984)

directly linked to a conceptual store and second language (L2) words are only indirectly linked to concepts through connections to first language words (L1). These models are usually tested by comparing picture and word naming latencies in L2 to translation latencies from L1 to L2 across languages. It is predicted that if word association is the route of processing, translation should take less time than picture naming, which requires conceptual access; on the other hand, conceptual mediation would be supported if picture naming and translation were found to take approximately the same amount of time. Potter et al. (1984) proposed a developmental theory in which less proficient bilinguals in an early stage of L2 acquisition would be more likely to have word-to-word connections, while proficient bilinguals at a later stage in acquisition use concept mediation. They compared translation and picture naming performance in fluent Chinese-English bilinguals who had lived in an English-speaking environment for more than a year, and non-fluent English-French bilinguals who had been studying French in high school for two years. Latencies were found to be the same for translation and picture naming in both groups of bilinguals, suggesting that both groups used a conceptual route of processing. These findings failed to support Potter et al.'s (1984) theory, and at the same time countered Paradis' (1978) concept of subordinate bilingualism. In an attempt to explain the unexpected findings, Kroll and Curley (1988) suggested that perhaps the subjects in Potter et al.'s nonfluent group had already passed a "critical" stage in their L2 acquisition.

Had a less experienced nonfluent group been tested, they argued, support for the original hypothesis would have emerged. They thus tested German-English bilinguals with a broader range of acquisitional experience, and found that proficient bilinguals with over two years of L2 experience translated equally as quickly as they named pictures, replicating Potter et al.'s (1984) concept mediation findings; however, they also found that less fluent bilinguals with less than two years of experience performed translation faster than naming pictures, supporting the word association hypothesis (Potter et al., 1984). This finding is important in that it implies there is a "developmental shift" that takes place in bilingual lexical organization, and that this shift takes place during the initial stages of the acquisitional process (see also Chen and Leung, 1989).

Kroll and colleagues (Kroll & Curley, 1988; Kroll & Sholl, 1992; Kroll 1993) have expanded Potter et al.'s (1984) hypothesis into a developmental model of bilingual lexical organization wherein words are first mediated through lexical links and gradually, with increased proficiency, conceptual links develop and strengthen. The conceptual route then becomes the preferred route of processing. They add that lexical links probably continue to exist once the conceptual links are developed. Kroll (1993) explains that conceptual L1 links tend to be stronger than L2 links, especially if L2 is acquired after early childhood, and that increasing proficiency in L2 leads to greater reliance on conceptual links over lexical links. We might expect,

then, that subordinate bilinguals would have strong lexical connections until they gained conceptual links with increasing proficiency. Conceptual links, with continued use, would be assumed to gain strength; however, remaining lexical links would weaken due to lack of use. A bilingual who has completely shifted from lexical mediation to conceptual processing, then, would essentially become a compound bilingual, as they would have established conceptual links in both languages to a common conceptual store. The subordinate bilingual, relying on lexical links to access L2 words through L1 words would most likely be an adolescent or adult second language learner who has already acquired a first language and thus a first language lexical system. Kroll (1993) hypothesizes that adult second language learners, having already acquired a first language, need not learn new concepts as

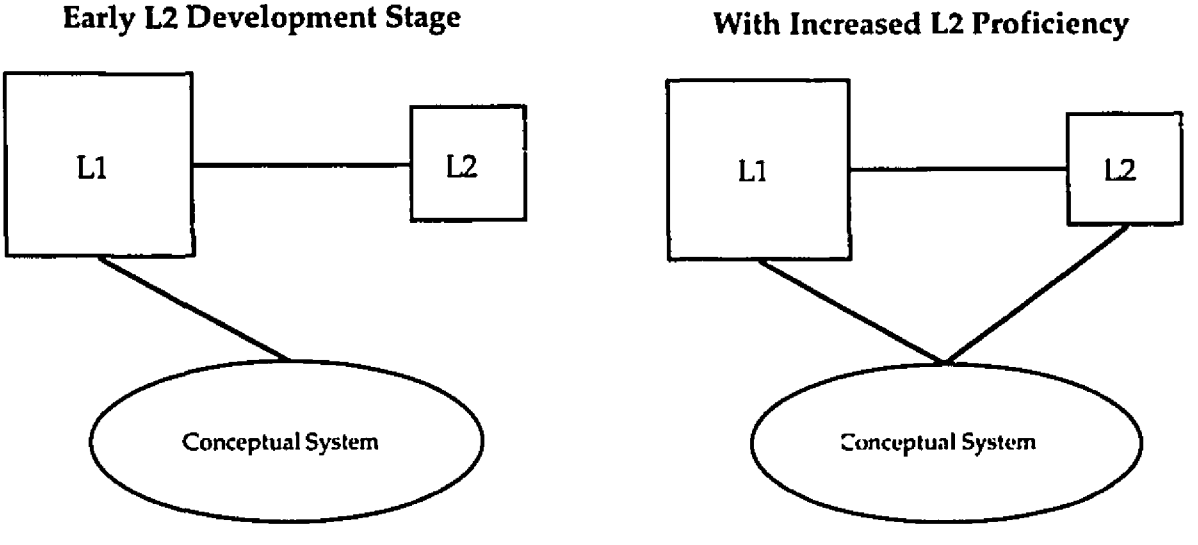


Fig. 3. Model of bilingual lexical development based on Kroll (1993).

would a child first language learner, but rather need to develop links between existing conceptual representations and new word forms. On the other hand, a child who acquires L2 during the same period of time as L1 would be expected to form conceptual links in L2 to the same extent and in the same manner as in L1. This type of acquisition would result in a concept mediation system with either an absence of lexical links or very weak lexical links from infrequent usage. Such a system would correspond to the compound bilingual system. Figure 3 above illustrates these proposed subordinate and compound lexical systems. The developmental model is highly appealing, in that it accounts for differences in processing strategies between bilingual types. However, the tasks used to test this model are less than ideal to investigate the organization of the lexicon for two main reasons. First, a pitfall noted by Snodgrass (1993) is that picture naming and translation often result in differing baseline scores, and that often makes it difficult to compare results from the two tasks. Second, translation and picture naming are tasks which allow the interference of conscious, attentional processes and as such do not reflect on-line, automatic processing in lexical access. A better means of investigating the organization of the bilingual lexical network is through the primed lexical decision task, wherein attention-demanding processes can be controlled by imposing a short SOA. In order to evaluate the models proposed above, the task must assess both conceptual and lexical links within the bilingual's lexical system.

Cognates: A Rare Experimental Opportunity

In order to determine how the bilingual lexicon is organized as a whole, in terms of relationships between not only semantic networks but also phonological-orthographic connections, it is interesting to examine the processing of cognate versus noncognate translations. Cognates are words between languages that share a meaning, like translations; however, they also share similar orthographic and/or phonological features (e.g. English-French: CARROT-CAROTTE). Cognates and noncognates thus provide the opportunity to examine two different aspects of processing--one lexical, or form-based, and one semantic, or conceptually-based--in the same word.

It has been reported in the literature that translations prime one another, usually to a greater extent than do cross-language associated words (e.g. Chen & Ng, 1989; Jin, 1990; de Groot & Nas, 1991). Moreover, cognate translations have been found to facilitate lexical processing relative to noncognate translations in tasks of continued word association (Taylor, 1976), word translation (de Groot, 1992a; Sánchez-Casas et al., 1992; de Groot et al., 1994) and primed lexical decision (de Groot & Nas, 1991). There is some debate among researchers as to whether this effect is attributable to stronger links at the lexical level between cognate translation representation nodes, or whether this is due to a *shared* representation across languages. Brown, Sharma and Kirsner (1984, as cited in Cristoffanini et al., 1986) have found

cognate priming for visually presented words which share a spoken form across languages but which differ in script and in direction of reading (Hindi and Urdu), interpreted by some as evidence that the cognate effect does not originate at the lexical level of processing; however, it is possible that this effect only reflects strengthened lexical links due to phonological similarities in spoken language, which is likely the principal modality of lexical functioning. Yet there is additional evidence that this effect is in fact lexically-based. Bowers and Mimouni (1994) examined the effects of phonological cognates presented visually in the differing scripts of French and Arabic. Although they found priming for literal repetitions within languages, they found no priming for cognates, indicating that cognate priming does not occur at a conceptual level. Gerard and Scarborough (1989) investigated the effects of cognates, noncognates, and cross-language "homographs" (words similar in form, but differing in meaning, such as the French-English COIN-COIN) in a primed, visual lexical decision task. They found facilitation for cognates relative to unrelated words, but no effect of noncognates; more interestingly, they found that the homographs had as large a facilitation effect as did cognates, further reinforcing the idea that the cognate effect is attributable to processing at the lexical-form level (see also Cristoffanini et al., 1986).

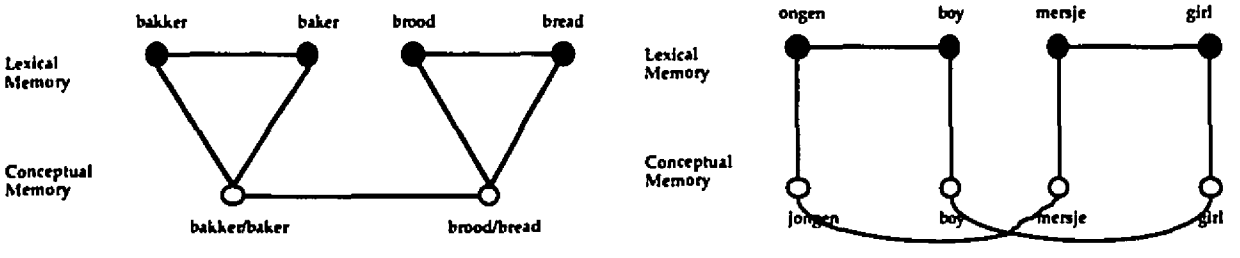
It is interesting to note that in all the research we have reviewed regarding cognate priming, only visual/orthographic presentation techniques

have been employed. There are a number of potential confounds with such a methodology, in particular the possibility of subjects perceiving stimuli in a language other than that intended by the experimenter. Since cognate words are selected for their great degree of orthographic overlap (sometimes identical), how can one ensure that the subject does not simply perceive the prime and/or target as being in the same language (perhaps simply misspelled)? Setting up specific language expectations is insufficient. It is not surprising, then, that cognate effects are found to be similar to within-language identical repetition effects; they could in fact be one and the same. A more reliable technique might be to utilize auditory presentation, as phonetic codes contain language-specific cues which are immediately identified by the listener as being in one language or the other (e.g. Caramazza et al., 1974).

A second potential drawback of a number of cognate priming studies (e.g. Cristoffanini et al., 1986) is the potential for interference of conscious processes (via long prime-target SOAs or the use of explicit memory tasks). De Groot & Nas (1991) argue that there may be two types of "repetition" (literal and cross-language translation) effects: one which involves lexically-based (automatic) processes, and one which may involve attentional processes. They further suggest that the lexically-based processes are highly transient in nature and may disappear over long SOAs. In the studies discussed above, it is not possible to differentiate the automatic from the

attentional processes.

To explore these issues more directly, de Groot and Nas (1991) examined both translation and associative priming in Dutch-English "compound" bilinguals. Subjects performed within- and cross-language primed lexical decision tasks which contained both cognate and noncognate word pairs. A visual masking technique was used in which stimuli were presented only 60 ms apart to prevent the interference of conscious processes. Translation, repetition, and associative priming effects were found within and across languages, with and without masking. Overall, translation effects were greater than associative priming effects; further, in the masking condition, between-language associative priming disappeared altogether for the noncognates (see their Experiments 3 and 4). In order to account for these findings, the authors proposed a model of organization in which cognate words are connected between languages at both the lexical (form-based) and



Cognates **Noncognates**

Fig. 4. Model of cognate versus noncognate Dutch/English stimuli as proposed by de Groot & Nas (1991).

since conceptual levels, while noncognates are connected between languages only at the lexical level, illustrated in figure 4 above. De Groot and Nas claim that,translation priming, (a "lexically-based effect"), occurred for both cognates and noncognates, this would indicate the presence of lexical links between these nodes across languages; however, since there was no associative priming found for noncognates across languages, there would be no links between noncognate item nodes at the conceptual level across languages.

These findings are perplexing in that they are contrary to what we would expect to find for a "compound" bilingual type: in fact, these results support the word association model of lexical organization and would be consistent with a subordinate bilingual type. Is it possible that de Groot and Nas' subjects were actually subordinate, and not compound bilinguals? The rather vague description of the subjects' linguistic profile allows the possibility that they were in fact subordinate: "All subjects had Dutch as their native language and were reasonably good at comprehending English" (p. 99, Experiments 2 to 4). Thus, the pattern of results found in this study could have been attributed to the L2 acquisition history and proficiency of the subjects under investigation. As discussed earlier, many investigators (e.g. Kroll and Curley,1988; Chen and Leung, 1989) have demonstrated that subjects' language profiles can highly influence the organization of the lexical system, and thus must be well understood when undertaking a study of

bilingual lexical organization. According to the developmental model of bilingual lexical organization described earlier (Potter et al., 1984; Kroll & Curley, 1988), we would predict that compound bilinguals would demonstrate use of conceptual links while subordinate bilinguals would evidence reliance on lexical links. This hypothesis might be tested by applying a paradigm similar to that used by de Groot and Nas (1991) to two corresponding subject groups--one compound, and one subordinate--carefully selected according to strict criteria regarding proficiency and language acquisition history (age and manner of L2 acquisition). Rigorous subject selection procedures would give us the confidence to reveal whether there are in fact differences in lexical organization between bilingual "types".

In summary, we have reviewed evidence that supports both the linguistic independence and linguistic interdependence hypotheses of bilingual lexical organization. The wide variety of experimental tasks that have provided these data are believed to tap different levels of processing; a comprehensive view of bilingual lexical organization is therefore a hierarchical one which incorporates both the lexical (form-based) and conceptual (semantic) levels of processing reflected in these tasks (Potter et al., 1984; Kroll & Curley, 1988; Kroll & Stewart, 1994). Second language development factors, previously sadly neglected by many authors in the field, have been discussed in terms of their impact on lexical organization. We have highlighted the importance of certain L2 acquisition factors in the

developing bilingual, in particular, age, context, and manner of acquisition, and level of proficiency in L2. A developmental model of lexical organization in bilinguals has thus been considered to account for bilinguals of differing proficiency, age, and stage of L2 acquisition (Potter et al, 1984; Kroll & Curley, 1988). Moreover, after review of certain methodological difficulties, it has been proposed that the primed lexical decision task may provide a highly reliable test of lexical organization, in that it allows the investigator to assess on-line lexical processes. The use of cognate and noncognate stimuli has also proven to be a useful research tool in the investigation of bilingual lexical organization, in that these words are believed to differ in terms of their lexical and conceptual connections.

The Present Study: Lexical Organization in Compound and Subordinate Bilinguals

As we have reviewed so far, the literature on bilingual lexical organization has provided much data supporting a hierarchically structured lexical system comprising a conceptual and a lexical level of representation. However, due in large part to lack of both strict subject selection criteria and/or reliable testing procedures in past research, the compound-subordinate distinction remains unresolved and the nature of this distinction with regard to lexical organization remains to be determined. The present study will attempt to address the nature of the compound-subordinate distinction (Weinreich, 1953; Paradis, 1978) through an investigation of lexical processing. The current experiments will expand on previous studies by extending the bilingual priming paradigm to the auditory modality. Lexical-form and conceptual routes of processing will be examined through a comparison of cognate and noncognate translations, as described in detail below. To evaluate the developmental hypothesis (Potter et al, 1984; Kroll & Curley, 1988), we will compare two groups of adult subjects: 1) a Compound group of French-English bilinguals who have achieved a high level of fluency in both languages and who have learned both languages in early childhood; and 2) a Subordinate group of bilinguals who are native French speakers, with low L2 (English) proficiency and who began L2 acquisition during adolescence or adulthood. A primed lexical decision task

will be employed, using a brief interstimulus interval (ISI) to control for the interference of attention-demanding processes. The design of the experiment is based in large part on that used in de Groot and Nas (1991), in which associative and translation priming were examined in cognate and noncognate word pairs.

According to the developmental hypothesis (Potter et al., 1984; Kroll & Curley, 1988), we expect to find that the Subordinate group will rely more on the lexical route of cross-language processing, consistent with the word association hypothesis. Since the only conceptual links that are hypothesized to exist lie between the L1 representations and their concepts, within-language associative priming should only be found in L1. Between languages, only indirect access to concepts would be possible through direct lexical connections to L1 words, so we would predict weaker cross-language associative facilitation for Subordinates than for Compounds. Subordinates should only exhibit translation priming, with more facilitation for cognates than noncognates.

The Compound group, on the other hand, would follow a semantic route of processing, consistent with the concept mediation hypothesis. Given that Compound bilinguals learned both languages at a very early age and are not believed to have developed lexical links between translations, effects of cognates that are related to lexical form should not occur. This group would be expected to show equivalent within-language associative

priming in either L1 or L2, as subjects have access to conceptual links in both languages. While cross-language associative and translation priming would be predicted, translation priming would be conceptually and not lexically mediated. Moreover, due to an absence of lexical links, no increased facilitation would be expected in the Compound group for cognates relative to noncognates. De Groot and Nas (1991) have proposed a model of compound organization wherein conceptual connections exist only for cognate stimuli and not for noncognate stimuli. If this hypothesis were correct, we would expect the Compound group to show more facilitation for cognates than noncognates due to the omnipresence of lexical links, but associative priming only for cognate stimuli. Moreover, if translation priming were mediated by conceptual links, we would expect it to be compromised in the noncognate translation condition due to the lack of direct conceptual links.

Finally, should both groups show exactly the same pattern of facilitation, we might then deduce that there is no difference in underlying lexical representation between the two types of bilinguals, and that perhaps surface differences between these two groups (e.g. proficiency) might be determined by conscious processing factors.

Method

Design. Three auditory primed lexical decision experiments were designed to assess bilingual lexical organization. To verify whether subjects

in each group (Compound and Subordinate) demonstrated associative priming within each of the two languages in a monolingual mode, two control experiments were performed, one in French and one in English. In these two experiments, in addition to the nonword responses, two within-language experimental conditions were included: 1) semantically associated pairs and 2) unrelated pairs. In the main cross language experiment, the two groups of subjects were presented with five stimulus conditions (in addition to nonword targets): 1) cognate translation (CT) pairs, 2) noncognate translation (NT) pairs, 3) cognate associated (CA) pairs, 4) noncognate associated (NA) pairs, and finally, 5) an unrelated (UR) pairs control condition (see "Stimuli" section ahead for examples).

Subjects. In total, forty-six (46) French-English bilinguals between the ages of 17 and 32 from the Montréal, Québec area participated in this study; however, after screening criteria were assessed (see below), only 36 subjects were included in the study. Subjects were paid a small fee for participating, and were, for the most part, university students. Subjects were placed in either the Compound group, the Subordinate group, or rejected from the study on the basis of responses to an extensive language background questionnaire[2] as well as proficiency ratings from native judges in each

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[2] Self-ratings of proficiency in speaking and understanding each language were also collected. In factor analyses of correlations between language skill scores and self-reporting scores, it has been demonstrated that self-ratings are valid screening measures of bilingual proficiency, since high agreement has been found on these indirect measures and more detailed direct testing (Macnamara, 1967; Fishman & Cooper, 1969). However, self-ratings were not used as inclusionary criteria in this study, as it was necessary to use a measure that would be consistent and comparable across all subjects.

language. A team of five (5) native speaking judges in each language was employed to rate recorded language samples (see description in Procedures below) from each subject. The same rating scale was used for self-ratings (see footnote 1) and judge ratings; a seven-point scale on which "1" represented the poorest proficiency, while "7" represented the greatest was utilized. All raters were asked to consider all aspects of language when rating (e.g. accent, vocabulary use, grammar and syntax) and to give a global score rating overall language ability. Questions on the language background questionnaire were based in large part on the language profile data presented in Schwanenflugel & Rey (1986); for a detailed profile of each subject group, see Appendices A through D). Subjects with a hearing impairment or diagnosed speech-language disorder were excluded from the study.

Nineteen (19) subjects were included in the Compound group based on the criteria that 1) they had acquired both languages by the age of five (5) and 2) they had production ratings of "5" or above out of "7" from the native judges in each language. Sixty-eight (68) percent of these subjects indicated that they acquired both languages simultaneously, while 79% reported speaking both languages in the home as a child. Nine Compound subjects had both English and French as maternal languages. All other subjects had been exposed to French before English (the same "L1" as for the Subordinate subjects), with only two subjects being exposed to English before French. The majority of subjects were exposed to both languages within the first year of

life, and thus, as a group, the Compound subjects do not really have "one" maternal language, but rather two. Seventy-four (74) percent expressed that they are just as comfortable speaking either language. In response to the question "How often do you switch from one language to another?", fifteen (15) subjects replied "often" or "almost always". In terms of language usage, subjects reported that, on average, they spoke French a mean of 39% of the day, and spoke English for a mean of 61% (many of these subjects were McGill students who attended classes and had to read and write in English). Furthermore, subjects indicated that they spoke (or had spoken) French and English on a regular basis in the contexts of home (19 in French, 13 in English), work (16 in French, 17 in English), school (14 in French, 17 in English), and for social purposes (18 in French, 17 in English), demonstrating that they use both languages interchangeably in a wide variety of contexts and would best represent a "compound" type of bilingual.

The Subordinate group, on the other hand, consisted of seventeen (17) subjects who were included based on the criteria that 1) French was their native language; 2) they had acquired, or first begun using English in a productive mode after the age of 13 (hence, they may still be in the process of acquiring English), and 3) they had production ratings of less than "5" out of "7" in their second language, English. Mean age of acquisition for the subordinate subjects, as a group, expressed as the age at which acquisition began, was "0" for French (the same for all), and "16" for English (with a

range from "14" to "20"). For all subjects, French was the native and most proficient language, while English was a later-learned second language of poorer proficiency. Subjects had a mean comprehension ability self-rating of "5" out of "7" in English, with a range from "3" to "6"; when asked prior to testing, all subjects responded that they could understand English quite well if it was not spoken too quickly, and after testing, commented that they had no difficulty understanding the English stimuli. In terms of language usage, the subordinate group reported, on average, speaking French a mean 88% of the day, while they spoke English for only 10% (the remaining 2% reflects one subjects' use of a third language). Sixteen (16) subjects reported that they spoke only French at home and fifteen (15) spoke (or had spoken) French on a regular basis in all four contexts of home, work, school, and for social purposes. On the other hand, nine (9) spoke English in only one setting, three (3) in two settings, and only four (4) in three or more settings. One subject claimed she rarely spoke English at all, in any setting. Sixteen (16) of these subjects expressed that they felt more comfortable speaking French than English, while only one felt as comfortable speaking either language.

Stimuli. The within-language portions of the study, the monolingual French and English experiments, were each composed of 68 stimulus pairs, with 17 pairs of words in both associated (e.g. CEILING-FLOOR or FRERE-SOEUR) and unrelated conditions (e.g. AUNT-ROOM or RIDEAU-TASSE), and 34 word-nonword pairs (e.g. PENCIL-GREE or FOIN-IDOSSE), all of

which were recorded one word at a time from a randomly-ordered list, by the same bilingual female speaker, in both French and English (see Appendices F and G for a complete list of stimuli used in the French and English experiments, respectively). For the cross-language task, the stimulus set comprised a total of 170 stimulus pairs consisting of a French prime word and a target word or nonword in English. Stimuli consisted of 17 pairs of words in each of five conditions, as well as 85 word-nonword pairs. The five conditions were: 1) cognate translations (e.g. POLICE-POLICE), 2) noncognate translations (e.g. LIVRE-BOOK), 3) cognate associated pairs (e.g. LETTRE-PAPER), 4) noncognate associated pairs (e.g. FILLE-BOY), and 5) unrelated pairs (e.g. BATEAU-EAR). Associated words for all experiments were rated in English by 10 anglophone university students (none of whom participated in the experiments). All associated words scored a mean rating of at least "4" on a five-point scale ("5" being "highly related", "1" being "not at all related"), while unrelated word pairs all scored mean ratings of less than "2" on the same scale. In each experiment, all stimulus items were nouns, were matched for mean number of syllables across conditions, and no targets were ever repeated during the three experimental tasks. Word frequency was matched in that all target items had a frequency equal to or above 49 in English according to Kucera & Francis (1967). French word frequency norms were not consulted as their scale and sampling corpus differ from that of Francis & Kucera, and hence would not be comparable. Thus real word

stimuli, all nouns with a rating above 49 in English, were of relatively high frequency and deemed by the experimenter to be culturally neutral; they were thus assumed to be of comparable frequency in French for the purposes of this study (see Appendix E for a complete listing of stimuli for the cross-language task).

The tape recorded stimulus items were sampled onto an IBM-compatible computer using the BLISS speech analysis system (Metus, 1989), at a sampling rate of 20 kHz with a 9 kHz low-pass filter and 12-bit quantization. Prime and target stimuli (including five initial practice trials) were paired by the program with a 250 ms ISI (see Procedures below) and were presented to subjects auditorily.

Procedures and Apparatus. Subjects were tested individually in one-hour sessions which consisted of a brief screening followed by presentation of the three experimental tasks. A questionnaire was completed by each subject prior to testing which outlined their language background and self-evaluation of their proficiency in each language. They were then asked to "tell a story" about two standardized pictures for two minutes each--the "cookie theft" picture from the Boston Diagnostic Aphasia Exam (Goodglass & Kaplan, 1983), and the "kite-flying" picture from the Minnesota Test for Differential Diagnosis of Aphasia (Schuell, 1965)--one in English and one in French, while being tape recorded. Tape recorded language samples were then rated on a seven-point scale for proficiency in each language by a team

of five (5) native French speakers for the French samples, and by a team of five (5) native English speakers for the English samples.

Stimuli were presented in one of three random orders assigned randomly to the subject, with an interstimulus interval (ISI) of 250 ms between each prime and target and a 5s inter-trial interval (ITI). Target word lexical decision responses and reaction times were recorded by the computer program. Subjects were seated comfortably in a sound-treated booth where stimuli were presented binaurally through high-fidelity headphones. The experimenter instructed each subject to listen to both words but only to decide if the second word in each pair they heard was a real word or a nonword. Instructions were presented in the subjects' language of choice. Subjects were asked to convey their response by pressing the appropriate button (one labelled YES/OUI, one NO/NON) on the response box; they were required to use their dominant hand, to rest their palm on the surface of the box while delicately resting their index and fourth finger on each button. The experimenter encouraged subjects to respond as quickly as possible while maintaining as high a level of accuracy as possible. Subjects were given instructions prior to each of the three experiments, and were informed as to which language(s) would be presented for that particular experimental task. The order of presentation of the three experimental tasks was counterbalanced across subjects in each group.

Results

In all three experiments, a mean reaction time (RT) of each subject's correct responses was calculated for each of the Prime Type conditions. RTs outside 2 standard deviations (SD) from the mean were rejected in calculating these means, as well as any RT over 5000 ms. Mean RTs across subjects (within groups) were also calculated for each stimulus item, again within 2 SD from the mean. RTs to nonword stimuli were not included in any analyses as the sole purpose of these stimuli was to provide foils for the lexical decision task. Mean error rates for real word stimuli (yes responses) were relatively low in all three experiments, with overall mean error rates of 6.7% for Compounds and 7.9% for Subordinates in Experiment 1, 9.7% for Compounds and 11.4% for Subordinates in Experiment 2, and 7.0% for Compounds and 7.6% for Subordinates in Experiment 3 (see Appendices H to J for mean error rates in each condition of each experiment). Two two-way ANOVAs (Group X Prime Type) were performed for each of the three experiments, one on subject data, and one on item data. Min F' was then calculated based on F1 (subjects) and F2 (items) to determine if the results would generalize across both subjects and items (only Min F' results will be reported here). Before turning to the results of the cross-language experiment, the results of the two monolingual (within-language) experiments will first be discussed, as these were intended to ascertain the occurrence of associative priming in a monolingual mode.

Monolingual French Experiment

As indicated in the bar chart in figure 5 below, both subject groups responded more quickly to associated stimuli than to unrelated stimuli when both the prime and target were presented in French. Overall, Compound subjects tended to respond to stimuli somewhat more quickly than Subordinate subjects. Every subjects' individual data followed the group pattern of facilitation for associated stimuli relative to unrelated stimuli, in both the Compound and Subordinate groups (see Appendix I for individual subjects' mean RTs and standard deviations, for Compound and Subordinate groups, and Appendix L for mean RTs to items across Ss).

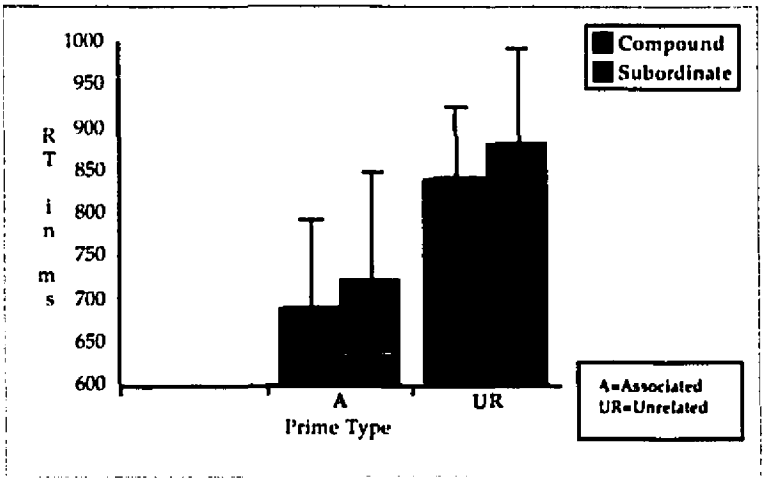

Fig. 5. Mean reaction times (RT) in milliseconds (ms) and standard deviations of Compound and Subordinate groups in Monolingual French Experiment.

When a 2 X 2 ANOVA (Group X Prime Type) with repeated measures was performed on these data, a significant main effect of Prime Type was

revealed (min F'(1, 40)=23.00, p<.01). This finding indicates that overall, subjects in both groups responded to associated stimuli significantly faster than to unrelated stimuli. Thus, when subjects listened to words presented in a monolingual French mode, they showed significant facilitation for associated pairs relative to unrelated pairs, whether they were Compounds or Subordinates. In addition, the item analysis yielded a significant main effect of Group (F (1, 32) = 19.41, p<.01), suggesting that there may have been a difference in the way the two groups reacted to the stimuli; however, this effect was not found in the subject analysis. There were no other significant main effects or interaction.

Monolingual English Experiment

Figure 6 displays mean RT data from the monolingual English experiment which follows approximately the same pattern as for the French experiment, in that both subject groups responded more quickly to associated than to unrelated stimuli, while the Compound group tended to respond more quickly, overall, than the Subordinate group. Again, mean RT data were quite consistent across subjects, with 95% of Compound subjects and 100% of Subordinate subjects following the group trend (see Appendix J for individual subject mean RTs and standard deviations, and Appendix M for mean RTs to items across Ss).

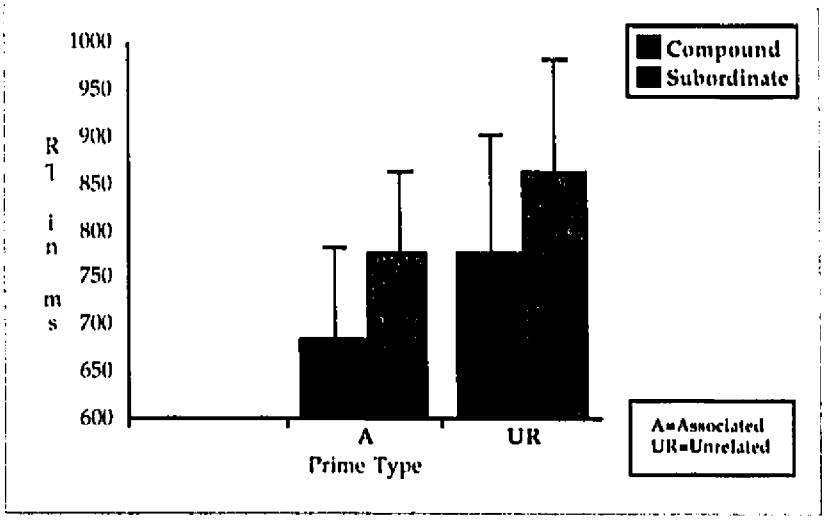

Fig. 6. Mean reaction times (RT) in milliseconds (ms) and standard deviations of Compound and Subordinate groups in Monolingual English Experiment.

A 2 X 2 ANOVA (Group X Prime Type) of these data with repeated measures detected a significant main effect of Group (min $F'(1, 46)=5.67$, $p<.05$) and of Prime Type (min $F'(1, 36)=7.54$, $p<.01$) which held across both subjects and items. There were no significant interaction effects. As noted in figure 6 above, Compound subjects responded significantly more quickly to stimuli than did Subordinate subjects, and responses to Associated stimuli were significantly faster than to Unrelated stimuli. Thus, while the Subordinate group showed slower RTs overall, both groups showed facilitation for semantically associated word pairs relative to unrelated word pairs when they were functioning in a monolingual English mode.

Interestingly, in both languages, net facilitation (unrelated RT minus associated RT) was highly comparable for both Compounds and Subordinates, with values of 151 ms for Compounds and 158 ms for

Subordinates in the French experiment, and values of 93 ms for Compounds and 90 ms for Subordinates in the English experiment. Calculated proportional increase over baseline (unrelated) values were also highly comparable, with 0.18 for both Compounds and Subordinates in French, and 0.12 for Compounds and 0.10 for Subordinates in English.

Cross-Language Experiment (French and English)

Figure 7 shows mean group RTs for each condition of the cross-language (French/English) experiment. The same basic pattern of RTs was found for both groups of subjects across prime type conditions: Subjects responded most quickly to cognate and noncognate translation stimuli, followed by noncognate associated stimuli, cognate associated stimuli, and finally, unrelated stimuli. Individual subject mean RT patterns varied to some extent, but a large percentage of subjects in each group followed the group patterns (see Appendix H for individual subject RTs and standard deviations for Compound and Subordinate groups, and Appendix K for mean RT of each item across Ss). Eighty-four (84)% of Compounds and 76% of Subordinates showed the group pattern of responding to translated words more quickly than to associated words. Finally, 79% of Compounds and 100% of Subordinates responded more quickly to both translated and associated stimuli than to unrelated stimuli.

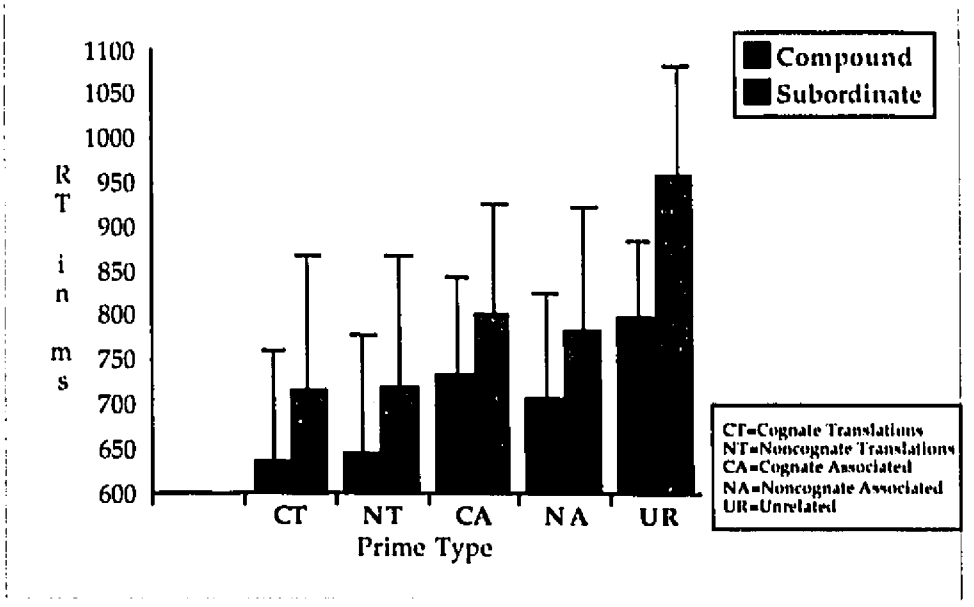

Fig. 7. Mean reaction times (RT) in milliseconds (ms) and standard deviations of Compound and Subordinate groups in Cross-Language Experiment.

The RT data were analyzed by means of two 2 X 5 ANOVAs (Group X Prime Type) with repeated measures, one on subject data, and one on item data. These analyses yielded a significant main effect of Group across both subjects and items (min $F'(1, 36)=4.98$, $p<.05$), indicating that overall, the Compound group responded significantly more quickly to cross-language stimuli than did the Subordinate group. A main effect of Prime Type was also detected, again significant across both subjects and items (min $F'(4, 103)=16.38$, $p<.01$). Newman-Keuls post hoc analyses of the Prime Type effect (subject analysis) revealed significant differences between each of the Prime Type conditions ($p<0.05$) except for the CT and NT conditions which did not differ.

A Group X Prime Type interaction also emerged (min F'(4, 172)=2.75, $p<.05$). This effect was treated using the Keppel error term (between-subjects variable only), to reveal that the source of the interaction occurred only at the level of the UR condition; Subordinate subjects were slower in this condition relative to other conditions than were Compound subjects ($p<0.001$), a finding which held across subjects and items. Net facilitation relative to UR ranged from 67ms (CA) to 155ms (NT) for Compound bilinguals, compared to a range of 159ms (CA) to 244 (CT) for Subordinate bilinguals. This leaves a large difference in net facilitation between the two groups, in contrast with comparable amounts of net facilitation found between these groups in the monolingual experiments. Hence, the Subordinate group showed more facilitation relative to the control UR condition (or, possibly, more inhibition for UR) than did the Compound group in the cross-language experiment, where near equal facilitation was found for both groups in the within-language experiments relative to UR. However, calculated proportional increase over baseline (unrelated) values were highly comparable between groups, with a range of 0.80 (CT) to 0.92 (CA) for Compounds, and a range of 0.80 (CT) to 0.91 (CA) for Subordinates. For both subject groups, significant facilitation was found for associated and translated stimuli, relative to unrelated stimuli, with greater facilitation for the translated items. No facilitation effects of cognates versus noncognates emerged within either the translated or associated conditions, indicating that cognates did not speed

responses relative to noncognates.

Discussion

The present study explored and compared lexical organization in Subordinate versus Compound bilinguals. When taken together, the results stand as evidence for a common, interconnected bilingual semantic network, consistent with past studies of cross-language priming (Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Chen & Ng, 1989; Jin, 1990; de Groot & Nas, 1991; Tzelgov & Eben-Ezra, 1992). Moreover, contrary to Kroll & Curley's (1988) developmental model, Subordinate and Compound bilinguals were found to share the same pattern of priming both within and across languages, suggesting that these two bilingual types are much alike in terms of lexical organization. We shall begin with a discussion of the two control monolingual experiments, then proceed to a detailed examination of our cross-language findings.

Monolingual French and Monolingual English Experiments

Across conditions, Subordinate bilinguals were found to respond, overall, significantly slower than Compound bilinguals when performing in English. This finding was expected, as the Subordinates were performing in their L2 (English), a language of reduced proficiency, while Compounds were highly proficient in both English and French. The fact that Subordinate bilinguals responded more slowly to French stimuli than Compounds (in the

item analysis) was not expected; however this finding was not significant for the subject analysis. Analyses also revealed significant associative priming effects for both Compound and Subordinate bilinguals in both English and French experiments, consistent with results of semantic and associative priming studies in the monolingual literature (e.g. Collins & Quillian, 1969; Meyer & Schvaneveldt, 1971; Collins & Loftus, 1975). Kroll & Curley's (1988) developmental hypothesis predicts associative priming for Compound bilinguals due to the presence of L1 and L2 conceptual links; our findings are consistent with this prediction, as Compounds demonstrated significant associative priming in each of their languages. However, the finding that Subordinate bilinguals show equivalent associative priming to Compounds in their L2 (English) was unexpected. The developmental hypothesis predicts that Subordinate bilinguals, possessing a mature L1 linguistic system and having minimal proficiency in L2, should mediate L2 access through L1 lexical links, and thus only access meaning indirectly due to a lack of L2 conceptual links. If this were the case, we would expect that access to conceptual information would take longer in Subordinates than Compounds in their L2, as indirect access would be more time consuming. Thus, L2 associative priming would not be expected for Subordinates, or if found, would be expected to be much smaller than that found in L2 for Compounds. The present findings, however, provide evidence to the contrary. The fact that Subordinate bilinguals showed equivalent L2 associative priming to

Compound bilinguals suggests the presence of L2 conceptual links in the Subordinate's lexical network. It is plausible that associative priming could have resulted from indirect conceptual access in the absence of conceptual links through lexical mediation; however, indirect access would be expected to be slower than direct access, yet there was very little difference in net facilitation between groups in either monolingual experiment, suggesting that the same conceptual route of processing was used for both L1 and L2 associative priming.

Cross-Language Experiment (French and English)

We now turn our discussion to our cross-language experiment, the main focus of this study. The first goal of the investigation was to examine three different priming effects across languages in an auditory modality: associative priming, translation priming, and cognate priming. While most studies in the literature on bilingual lexical organization to date have used visual presentation, the present experiment extended the cross-linguistic priming paradigm to examine bilingual lexical organization by means of an auditory task.

Associative Priming Effects

As in the two monolingual experiments just discussed, both Compound and Subordinate bilinguals demonstrated associative priming; that is, they responded significantly faster to associated stimuli--in both the

cognate and noncognate conditions--than to unrelated stimuli, across languages. This result converges with evidence of semantic and associative priming from both monolingual (Meyer & Schvaneveldt, 1971; Collins & Loftus, 1975) and bilingual primed word recognition studies (Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Chen & Ng, 1989; Jin, 1990; de Groot & Nas, 1991; Tzelgov & Eben-Ezra, 1992). We shall once again consider the present results within the framework of Kroll & Curley's (1988) developmental hypothesis. The presence of associative priming across languages suggests that both groups of bilinguals have access to direct connections among lexical representations in each language and a common conceptual system. As with the associative priming found in the monolingual experiments, these cross-language findings only partly support Kroll & Curley's hypothesis, which predicted the existence of direct conceptual connections for Compound bilinguals only. However, the fact that Subordinates showed associative priming in both the monolingual English (L2) and cross-language tasks strongly indicates the presence of direct conceptual connections in this less experienced, less fluent group of bilinguals, counter to Kroll & Curley's hypothesis. As suggested earlier in our examination of the monolingual data, it is possible that associative priming in the Subordinate group could be attributed to indirect access to L2 concepts through lexical mediation; however, as noted, we would expect indirect access to take longer than direct conceptual access. The monolingual

findings discussed above showed equivalent facilitation for Compounds and Subordinates, suggesting that the same route of processing was used for both groups of bilinguals, that most likely being a direct conceptual route. The cross-language data provide even stronger evidence against indirect associative priming in Subordinates, as this bilingual group showed more facilitation for associated stimuli relative to unrelated stimuli than Compounds who are hypothesized to possess direct conceptual links. Thus, it is likely that direct conceptual links are responsible for the associative priming found for Subordinate bilinguals in both the monolingual and cross-language experiments.

The cross-language associative priming effect has previously been obtained only in the visual modality (Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Chen & Ng, 1989; Jin, 1990; de Groot & Nas, 1991; Tzelgov & Eben-Ezra, 1992) and has usually been tested on bilinguals with higher proficiency than our Subordinates. Our findings thus extend previous support for the robustness of the cross-language semantic priming effect (e.g. Schwanenflugel & Rey, 1986; Tzelgov & Eben-Ezra, 1992) as this effect was successfully replicated in the auditory modality with associated stimuli, and with bilingual subjects with relatively low L2 proficiency.

Translation Priming: Lexical or Semantic in Nature?

As noted earlier, translation priming effects emerged clearly in the present data. Such effects may reflect connections either at the lexical level or

the semantic/conceptual level. De Groot & Nas (1991) suggested that "repetition" (translation) effects across languages were the cross-language equivalent to identity repetition, and as such that these effects were lexically based; however, as discussed in the introduction, translations are better cross-language parallels to synonyms than repetitions, as only meaning is shared. As such, an equally if not more plausible account is that translations share more semantic information than do associated words across languages and thus result in more facilitation than cross-language associated words. De Groot and Nas hypothesized that translations might share a single conceptual representation in semantic memory, but their failure to obtain priming for noncognate associated words under masking conditions prompted them to change their model. As a solution, they proposed separate and only indirectly connected conceptual nodes for noncognate translations, with direct links between L1 and L2 at the lexical level. This notion is counterintuitive: why would lexical information be directly connected across languages when conceptual information is organized separately? If anything is shared between languages, it should be conceptual information, and not language form. In the present study, significant facilitation for cross-language associated words and translations (both cognate and noncognate) was found at short ISIs, favoring a model in which conceptual information for all word types is shared across languages. In fact, de Groot (1992a) herself has recently softened her claims and has instead elaborated on a model of

"distributed conceptual representations" described by Taylor and Taylor (1990). Within this model, words both within and across languages are linked to a number of conceptual nodes containing different semantic attributes (de Groot, 1992a; 1992b; 1993). As illustrated in figure 8 below, some words, such as translations, may have more overlap in the number of shared conceptual nodes across languages, while others, such as associated words, would have fewer shared conceptual nodes. In this view, words are organized on a semantic continuum in bilingual memory; those with the most shared semantic features (e.g. translations) would show the most semantic priming while others with fewer shared features (e.g. associated

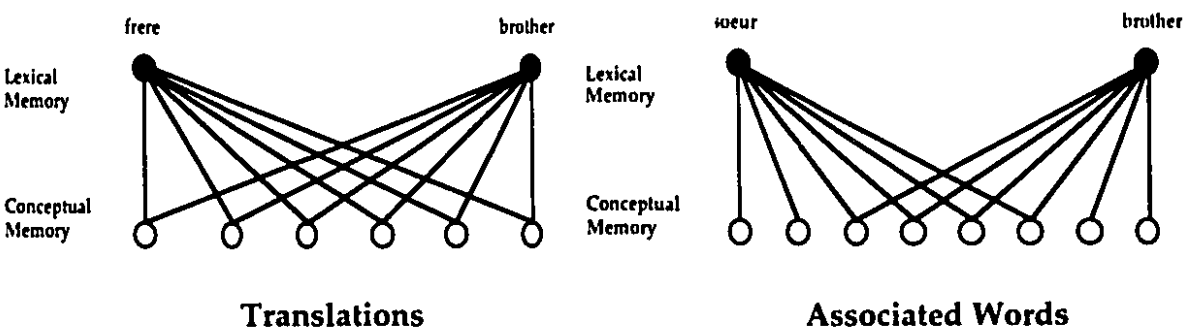

Fig. 8. Model of associated words and translations in bilingual lexical memory within a model of distributed conceptual representations (de Groot, 1992a; 1992b; 1993).

words) would show less priming (Collins & Loftus, 1975; de Groot, 1992a; 1992b; 1993). Subjects in the present study not only showed significant facilitation for related words (translations and associated words) in relation to unrelated words, but also showed significantly more facilitation for translations than associated words, findings compatible with this model.

Absence of Cognate Priming: Implications

Another interesting finding from the present study was that there was no significant facilitation effect found for either bilingual group for cognate stimuli relative to noncognate stimuli in any condition. The fact that we found a small inhibition effect for cognates relative to noncognates in the associated condition (subject analysis only) was even more surprising. There are several possible explanations for the unexpected results.

The first issue that must be addressed is that of cognate inhibition relative to noncognate stimuli in the associated condition. This pattern is in direct contrast to expectations concerning cognates (Cristoffanini et al., 1986; de Groot & Nas, 1991; de Groot, 1992a; Sánchez-Casas et al., 1992; de Groot et al., 1994); equally as remarkable is the fact that this inhibition was present in the associated condition and not in the translation condition. Upon re-examination of the stimuli used in the cross-language experiment, a possible explanation for the unanticipated results presented itself. A number of studies have reported effects of concreteness on lexical access across languages (Kolers, 1963; Taylor, 1976; Winograd, Cohen, & Barresi, 1976; Jin, 1990; de Groot, 1992a). Results of a recent study by Jin (1990) pointed to the possibility that effects of concreteness may even be *more pronounced across languages* than within languages; Jin found more priming for concrete words than abstract words across languages, but no effect of concreteness within languages. It could be argued that concrete words may overlap the most in

meaning from one language or culture to another. Interpreted within the framework of a model of distributed conceptual representations, concrete words result in more facilitation because they share more conceptual nodes than abstract words that tend to vary more from one culture to the next. Due to a variety of other constraints, concreteness had not been controlled in stimulus selection in the present investigation. Upon informal analysis, it was observed that there was indeed a large imbalance in the number of

TABLE 1

Proportion of Concrete and Abstract Target Words per Stimulus Condition*

	Concrete	Abstract
Cross-Language Experiment		
Cognate Translation	9 (53%)	8 (47%)
Noncognate Translation	10 (59%)	7 (41%)
Cognate Associated	6 (35%)	11 (65%)
Noncognate Associated	15 (88%)	2 (12%)
Unrelated	11 (65%)	6 (35%)
Monolingual French Experiment		
Associated	9 (53%)	8 (47%)
Unrelated	13 (76%)	4 (24%)
Monolingual English Experiment		
Associated	7 (41%)	10 (59%)
Unrelated	10 (59%)	7 (41%)

*Each stimulus condition contained 17 target items.

concrete and abstract words utilized in the cross-language experiment, particularly in the associated condition (see Table 1 for proportions of concrete words in each condition, as rated informally on a post hoc basis).

While the cognate associated condition contained 6 out of 17 (35%) concrete word targets, the noncognate condition contained 15 out of 17 (88%) concrete targets. Further, as illustrated in figure 9 below, when mean reaction times for the concrete and abstract words were examined separately, only the abstract words displayed the unexpected pattern of faster response times

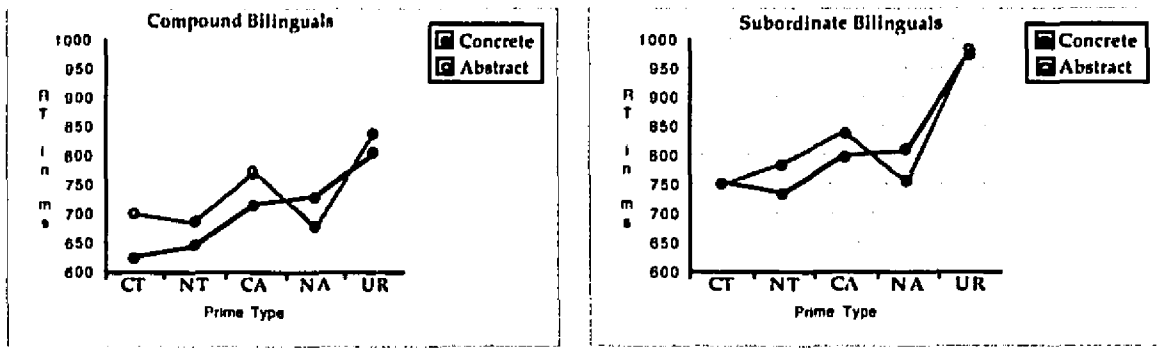

Fig. 9. Mean RTs for concrete versus abstract words in Cross-Language Experiment, for both Compound and Subordinate groups.

in the noncognate relative to the cognate associated condition. No difference in mean reaction times was found for the concrete words. Thus, the faster RTs in the noncognate associated condition, which originally appeared to be cognate inhibition, may in fact have been due to a high proportion of concrete words in the stimulus condition rather than to the cognate status of the stimuli. Of course, such an explanation remains speculative; however, it presents an interesting issue to be investigated in future research.

Given that the "inhibition" effect obtained in the subject analysis of the cognate and noncognate associated conditions is likely attributable to the

large proportion of concrete stimuli, one question remains: Why was cognate facilitation not obtained? The design of the present investigation was remarkably similar to that used in de Groot and Nas' (1991) experiment that found cognate effects in all conditions across languages (our translations were what they termed "repetitions"). There were two main differences, aside from the wider range of subjects in the present investigation: 1) the languages used in the current study were French and English, whereas the languages tested by de Groot and Nas were Dutch and English; and 2) the stimuli in the present study were presented auditorily, rather than visually. With respect to the first methodological difference, when the specific languages featured in these two studies are considered, it is possible that the Dutch-English combination has more cognate words than French-English, since the former are both Germanic languages while the latter pair involves the combination of a Romance language with a Germanic language. As such, Dutch-English cognates may be more similar in form, both orthographically and phonologically than French-English cognates. However, this seems to be an unlikely account of the discrepant findings. In particular, cognate priming effects have been demonstrated in Spanish-English bilinguals (Cristoffanini et al., 1986; Gerard & Scarborough, 1989), suggesting that the language relationship did not play a major role in the absence of cognate priming. Moreover, although a priming paradigm was not employed, Taylor (1976) reported an effect of cognate status in a continued word association task for

French-English bilinguals, suggesting that it is possible to obtain cognate effects with this specific language combination.

An alternative explanation centers on the modality of presentation. To our knowledge, all past studies of cognate priming reported in the literature have focused on *visual*, rather than *auditory* presentation of stimuli. As noted in the introduction, relying on the visual modality poses a problem, as there is no way to ensure that the subject has perceived the stimulus in the language intended by the experimenter. A cognate word is called "cognate" simply *because* it shares so many phonological and form-based features with its translation equivalent. One or two letters' difference may not be enough to prevent a subject from "mis-perceiving" the intended language of a prime or target; if monolingual readers demonstrate the ability to read misspelled words, why would we not expect the same from bilingual readers? Both primed lexical decision and translation task paradigms that have supported the cognate effect in the literature are at high risk for this "mistaken identity" factor in that they have presented either the prime, the target, or both, through visual/orthographic means. In their 1991 study, de Groot and Nas found that cognate translation ("repetition") priming was equivalent to within-language literal repetition priming. It is possible then, that the cognate translation effect could be, in fact, a literal repetition effect if the subject perceives both the prime and target as being in the same language. The present study has reduced the risk of "mistaken language identity" by

presenting primes and targets auditorily, as the degree of overlap in phonetic/phonological information between words in the two languages is considerably decreased compared to orthography. Contrary to orthographic word recognition, in which words of two languages may share identical letter symbols, there is evidence that spoken word recognition is tagged with language-specific phonetic cues (e.g. VOT) which automatically label items as belonging to one language or the other in the pre-lexical, or perceptual, stage of processing (Caramazza et al, 1974). Although we must always caution against interpreting a null result, the lack of a cognate status effect in the present study under auditory presentation conditions raises the question of whether it is possible to replicate this effect in the auditory modality.

If it is indeed impossible to obtain the effect of cognate status auditorily, then why? One possibility is that cognate priming in visual experiments (and possibly identity repetition priming as well) may reflect facilitation at the pre-lexical, perceptual stage of processing (access to phonology). As such, auditorily presented cognates, possessing more dissimilar information at the perceptual and phonological levels, would show less pre-lexical facilitation than visually presented words, as the degree of perceptual overlap, or "matching", is much higher in the case of orthographically presented cognates.

How much phonetic and phonological similarity is needed to result in priming? Evidence for facilitation of spoken word recognition based on

phonological similarity comes from monolingual phonological and rhyme priming studies. Slowiaczek et al. (1987) demonstrated that although words overlapping in only one initial phoneme did not produce any more priming than words sharing no phonemes, significant priming was found for phonologically identical words, words with two or more initial overlapping phonemes, or overlapping final phonemes. Priming has also been found for rhyming words and non-words (Burton, 1989, as cited in Gordon, 1992). Although the cognate stimuli in our study may have had a great number of overlapping graphemes, there is a possibility that they shared very few phonemes, and that if any phonemes were shared, there were never two or more overlapping in sequence.

This brings us to yet another question: are phonological units represented separately across languages, or do general language-independent phonological units exist which contain allophones (different phonetic realizations) of each phoneme, depending on the language of use? For example, as noted earlier, it has been found that the phonemes /p/ and /b/, /t/ and /d/, and /k/ and /g/ have a different VOT when produced in French than in English, and that these phonemes are thus automatically and immediately perceived in CV syllables as being in one or the other language, regardless of language context (Caramazza et al, 1974). This finding suggests that phonological information is represented in a language-specific manner, and could explain why we failed to obtain phonological priming across

languages; however, this issue needs to be investigated more fully.

Another possible explanation for the lack of phonological priming is that there is some evidence that the phonological priming effect is strategic, or conscious, in nature, and is thus influenced by length of ISI and proportion of phonologically related words (Goldinger, Luce, Pisoni & Marcario, 1992). Moreover, it has been noted to occur in a word identification task (e.g. Slowiaczek et al., 1987) but not in a short-ISI lexical decision task (Slowiaczek and Pisoni, 1986). Thus it is possible that phonological priming did not emerge in the present study because, consistent with results from Slowiaczek and Pisoni (1986) and Goldinger et al. (1992), the short-ISI lexical decision task significantly reduced the opportunity for conscious processing.

There is one final possible explanation for the absence of cognate priming. Goldinger and colleagues (Goldinger, Luce, & Pisoni, 1989; Luce, Pisoni, & Goldinger, 1990; Goldinger, Luce, Pisoni & Marcario, 1992) have distinguished between phonological and *phonetic* priming. Where phonological priming would involve the overlap of phonemes, *phonetic* priming is described by these authors as the effect obtained when primes share acoustic-phonetic features with targets, or phonemes rated as highly "confusable" (e.g. /b/ vs. /v/), yet in the absence of overlapping phonological information. Within this framework, although the cognate stimuli may have had very little *phonological* overlap, they may have possessed a great deal of overlapping *phonetic* information. Goldinger and colleagues have

developed a model in which spoken word recognition is influenced by a "neighborhood" of phonetically similar words which is initially activated along with the target stimulus (Goldinger et al., 1989; Goldinger et al., 1992). According to this model, competition arises from other members of this "similarity neighborhood", resulting in inhibition of word recognition (slower response times in the lexical decision task). Thus, this model predicts that phonetically related words (e.g. BULL-VEER) should produce more inhibition than unrelated words (e.g. GUM-VEER). It is has been found that as neighborhood density (number of phonetically similar words activated by the prime) increases, so too does inhibition, suggesting increased competition from other members of the neighborhood (Goldinger et al. , 1989). Moreover, unlike the phonological priming effect, the *phonetic* priming effect has been found to be automatic in nature, reflecting pre-lexical processes. The cognate words in the present study may have had a high degree of phonetic similarity not only because "equivalent" phonemes across languages share similar phonetic features (e.g. place and manner of articulation), but also because cognate word pairs naturally share similar vowel-consonant syllable structure. It is possible, then, that this phonetic similarity may have resulted in activation of a phonetically similar "neighborhood"of competitors, leading to inhibition of target recognition; however, to date it remains unclear how words that share auditory characteristics affect one another, and further investigations are required to understand the nature of phonological and

phonetic priming.

In sum, the lack of cognate priming in the present study is inconsistent with previous findings of cognate priming in visual priming studies (Taylor, 1976; Cristoffanini et al., 1986; de Groot & Nas, 1991; de Groot, 1992a; Sánchez-Casas et al., 1992; de Groot et al., 1994). Previous studies that have obtained cognate priming have suggested that cognates may be represented within shared representations at the lexical level; our failure to replicate this effect in the auditory modality does not support this hypothesis. Moreover, whereas de Groot & Nas (1991) obtained this effect in a visual lexical decision paradigm, the present study failed to replicate cognate priming in a comparable auditory task. It is clear that this issue merits further attention in future investigations of bilingual cognate priming.

Compound versus Subordinate Lexical Organization

The second main goal of the present investigation was to determine whether there are differences in lexical organization between Compound and Subordinate bilinguals, as per the developmental hypothesis (Kroll & Curley, 1988; Kroll & Sholl, 1992; Kroll, 1993). Recall that the developmental hypothesis holds that early in second language acquisition, words are mediated through lexical links and gradually, with increased proficiency, conceptual links develop and strengthen, shifting the preferred route of processing from word association to conceptual mediation (Potter et al., 1984).

We tested this hypothesis by including not only older second language learners, but also young childhood learners who acquire both L1 and L2 simultaneously, resulting in compound bilingualism (Weinreich, 1953). It was proposed that compound bilinguals acquire L2 conceptual links within the same time frame and acquisitional process as for L1, due to their simultaneous acquisition of L1 and L2 word concepts. Compounds thus develop equivalent fluency in each language by accessing L2 concepts as efficiently and directly as L1 concepts, never needing to rely on lexical links. Based on these assumptions, it was predicted that the Compound bilinguals, having acquired both languages before age five and demonstrating near equal fluency in both English and French, would show evidence for direct conceptual links in both L1 and L2, with an absence of direct lexical links across languages.

Contrary to Compound bilinguals, we predicted that the Subordinate bilinguals should reflect the initial stage of acquisition described in the developmental model as they are adult learners who have already fully acquired L1 but who still have low L2 proficiency. According to this model, subordinate bilinguals should only demonstrate indirect L2 conceptual access through lexical connections to L1, as no L2 conceptual links are expected to have developed at this early stage. Somewhat surprisingly, the present findings provided little support for the developmental model of compound versus subordinate lexical organization in that both subject groups

demonstrated similar performance on all three experimental tasks; however, a more general model of bilingual lexical organization may be derived from our results.

Compound Bilinguals

As predicted, the Compound bilinguals showed conceptually mediated translation and associative priming, not only for both within-language experiments, but also across languages, indicating the existence of direct conceptual links in both L1 and L2. This group showed no evidence of direct lexical links, however, in that no presumably form-based facilitation was shown for cognates relative to noncognates in either translation or associated conditions (but see earlier discussion concerning the absence of a cognate effect). Thus, the Compound bilinguals' conceptually mediated performance is consistent with a number of models in which the lexico-semantic system of Compound bilinguals is characterized by a common conceptual store accessed by both L1 and L2 direct links (Weinreich, 1953; Ervin & Osgood, 1954; Paradis, 1978; Potter et al., 1984). Absence of formal mediation is consistent with our predictions regarding a bilingual who acquires two languages simultaneously. This finding counters Kroll's (1993) prediction that lexical links remain in highly proficient bilinguals; however, Kroll was referring to the older second language learner and not to simultaneous, bilingual language acquisition in a young child. Although the absence of

lexically-based effects in the present study is consistent with our prediction (as part of an extended developmental model) of the absence of lexical links in the *early childhood* bilingual, we must take caution in interpreting this null result, as the lack of these effects in the present study might be explained by a number of other factors, as discussed earlier. However, should this finding simply reflect a lack of direct lexical links in the Compound bilingual, it might be explained in the following manner: as the child developing two languages begins to associate word forms with concepts in the world around him, he acquires mappings between those word forms and the concepts which they represent in both languages at the same time. Unlike an older child or adult who already possesses mappings of L1 forms to concepts and who can benefit in L2 performance from "borrowing" of L1 conceptual knowledge, the very young bilingual lacks a developed conceptual system and thus can find no benefit from mediating L2 words through L1 connections.

In sum, based on evidence from the present study, the compound bilingual lexical system may be described as one in which word forms are directly connected across languages by means of a shared conceptual system (Weinreich, 1953; Ervin & Osgood, 1954; Paradis, 1978; Potter et al., 1984). As previously discussed, this conceptual system may be characterized as a network of distributed conceptual information nodes in which items across languages with more shared conceptual information have more direct

connections, indicated by increased facilitation for translations relative to associated words (Collins & Loftus, 1975; Jin, 1990; de Groot & Nas, 1991; de Groot, 1992a; 1992b; 1993). One might tentatively conclude that Compound bilinguals showed no reliable evidence of direct lexical links across translation equivalents, given the absence of an effect of cognate status. As noted earlier, this claim must be interpreted cautiously, however, due to the myriad of potential explanations on the lack of this effect. The underlying lexical profile of our Compound bilinguals is consistent with past models of compound bilingualism in that words are represented by separate lexical (form-based) representations across languages, each with their own direct links to common conceptual information (Weinreich, 1953; Ervin & Osgood, 1954; Paradis, 1978). However, it differs from previous models in that the shared conceptual information appears to be represented across several distributed information nodes, as opposed to one, single shared concept node, as evidenced by differences in size of facilitation effects depending on degree of semantic overlap, from translations to associated words (Collins & Loftus, 1975; Jin, 1990; de Groot & Nas, 1991; de Groot, 1992a; 1992b; 1993).

Subordinate Bilinguals

In contrast to the compound bilinguals, the developmental hypothesis predicts that the underlying lexical organization of low L2 proficiency, subordinate bilinguals will be consistent with Potter et al.'s (1984) word

association model. As noted earlier, this model predicts that subordinate bilinguals--lacking in L2 proficiency--will demonstrate L2 to L1 lexical mediation as they lack direct L2 conceptual links; they must rely on direct lexical links between translation equivalents in order to access meaning indirectly through L1. According to this model, conceptually-based translation and associative cross-language priming effects should either be significantly reduced or not at all present, as all conceptual access occurs indirectly through lexical mediation. Moreover, since the word association model holds that direct conceptual links are absent in L2, conceptually-based priming in a monolingual L2 experiment should be even more reduced than for a cross-language experiment, as access from one L2 concept to another would occur entirely by means of L1 lexical mediation. For this reason, we expected associative priming to be reduced in the monolingual L2 (English) experiment relative to the monolingual L1 (French) experiment, or possibly altogether absent. Contrary to the word association model on both counts, the Subordinate bilinguals showed strong and significant conceptually-based translation and associative priming, not only in a monolingual L1 (French) experimental task, but also in both L2 (English) and cross-language experiments. Moreover, the cross-language priming effects were noted to be equivalent to those obtained for Compound bilinguals, if not stronger, while priming effects in the monolingual L2 (English) task were comparable to those obtained in the monolingual L1 (French) task where direct conceptual

links were presumed to have existed. The Subordinate bilinguals' performance was thus inconsistent with the word association model (Potter et al., 1984); in contrast, like the Compound bilinguals, the performance of the Subordinate group was consistent with Potter et al.'s (1984) concept mediation model, in which direct conceptual links exist in both L1 and L2. Moreover, like the Compound bilinguals, the Subordinates failed to demonstrate expected cognate facilitation effects (presumed to be lexically-based), suggesting the possibility of a lack of direct lexical connections between translations and further supporting the concept mediation hypothesis (but see earlier discussion cautioning regarding conclusions based on a lack of the cognate effect). Therefore, the performance of the Subordinate bilinguals is inconsistent with the initial word association stage, as per the developmental shift hypothesis (Kroll & Curley, 1988; Kroll & Sholl, 1992; Kroll, 1993). Surprisingly, even when selected for their low proficiency and limited second language experience, the Subordinate bilinguals demonstrated the same pattern of conceptual processing (conceptual mediation) as the high-proficiency, "richly" bilingually experienced Compound group. This finding is inconsistent with the results of Kroll and Curley's (1988) study which found support for a "critical phase" in L2 lexical development (Potter et al., 1984) in which beginning, low fluency bilinguals must rely on lexical links for indirect conceptual access (word association) until they become proficient enough to develop direct L2

conceptual links (concept mediation). Aside from the fact that they employed a different task, Kroll and Curley selected their "less fluent" bilinguals on the basis of "expertise", an ambiguous term because it simultaneously implies proficiency and amount of experience in L2. If it is in fact *experience* and not *proficiency* that is the key factor in determining the "critical phase" of bilingual lexical development, then it is possible that our bilinguals may have already passed through this "word association" phase of development. Although they were rated as having relatively low L2 proficiency, the Subordinate bilinguals in the present study had a mean length of L2 speaking experience of 7.5 years as compared to Kroll and Curley's (1988) bilinguals who had only 2.5 years experience in L2 usage. Thus, the Subordinate bilinguals in the present study may already have passed the critical *experiential* phase of lexical development, though their proficiency remains relatively low. However, should a "critical phase" exist, its nature and determinant factors remain to be explored further in future research on second language acquisition.

Although it is possible that the Subordinate bilinguals in the present study have already passed through a critical phase from word association to conceptual mediation, Kroll and Sholl (1992) hold that bilinguals (older second language learners) who have developed L2 conceptual links still possess lexical links. They propose that lexical links remain active for these bilinguals, even once conceptual links are established, and that these links

may still be used when lexical processing is more beneficial than conceptual processing. Contrary to expectations, there was no evidence of facilitation for cognates relative to noncognates in either the translation or the associated conditions. If we assume that the absence of a cognate priming effect is not simply a function of methodological constraints, then it may indicate that the lexical route of processing was not employed, contrary to Kroll and Sholl's (1992) hypothesis. One possible explanation for such a finding might be that following acquisition of L2 conceptual links, the Subordinate's lexical links may weakened from lack of use to the point that they are no longer as efficient as conceptual links, or lexical links may even disappear altogether.

The findings of the present investigation are most consistent with Ervin and Osgood's (1954) model of compound bilingualism, which fused Weinreich's (1953) subordinate developmental profile with the compound type. According to Weinreich (1953), the subordinate system is closely related to the compound system, in that a subordinate, lexically mediated system may develop into a compound, conceptually mediated one; moreover, lexical organization may differ depending on the bilingual's experience with each specific word. As such, our Subordinates may actually have developed a compound lexical system for many basic, high frequency L2 lexical items such as the ones tested in this experiment, while still using a subordinate organization for less frequently encountered L2 items. Similarly, there may be a dissociation in organization between the different components of

language processing and representation: for example, while the lexico-semantic system of the Subordinate bilingual may be compound, or conceptually mediated, implicit knowledge required for processing of L2 grammatical meaning might be mediated through L1 knowledge. These issues are all essential to a better understanding of subordinate bilingualism and thus merit further investigation.

The present results support a bilingual lexicon which is hierarchically organized (Snodgrass, 1984; Kroll & Sholl, 1992; Kroll & Stewart, 1994) with a common, language-independent conceptual network on one level (Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Chen & Ng, 1989; Tzelgov & Eben-Ezra, 1992) and separate representations across languages at the lexical level (Durgonoglu & Roediger, 1987; Paivio & Desrochers, 1980; Paivio, 1991). There is evidence that this conceptual network is organized in terms of shared distributed conceptual representations (de Groot, 1992a; 1992b; 1993), where increases in overlap of semantic feature nodes across languages result in greater facilitation effects (e.g. translations significantly faster than associated words, concrete word pairs significantly faster than abstract word pairs).

Differences in Compound vs. Subordinate Performance Factors

It should be noted that although our two subject groups did not differ in terms of patterns of priming, the Subordinate subjects were found to

respond significantly slower than Compounds overall in the monolingual English experiment, the Subordinate group's L2, as well as in the cross-language experiment, evidence that lexical processing occurred more slowly in their non-dominant language. These findings are best explained through a model of lexical access which is sensitive to word frequency, such as the logogen model (Morton, 1969). Increased word frequency has been found to facilitate word recognition in both monolingual and bilingual language processing tasks (Morton, 1969; de Groot, 1992a). Within the logogen model explanation, resting activation levels are determined in large part by word frequency, as high frequency words are activated more often. Morton proposes that less input is required to reach the activation threshold for these high frequency lexical nodes, explaining his findings that high frequency words are recognized more quickly than lower frequency words (Morton, 1969). Recently, Morrison and Ellis (1995) have provided evidence that word frequency effects are related to the age of acquisition of specific lexical items in monolinguals, in that words acquired earlier in the lifespan had stronger word frequency effects. We might extend this notion to our study of the bilingual lexicon, and expect that the Subordinate bilinguals, having only begun to acquire L2 lexical items later on in life (after age 14), would show reduced resting activation levels for L2 words, regardless of their "normed" frequency, simply because they have had less experience activating these lexical nodes. The current findi[illegible] slowed lexical decisions in L2 or L2-L1

conditions with intact semantic priming effects supports this hypothesis, and is consistent with previous findings of slowed L2 performance from other bilingual priming studies (citations to follow).

A surprising finding is that the Subordinate group showed significantly more facilitation relative to unrelated stimuli than the Compound group, but only for cross-language stimuli. This finding, combined with the fact that Subordinates showed overall slower RTs in relation to Compounds, suggests a possible influence of post-lexical meaning integration processes, occurring after automatic lexical access (Seidenberg et al., 1984). Even though we attempted to control for pre-lexical, strategic processes by employing a short ISI, subjects who took longer to respond would have had more opportunity to have been influenced by contextual information after lexical access. A recent paper by Keatley and de Gelder (1992) has demonstrated that the cross-language semantic priming effect may be influenced by semantic information after word recognition in order to achieve greater comprehension, but that this semantic integration process may be significantly reduced by encouraging speeded responses from subjects. If these post-lexical processes were in part responsible for the magnitude of the facilitation effects found, then it would follow that those subjects (Subordinate) who responded more slowly would have had more opportunity to use contextual information and thus show larger priming effects. Future investigations of Compound versus Subordinate bilinguals

employing speeded response conditions might shed more light on this issue.

Surface Differences and Underlying Similarities

While the present findings shed much light on bilingual lexical organization, the effect of language acquisition factors on lexical function remains ambiguous. It is perplexing that two groups of bilinguals with such developmentally contrasting profiles would show the same basic underlying lexical system. How is it possible for two groups so different on the surface in terms of proficiency, or language "performance", to be so similar in underlying lexical "competence" (Chomsky, 1965)? The present study demonstrates a clear dissociation between underlying implicit lexical knowledge on one hand, and developmental factors such as age, manner, and context of L2 acquisition on the other. Surface differences between bilinguals might better be explained in terms of differences in the underlying competence of other aspects of linguistic knowledge (e.g. phonology, grammar, syntax) or from differences in processing strategies on a more conscious and explicit level; both of these are issues which require future investigation.

Conclusions

The results of the present study failed to support the existence of an early word association stage in L2 development (Potter et al., 1984; Kroll & Curley, 1988; Kroll & Sholl, 1992; Kroll, 1993). Compound bilinguals demonstrated the expected pattern of lexico-semantic processing, supporting the concept mediation model and previous descriptions of the compound bilingual system (Weinreich, 1953; Paradis, 1978). However, Subordinate bilinguals, specifically selected to represent the least linguistically "balanced" end of the bilingual continuum, were found to use conceptual mediation, even though they had reduced proficiency in L2 and were older L2 learners. These findings suggest that second language acquisition factors such as age of acquisition and level of proficiency have little influence on underlying lexical organization, at least with regard to Subordinate and Compound bilingualism. This finding has significant implications for the field of second language education in that it indicates that it is possible for older language learners to attain the same underlying L2 lexico-semantic competence as infant bilinguals for word recognition, even with a low level of spoken proficiency in L2. The results also have implications regarding the treatment of bilingual aphasics, in that even premorbidly low-proficiency L2 speakers may be able to benefit from indirect cueing (possibly even self-cueing) strategies through activation of lexical nodes in the more preserved language. Surprisingly, the Subordinate group's lexical profile failed to

match the lexically mediated one described by Weinreich (1953) and Paradis (1978), but instead followed the conceptual mediation model.

Consistent and statistically significant translation and associative priming effects were obtained for both groups of bilinguals, converging with previous findings in support of a common conceptual network (Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Chen & Ng, 1989; Tzelgov & Eben-Ezra, 1992). The presence of these effects across both bilingual groups supports the robustness of the semantic and associative priming effects (Tzelgov & Eben-Ezra, 1992), in that 1) they were found not only for fluent early bilinguals, but also for less fluent late bilinguals, and 2) they were replicated in an auditory modality. On the other hand, the current lack of cognate facilitation raises many questions regarding the nature of the cognate priming effect--especially in the auditory modality--and merits further investigation.

Based on the obtained patterns of lexical and conceptually-based effects, a general model of compound bilingualism has been proposed which fuses the two language acquisition profiles of Weinreich's (1953) Compound and Subordinate bilinguals together in a manner similar to Ervin and Osgood (1954). Thus we have evidence for a more general compound bilingual model of lexical organization, characterized by direct connections to a common system of distributed conceptual nodes at the level of underlying lexical representation, but which corresponds to a wide range of acquisitional

and performance factors on the surface. The notion of Subordinate bilingualism may apply more appropriately to other linguistic processing components. More detailed study of bilinguals with a wider range of L2 acquisitional experiences is needed in order to better understand the relationship between these developmental factors and the organization of the bilingual lexicon.

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Appendix A: Language Profiles of Compound and Subordinate Subjects (Distribution of Responses on Questionnaire)

Compound Bilinguals (N=19)

Subjects: CC, CD, CE, CF, CG, CH, CI, CJ, CK, CL, CM, CN, CQ, CR, CS, CT, CU, CV, CY.

Mean Age: 23.4

Age Range: 17 - 31

Gender: 6 Male 13 Female

Handedness: 17 Right 1 Left 1 Both

Level of education completed: 1 CEGEP 9 Some university
7 University 2 Postgraduate or Doctorate

Did you learn French and English at the same time? 13 Yes 6 No

Did you acquire both languages before age 5? 19 Yes 0 No

Did you speak both languages in the home? 15 Yes 4 No

Do you speak any other languages well? 6 Yes 13 No

If so, which other languages? 4 Spanish 1 Arabic 1 Italian 1 Hebrew
1 Yiddish 1 German

Which language are you most comfortable speaking? 3 English 2 French
14 Both Equally

How often do you switch from one language to another? 4 Sometimes
9 Often
6 Almost Always

Do you find that switching from one language to the other is
0 Very Difficult 0 Somewhat Difficult 2 Relatively Easy 17 Very Easy

I speak (or have spoken) French on a regular basis at:

19 Home 16 Work 14 School 18 Socially

Combinations: 11 Home, Work, School & Socially
4 Home, Work & Socially
1 Home & Work
3 Home, School & Socially

I speak (or have spoken) English on a regular basis in the following contexts:

13 Home 17 Work 17 School 17 Socially

Combinations: 12 Home, Work, School & Socially
4 Work, School, Socially
1 Home, Work & School
1 Home, Work & Socially
1 Socially Only

I usually listen to the radio in	8 English	0 French	11 Both Languages
I usually watch television in	11 English	0 French	8 Both Languages
I usually watch movies in	10 English	0 French	9 Both Languages

Subordinate Bilinguals (N=17)

Subjects: SA, SB, SF, SG, SH, SI, SJ, SK, SM, SN, SO, SP, SQ, SR, SS, ST, SU.

Mean Age: 24.3

Age Range: 20-32

Gender: 5 Male 12 Female

Handedness: 16 Right 1 Left

Level of education completed: 2 CEGEP 8 Some University
6 University 1 Postgraduate or Doctorate

Did you learn French and English at the same time? 0 Yes 17 No

Did you acquire both languages before age 5? 0 Yes 17 No

If not, did you acquire English after age 14? 17 Yes 0 No

Did you speak both languages in the home? 1 Yes 16 No

Do you speak any other languages well? 1 Yes 16 No

If so, which other languages? 1 German

Which language are you most comfortable speaking? 0 English 16 French
1 Both Equally

How often do you switch from one language to another? 5 Rarely
7 Sometimes
4 Often
1 Almost Always

Do you find that switching from one language to the other is
0 Very Difficult 5 Somewhat Difficult 9 Relatively Easy 3 Very Easy

I speak (or have spoken) French on a regular basis at:

17 Home 16 Work 16 School 17 Socially

Combinations: 15 Home, Work, School & Socially
1 Home, Work & Socially
1 Home, School & Socially

I speak (or have spoken) English on a regular basis in the following contexts:

1 Home 8 Work 7 School 11 Socially

Combinations: 1 Home, Work, School & Socially
3 Work, School & Socially
2 School & Socially
1 Work & School
4 Socially Only
3 Work Only
1 School Only
1 Only When Travelling
1 Never on Regular Basis

I usually listen to the radio in	3 English	2 French	12 Both Languages
I usually watch television in	1 English	2 French	14 Both Languages
I usually watch movies in	4 English	4 French	9 Both Languages

Appendix B: Age of Acquisition* of Subjects in Each Language

Subject	Compounds		Subordinates	
	French	English	French	English
1	0	2	0	14
2	0	0	0	15
3	0	0	0	19
4	3	0	0	15
5	0	2	0	20
6	0	0	0	14
7	0	0	0	15
8	0	0	0	14
9	0	0	0	17
10	0	0	0	14
11	0	3	0	16
12	0	4	0	19
13	0	0	0	15
14	0	5	0	16
15	0	4	0	14
16	4	0	0	17
17	0	0	0	17
18	0	4		
19	0	3		
Mean	0	1	0	16

*Ages calculated based on the answer to the question "How many years have you been speaking English/French?", subtracted from the subject's chronological age. Hence ages 0-2 refer to the age at which the acquisitional process began, not necessarily to the age at which the subject was actually *speaking* the language.

Appendix C: Total Language Ratings*- Compound and Subordinate Groups

Compound Bilinguals

Subject	Mean Scores- Production Ratings		Self-Ratings			
			Production		Comprehension	
	French	English	French	English	French	English
CC	7	6.2	7	7	7	7
CD	5.8	6.8	6	7	7	7
CE	6.2	5.6	7	7	7	7
CF	6.8	6.6	5	5	7	7
CG	6.6	6.6	7	7	7	7
CH	5.8	7	7	7	7	7
CI	7	6.8	7	7	7	7
CJ	6.6	6.8	6	7	7	7
CK	6.8	6.8	6	6	7	7
CL	6.2	5	7	7	7	7
CM	7	6.6	7	7	7	7
CN	7	6.8	6	7	7	7
CQ	5.8	6.2	7	7	7	7
CR	6.4	6.8	7	7	7	7
CS	6	6.2	6	7	7	7
CT	6.4	6.8	5	6	6	6
CU	5	6.2	6	7	6	7
CV	6.2	6.8	6	7	7	7
CY	5.6	7	5	7	7	7
Mean	6.33	6.51	6.32	6.79	6.89	6.95

Subordinate Bilinguals

Subject	Mean Scores- Production Ratings		Self-Ratings			
			Production		Comprehension	
	French	English	French	English	French	English
SA	6.4	3.2	7	6	7	6
SB	7	3.2	7	2	7	6
SF	7	3	7	3	7	5
SG	6.6	3.8	7	3	7	4
SH	6.4	3.8	7	2	7	5
SI	6.4	2.6	7	3	7	6
SJ	6.4	2.4	6	2	6	3
SK	6.6	4	7	3	7	4
SM	7	4.8	7	5	7	7
SN	6.6	3	7	2	7	5
SO	6.8	4.6	7	4	7	6
SP	7	3	7	4	7	6
SQ	6.4	2.4	7	4	7	6
SR	6.8	2.4	6	3	7	4
SS	6.6	3.6	7	5	7	5
ST	7	4	7	4	7	5
SU	6.4	4	7	5	7	6
Mean	6.67	3.4	6.88	3.53	6.94	5.24

*Language proficiency ratings based on 7-point scale where 1=worst and 7=best score.

Appendix D: Language Usage by Each Subject Group: Percentage (%) of Day when Each Language Spoken*

Subject	Compounds		Subordinates	
	French	English	French	English
1	30	70	98	2
2	50	50	95	5
3	70	30	99	1
4	75	25	100	0
5	65	35	90	10
6	5	95	100	0
7	50	50	66	1
8	60	40	99	1
9	35	65	95	5
10	25	75	95	5
11	95	5	90	10
12	40	60	98	2
13	10	90	95	5
14	55	45	90	10
15	4	96	50	50
16	1	99	50	50
17	45	55	80	20
18	10	90		
19	10	90		
Mean	39	61	88	10

*Self-judgments of proportion of daily speaking time in each language, in percent (%) .

Appendix E: Stimuli Used in Cross-Language Experiment

Cognate Translations	Cognate Associated	Unrelated Pairs
plante/plant	thé/coffee	fève/hair
forêt/forest	vallée/mountain	crayon/father
chaîne/chain	lettre/paper	bateau/ear
taxe/tax	soldat/army	écran/mouth
silence/silence	théâtre/film	clou/week
moteur/motor	rivière/lake	cadeau/grass
train/train	jury/judge	savon/shadow
police/police	pompe/gas	fil/stone
bébé/baby	piano/note	gazon/world
parc/park	bleu/colour	fantôme/bridge
code/code	minute/second	bougie/yard
art/art	océan/bay	chemise/nose
plan/plan	leçon/class	orage/wood
système/system	musique/dance	bonbon/shelter
tube/tube	docteur/patient	mouche/lawyer
branche/branch	orchestre/concert	bruit/clay
âge/age	est/west	coquille/level

Noncognate Translations	Noncognate Associated	Word + Nonword Pairs
doigt/finger	fille/boy	canard/trin
camion/truck	été/winter	pouce/sporm
maison/house	glace/snow	ordure/meath
genou/knee	main/foot	souris/drick
jambe/leg	porte/window	miel/mupe
lit/bed	homme/woman	tigre/glork
trou/hole	poisson/water	salade/blim
enfant/child	chapeau/head	aiguille/jave
écrivain/writer	sable/beach	pain/troz
cheval/horse	marteau/tool	lame/sab
livre/book	pluie/cloud	baleine/keef
fête/party	graine/flower	lapin/gort
chanson/song	jupe/dress	pomme/dilt
travail/work	roi/queen	castor/shim
voisin/neighbor	pneu/car	gant/saff
dent/tooth	aile/bird	règle/bolf
frère/brother	étoile/sky	huile/mub

Word + Nonword
Pairs (cont'd)

farine/loy
métro/shay
patin/glant
bijou/glab
crème/plet
agraffe/vab
éponge/seash
fauteuil/lape
colle/naf
écail/smed
goutte/visp
matin/crute
gibier/stin
exemple/stape
force/blun
proie/norb
laine/plave
mensonge/pish
plume/beace
terre/nize
formule/kafe
meuble/preak
pont/tretch
grève/blash
laitue/grom
microbe/gret
race/nark
foulard/gliss
gomme/drig
mine/dass
four/zill
épice/gleek
morue/tiss
foyer/trape
graisse/prit
langue/dom
moulin/plodge
fraise/louche
goudron/krade
érable/trass
sapin/lupp
navette/shing
fumée/spood
noix/biffle
larme/spiggle
rayon/sorneg
puce/lunter
linge/dontor
courge/shocket
écume/elran
cravate/tashet
épée/satter
croûte/clamis
fin/pooten
erreur/omler
épine/felman
flamme/parlet
espace/gassle
tonnerre/lemis
gâteau/tarem
radio/mortix
argent/monstry
drapeau/kromeg
cochon/corple
siège/banten
charbon/rensor
grenier/arnor
coude/gisto

Appendix F: Stimuli Used in Monolingual French Experiment

Associated

jour/nuit
frère/soeur
mois/année
cauchemar/rêve
vin/fromage
animal/chien
ennemi/ami
sport/équipe
religion/église
paix/guerre
pilote/avion
feuille/arbre
gorge/cou
chair/os
wagon/roue
vache/lait
poivre/sel

Unrelated

sac/mur
trompette/rue
soupe/poche
rideau/tasse
facture/racine
ours/courbe
menace/lumière
examen/mousse
oncle/oeuil
abeille/coeur
boite/cerveau
poupée/épaule
bain/ville
horloge/mer
citron/corps
lampe/emploi
chemin/poitrine

Word + Nonword

boue/mèdre
pièce/charpe
corde/quime
salle/bixe
peigne/grobe
stylo/muque
billet/ruit
tante/jamme
cloche/pidre
flèche/crite
montre/râche
épingle/gande
taxi/pouille
chat/chure
ruisseau/fûte
cuillère/houtte
serpent/nour
lèvre/satte
étang/turpe
clé/prue
chaleur/phède
visage/bûque
bras/hulle
globe/lude
guêpe/pitan
héro/ôlette
klaxon/vinoir
coton/tirou
liste/bognée
manche/armu
lutte/ordée
foin/idosse
loup/néfiste
renard/ilesse

Appendix G: Stimuli Used in Monolingual English Experiment

Associated

butcher/meat
ceiling/floor
shingle/roof
college/degree
height/length
bullet/gun
student/school
wife/husband
card/game
circle/square
fork/knife
restaurant/meal
air/wind
fashion/model
group/meeting
moon/sun
question/answer

Unrelated

rule/skin
mud/skill
patch/food
rope/traffic
hall/weapon
comb/kitchen
pen/wave
ticket/blood
aunt/room
bell/shoe
arrow/office
jaw/dust
nightmare/suit
watch/pool
pin/life
taxi/bottle
cat/trip

Word + Nonword

bean/pite
pencil/gree
boat/risp
screen/kade
nail/sare
gift/fint
soap/trin
thread/vorg
lawn/vig
ghost/preak
candle/snig
shirt/gaw
storm/plave
candy/goot
fly/noop
noise/speen
shall/greetch
bag/meace
flute/fitch
curtain/jarm
bill/plode
road/reast
bear/flade
threat/nadge
uncle/kompar
bee/hicket
box/kombly
doll/masha
bath/ramplin
clock/ansot
lemon/tanget
lamp/mensor
tape/neamer
sheet/mandest

Appendix H: Mean RTs* for Cross-Language Experiment

Compound Bilinguals

	Prime Type					
Subject	CT	NT	CA	NA	UR	NW
CC	840	764	900	888	904	1056
CD	709	626	710	648	785	950
CE	801	898	922	998	922	1121
CF	660	675	752	702	717	866
CG	462	444	617	606	710	728
CH	561	581	657	590	741	878
CI	477	485	637	603	709	757
CJ	581	597	589	627	665	907
CK	674	726	791	792	854	885
CL	651	611	705	685	719	801
CM	496	578	567	569	768	767
CN	765	764	865	796	848	1015
CQ	751	731	813	801	883	1111
CR	499	475	608	533	728	758
CS	677	722	854	756	941	1110
CT	605	685	746	767	908	904
CU	799	795	860	814	891	1217
CV	484	432	573	545	695	682
CY	628	661	765	728	820	909
Mean RT	638	645	733	708	800	917
SD	120	127	116	125	90	153
%Error**	6	6	7	6	8	
Mean RT	Translations	641	Associated	721	800	917
SD		122		120	90	153

CT=Cognate Translation Primes
NT=Noncognate Translation Primes
CA=Cognate Associated Primes
NA=Noncognate Associated Primes
UR=Unrelated Primes

NW=Nonword Targets (Foils)

N=19

*Mean Reaction Times Within 2 SD (in ms)
**Mean of Individual Subject Error Rates

Subordinate Bilinguals

Subject	CT	NT	CA	NA	UR	NW
			Prime Type			
SA	637	539	665	671	791	1016
SB	652	702	696	733	977	934
SF	638	640	717	706	894	869
SG	747	766	827	954	1135	1264
SH	541	536	669	560	786	1245
SI	795	748	842	824	1048	1041
SJ	693	725	949	874	954	1193
SK	708	650	738	737	917	1168
SM	842	774	917	865	1056	1872
SN	713	693	767	741	943	1104
SO	700	772	842	809	975	1129
SP	742	790	848	823	908	1011
SQ	435	476	643	637	840	800
SR	728	807	831	779	967	1080
SS	1161	1172	1164	1198	1302	1743
ST	715	716	723	704	934	1373
SU	747	699	789	739	918	963
Mean RT	717	718	802	786	961	1165
SD	148	151	129	142	125	283
% Error **	8	6	7	6	13	
Mean RT	Translations	718	Associated	794	961	1165
SD		147		134	125	283

CT=Cognate Translation Primes
NT=Noncognate Translation Primes
CA=Cognate Associated Primes
NA=Noncognate Associated Primes
UR=Unrelated Primes

NW=Nonword Targets (Foils)

N=17

*Mean Reaction Times Within 2 SD (in ms)
**Mean of Individual Subject Error Rates

Appendix I: Mean RTs* for Monolingual French Experiment

Compound Bilinguals

Subject	Prime Type A	UR	NW
CC	767	849	1359
CD	843	909	1265
CE	710	905	1086
CF	760	853	1005
CG	572	684	735
CH	587	839	992
CI	536	765	849
CJ	737	870	965
CK	756	812	920
CL	624	914	1011
CM	547	746	799
CN	813	875	1041
CQ	848	946	1452
CR	587	683	876
CS	753	929	1211
CT	703	878	1021
CU	732	934	1305
CV	504	702	755
CY	713	861	1132
Mean RT	689	840	1041
SD	107	85	204
% Error**	6	14	

N=19

A=Associated Primes
UR=Unrelated Primes

NW=Nonword Targets (Foils)

*Mean Reaction Times Within 2 SD (in ms)
**Mean of Individual Subject Error Rates

Subordinate Bilinguals

	Prime Type		
Subject	A	UR	N W
SA	609	741	1056
SB	660	808	912
SF	616	788	879
SG	761	847	1382
SH	792	954	930
SI	667	826	967
SJ	800	854	1093
SK	655	941	1017
SM	758	916	1623
SN	660	824	926
SO	747	926	1135
SP	804	899	1022
SQ	493	713	828
SR	681	857	1010
SS	1091	1186	1493
ST	785	1056	1905
SU	724	851	954
Mean RT	724	882	1125
SD	126	114	298
% Error**	7	14	

N=17

A=Associated Primes
UR=Unrelated Primes

NW=Nonword Targets (Foils)

*Mean Reaction Times Within 2 SD (in ms)
**Mean of Individual Subject Error Rates

Appendix J: Mean RTs* for Monolingual English Experiment

Compound Bilinguals

	Prime Type		
Subject	**A**	**UR**	**NW**
CC	836	905	1090
CD	686	775	890
CE	805	803	1031
CF	680	776	818
CG	570	685	719
CH	668	732	1045
CI	625	668	806
CJ	587	679	845
CK	737	779	840
CL	651	755	902
CM	603	756	869
CN	745	797	997
CQ	777	910	1314
CR	539	673	747
CS	796	943	1320
CT	666	847	908
CU	823	889	1052
CV	509	652	719
CY	711	761	1025
Mean RT	685	778	944
SD	98	88	174
% Error**	6	8	

N=19

A=Associated Primes
UR=Unrelated Primes

NW=Nonword Targets (Foils)

*Mean Reaction Times Within 2 SD (in ms)
**Mean of Individual Subject Error Rates

Subordinate Bilinguals

Subject	Prime Type A	UR	N W
SA	620	739	1069
SB	688	844	973
SF	724	793	846
SG	763	881	1251
SH	617	740	1369
SI	1041	1080	1201
SJ	795	858	1180
SK	795	1025	1128
SM	798	866	1308
SN	797	877	1356
SO	892	914	1164
SP	770	830	935
SQ	551	691	827
SR	767	848	1057
SS	1014	1111	1615
ST	786	853	1456
SU	770	778	1116
Mean RT	776	866	1168
SD	126	115	213
% Error**	8	8	

N=17

A=Associated Primes
UR=Unrelated Primes

NW=Nonword Targets (Foils)

*Mean Reaction Times Within 2 SD (in ms)
**Mean of Individual Subject Error Rates

Appendix K: Mean RTs*, % Error of Items Across Ss - Cross-Language Experiment

*Mean RTs within 2 SD (in ms)

Compound Bilinguals

Prime Type	Prime/Target	% Error	Mean RT*	SD
CT	plante/plant	0	642	106
CT	foret/forest	0	602	144
CT	chaine/chain	0	631	133
CT	taxe/tax	0	880	291
CT	silence/silence	0	711	234
CT	moteur/motor	0	653	161
CT	train/train	0	568	134
CT	police/police	0	612	174
CT	bebe/baby	0	627	135
CT	parc/park	0	689	186
CT	code/code	0	621	291
CT	art/art	0	613	136
CT	plan/plan	5	832	227
CT	systeme/system	0	722	198
CT	tube/tube	0	657	137
CT	branche/branch	0	558	142
CT	age/age	0	603	120
Mean RT			**660**	**86**
NT	doigt/finger	0	798	154
NT	camion/truck	0	630	236
NT	maison/house	0	628	172
NT	genou/knee	0	575	160
NT	jambe/leg	0	614	114
NT	lit/bed	0	602	196
NT	trou/hole	0	708	201
NT	enfant/child	0	624	207
NT	ecrivain/writer	0	601	172
NT	cheval/horse	0	705	222
NT	livre/book	0	570	200
NT	fete/party	5	765	166
NT	chanson/song	0	815	204
NT	travail/work	5	631	149
NT	voisin/neighbor	0	671	179
NT	dent/tooth	0	701	157
NT	frere/brother	0	622	132
Mean RT			**662**	**75**

CA	the/coffee	0	680	131
CA	vallee/mountain	0	769	183
CA	lettre/paper	0	741	208
CA	soldat/army	0	834	229
CA	theatre/film	0	816	124
CA	riviere/lake	0	673	122
CA	est/west	5	849	267
CA	jury/judge	0	691	126
CA	pompe/gas	0	668	158
CA	piano/note	0	714	119
CA	bleu/colour	0	667	111
CA	minute/second	0	856	188
CA	ocean/bay	5	772	128
CA	lecon/class	0	777	139
CA	musique/dance	5	748	160
CA	docteur/patient	0	702	133
CA	orchestre/concert	0	813	235
Mean RT			**751**	**66**

NA	fille/boy	0	722	214
NA	ete/winter	0	677	147
NA	glace/snow	0	845	129
NA	main/foot	0	776	210
NA	porte/window	0	683	138
NA	homme/woman	5	699	183
NA	poisson/water	0	727	228
NA	chapeau/head	0	668	195
NA	sable/beach	0	746	150
NA	marteau/tool	5	715	208
NA	pluie/cloud	0	800	240
NA	graine/flower	0	820	129
NA	jupe/dress	0	605	175
NA	roi/queen	0	674	169
NA	pneu/car	5	668	166
NA	aile/bird	0	685	226
NA	etoile/sky	0	780	125
Mean RT			**723**	**64**

UR	feve/hair	0	763	90
UR	crayon/father	0	853	89
UR	bateau/ear	21	749	229
UR	ecran/mouth	0	862	88
UR	clou/week	0	890	196
UR	cadeau/grass	0	807	190
UR	savon/shadow	5	968	135
UR	fil/stone	0	852	189
UR	gazon/world	0	721	137
UR	fantome/bridge	0	685	123
UR	bougie/yard	0	828	252
UR	chemise/nose	0	800	168
UR	orage/wood	0	672	159
UR	bonbon/shelter	5	881	99
UR	mouche/lawyer	5	863	100
UR	bruit/clay	0	857	158
UR	coquille/level	5	829	128
Mean RT			**816**	**78**

*Mean RTs within 2 SD (in ms)

Subordinate Bilinguals

Prime Type	Prime/Target	% Error	Mean RT*	SD
CT	plante/plant	6	734	157
CT	foret/forest	6	738	224
CT	chaine/chain	0	788	279
CT	taxe/tax	0	923	355
CT	silence/silence	0	697	213
CT	moteur/motor	0	856	405
CT	train/train	0	701	169
CT	police/police	0	673	144
CT	bebe/baby	0	727	246
CT	parc/park	6	668	158
CT	code/code	6	650	263
CT	art/art	0	692	160
CT	plan/plan	0	960	305
CT	systeme/system	0	753	172
CT	tube/tube	0	756	237
CT	branche/branch	0	810	313
CT	age/age	0	657	150
Mean RT			**752**	**91**
NT	doigt/finger	0	882	213
NT	camion/truck	0	659	200
NT	maison/house	0	835	178
NT	genou/knee	0	626	156
NT	jambe/leg	0	674	197
NT	lit/bed	0	663	296
NT	trou/hole	18	1106	448
NT	enfant/child	0	675	181
NT	ecrivain/writer	0	686	154
NT	cheval/horse	0	907	342
NT	livre/book	0	623	205
NT	fete/party	6	895	206
NT	chanson/song	0	765	199
NT	travail/work	0	665	263
NT	voisin/neighbor	0	681	128
NT	dent/tooth	6	783	250
NT	frere/brother	0	696	188
Mean RT			**754**	**131**

CA	the/coffee	0	749	114
CA	vallee/mountain	0	798	156
CA	lettre/paper	0	707	204
CA	soldat/army	0	791	304
CA	theatre/film	0	954	172
CA	riviere/lake	0	856	221
CA	est/west	0	799	213
CA	jury/judge	0	808	155
CA	pompe/gas	6	806	185
CA	piano/note	0	765	164
CA	bleu/colour	0	760	199
CA	minute/second	0	848	134
CA	ocean/bay	12	865	252
CA	lecon/class	0	977	340
CA	musique/dance	0	838	400
CA	docteur/patient	0	876	204
CA	orchestre/concert	0	814	118
Mean RT			**824**	**69**

NA	fille/boy	6	824	174
NA	ete/winter	0	775	176
NA	glace/snow	0	892	166
NA	main/foot	0	801	177
NA	porte/window	0	762	144
NA	homme/woman	0	749	221
NA	poisson/water	0	773	156
NA	chapeau/head	6	729	175
NA	sable/beach	0	770	155
NA	marteau/tool	6	853	198
NA	pluie/cloud	0	873	111
NA	graine/flower	0	926	221
NA	jupe/dress	0	715	216
NA	roi/queen	0	735	134
NA	pneu/car	0	764	161
NA	aile/bird	0	822	301
NA	etoile/sky	0	878	155
Mean RT			**802**	**63**

UR	feve/hair	6	929	147
UR	crayon/father	0	970	192
UR	bateau/ear	6	874	118
UR	ecran/mouth	24	1114	289
UR	clou/week	6	969	185
UR	cadeau/grass	6	960	199
UR	savon/shadow	6	1065	196
UR	fil/stone	6	1069	202
UR	gazon/world	0	876	151
UR	fantome/bridge	0	848	110
UR	bougie/yard	0	1025	354
UR	chemise/nose	6	989	186
UR	orage/wood	6	859	185
UR	bonbon/shelter	12	1083	153
UR	mouche/lawyer	6	1018	181
UR	bruit/clay	53	1008	222
UR	coquille/level	6	994	136
Mean RT			**979**	**81**

Appendix L: Mean RTs*, % Error of Items Across Ss - Monolingual French Experiment

*Mean RTs within 2 SD (in ms)

Compound Bilinguals

Prime Type	Prime/Target	% Error	Mean RT*	SD
Associated	jour/nuit	0	536	100
Associated	frere/soeur	0	671	240
Associated	mois/annee	0	806	182
Associated	cauchemar/reve	0	744	119
Associated	vin/fromage	0	772	162
Associated	animal/chien	0	677	115
Associated	ennemi/ami	0	633	131
Associated	sport/equipe	5	749	129
Associated	religion/eglise	0	705	148
Associated	paix/guerre	0	757	122
Associated	pilote/avion	0	634	145
Associated	feuille/arbre	0	855	252
Associated	gorge/cou	0	547	126
Associated	chair/os	0	659	90
Associated	wagon/roue	11	741	136
Associated	vache/lait	0	746	242
Associated	poivre/sel	0	714	180
Mean RT			**703**	**84**
Unrelated	sac/mur	0	839	156
Unrelated	trompette/rue	26	858	204
Unrelated	soupe/poche	0	1052	475
Unrelated	rideau/tasse	0	888	233
Unrelated	facture/racine	21	881	111
Unrelated	ours/courbe	0	1000	134
Unrelated	menace/lumiere	47	764	119
Unrelated	examen/mousse	11	897	159
Unrelated	oncle/oeuil	0	688	161
Unrelated	abeille/coeur	0	681	112
Unrelated	boite/cerveau	11	1050	551
Unrelated	poupee/epaule	11	853	119
Unrelated	bain/ville	37	876	180
Unrelated	horloge/mer	0	846	165
Unrelated	citron/corps	16	1193	381
Unrelated	lampe/emploi	5	912	112
Unrelated	chemin/poitrine	0	759	109
Mean RT			**885**	**132**

*Mean RTs within 2 SD (in ms)

Subordinate Bilinguals

Prime Type	Prime/Target	% Error	Mean RT*	SD
Associated	jour/nuit	0	608	151
Associated	frere/soeur	0	734	245
Associated	mois/annee	0	746	140
Associated	cauchemar/reve	6	742	156
Associated	vin/fromage	0	761	164
Associated	animal/chien	0	699	119
Associated	ennemi/ami	0	641	150
Associated	sport/equipe	0	806	264
Associated	religion/eglise	0	699	193
Associated	paix/guerre	0	786	149
Associated	pilote/avion	0	710	165
Associated	feuille/arbre	0	845	182
Associated	gorge/cou	6	622	126
Associated	chair/os	0	742	178
Associated	wagon/roue	6	814	134
Associated	vache/lait	0	763	207
Associated	poivre/sel	0	782	178
Mean RT			**735**	**67**
Unrelated	sac/mur	0	893	195
Unrelated	trompette/rue	6	961	269
Unrelated	soupe/poche	0	1137	259
Unrelated	rideau/tasse	0	882	237
Unrelated	facture/racine	18	944	122
Unrelated	ours/courbe	0	974	169
Unrelated	menace/lumiere	71	834	199
Unrelated	examen/mousse	0	942	151
Unrelated	oncle/oeuil	6	708	173
Unrelated	abeille/coeur	6	737	164
Unrelated	boite/cerveau	12	954	205
Unrelated	poupee/epaule	24	887	138
Unrelated	bain/ville	18	954	207
Unrelated	horloge/mer	0	961	123
Unrelated	citron/corps	6	1291	390
Unrelated	lampe/emploi	0	931	186
Unrelated	chemin/poitrine	0	804	177
Mean RT			**929**	**136**

Appendix M: Mean RTs*, % Error of Items Across Ss - Monolingual English Experiment

*Mean RTs within 2 SD (in ms)

Compound Bilinguals

Prime Type	Prime/Target	% Error	Mean RT*	SD
Associated	butcher/meat	0	642	143
Associated	ceiling/floor	0	694	144
Associated	shingle/roof	11	788	201
Associated	college/degree	0	626	105
Associated	height/length	5	769	150
Associated	bullet/gun	0	658	331
Associated	student/school	0	784	195
Associated	wife/husband	0	669	123
Associated	card/game	0	596	113
Associated	circle/square	0	720	99
Associated	fork/knife	0	604	150
Associated	restaurant/meal	0	758	111
Associated	air/wind	0	804	94
Associated	fashion/model	0	952	130
Associated	group/meeting	0	734	110
Associated	moon/sun	0	750	128
Associated	question/answer	0	680	234
Mean RT			**719**	**89**
Unrelated	rule/skin	0	821	72
Unrelated	mud/skill	11	1068	156
Unrelated	patch/food	0	804	89
Unrelated	rope/traffic	0	790	104
Unrelated	hall/weapon	5	765	132
Unrelated	comb/kitchen	0	681	111
Unrelated	pen/wave	5	941	172
Unrelated	ticket/blood	5	646	121
Unrelated	aunt/room	5	845	167
Unrelated	bell/shoe	0	814	195
Unrelated	arrow/office	0	801	116
Unrelated	jaw/dust	0	684	142
Unrelated	nightmare/suit	5	919	223
Unrelated	watch/pool	0	689	105
Unrelated	pin/life	0	801	112
Unrelated	taxi/bottle	11	780	127
Unrelated	cat/trip	5	774	134
Mean RT			**801**	**104**

*Mean RTs within 2 SD (in ms)

Subordinate Bilinguals

Prime Type	Prime/Target	% Error	Mean RT*	SD
Associated	butcher/meat	0	795	255
Associated	ceiling/floor	0	750	152
Associated	shingle/roof	5	876	135
Associated	college/degree	0	721	167
Associated	height/length	24	1167	211
Associated	bullet/gun	0	736	174
Associated	student/school	0	827	250
Associated	wife/husband	0	785	186
Associated	card/game	6	694	171
Associated	circle/square	0	781	178
Associated	fork/knife	6	758	223
Associated	restaurant/meal	0	746	116
Associated	air/wind	0	749	138
Associated	fashion/model	0	942	184
Associated	group/meeting	0	749	81
Associated	moon/sun	0	827	178
Associated	question/answer	0	722	243
Mean RT			**801**	**113**
Unrelated	rule/skin	0	865	89
Unrelated	mud/skill	0	1105	174
Unrelated	patch/food	0	893	177
Unrelated	rope/traffic	0	861	123
Unrelated	hall/weapon	0	892	167
Unrelated	comb/kitchen	0	740	132
Unrelated	pen/wave	0	945	130
Unrelated	ticket/blood	6	797	157
Unrelated	aunt/room	0	833	172
Unrelated	bell/shoe	6	975	280
Unrelated	arrow/office	0	939	215
Unrelated	jaw/dust	6	869	197
Unrelated	nightmare/suit	6	1028	200
Unrelated	watch/pool	0	876	316
Unrelated	pin/life	6	839	181
Unrelated	taxi/bottle	12	934	273
Unrelated	cat/trip	0	816	121
Mean RT			**895**	**88**