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The Model of Conceptual Structure Mapping: A Psycholinguistic Approach to Interlingual Representation

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1. INTRODUCTION. The purpose of the present paper is to demonstrate that the model of conceptual structure mapping (CSM) can be used to define the nature and the content of interlingual (IL) representation. The CSM model was initially proposed to address the issues of storage and representation in the memory of multilingual speakers (Belyayeva 1997). The model introduces the notion of conceptual structure as a heuristic device that explicates activation patterns in the memory of multilingual speakers in terms of a relational network organization of conceptual and lexical material. [1]

2. OUTLINE OF THE MODEL. Conceptual structure can be succinctly defined as a set of knowledge-based constructs such as frames, domains, and schemas that accommodate the conceptual knowledge and lexical items of a language in a way which reflects language-specific lexicalization patterns. The configuration of a given conceptual structure reflects language-specific lexical-conceptual activation patterns. According to the structural assumption of the CSM model activation patterns are determined by (1) similarity of word senses to a common abstraction, and (2) similarity between frames of reference. Initially, similarity relations between senses can be established at the basic level, where judgments primarily involve perception and interpretation of our immediate environments. Similarity between frames of reference can be established on the basis of common functional properties that can be realized within appropriate contexts. Both factors interact continuously. That is, retrieval patterns of non-prototypical senses, which are generally characterized by longer response latencies and lower frequency of recall, may be greatly facilitated by the activation of relevant contextual frames. For instance, the activation of such concepts as 'boxing' and 'wrestling' may provide a speeded access to the nonprototypical sense 'arena' in the relational organization of the English lexical item *ring*. [2]

The developmental assumption of the CSM model considers lexical-conceptual organization as a result of the lexical and conceptual development of an individual speaker. The processing patterns underlying concept formation and language acquisition are of particular importance, since they determine the possible activation patterns in lexical access.

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[1] The formal mechanisms assumed by the model include a relational network storage system with spreading activation. These are compatible with several theories and empirical findings of cognitive psychology and linguistics, e.g. Lamb's stratificational theory (Lamb 1966, 1971), a spreading activation theory of Collins and Loftus (1975), parallel distributed processing of McCelland, Rumelhart, et al. (1986), and Langacker's relational-network model (Langacker 1987, 1988).

[2] An example borrowed from Langacker (1988).

The notion of conceptual structure should be viewed as a heuristic device that explicates observed activation patterns in terms of a relational network organization of conceptual and lexical material. A bilingual has conceptual structures associated with L1 and L2, which I call CS1 and CS2. The mapping metaphor describes CS2 development as a process of mapping L2 lexical items onto converging conceptual representations in CS1. CS2 development is a result of the development and expansion of relational networks and inter- network connections. Relational networks of individual lexical items evolve when a lexical item is consistently used in different contextual frames. For example, a relational network of the English lexical item *ring* is formed in a variety of contextual frames that constitute bases for its component conceptualizations 'piece of jewelry', 'circular mark', 'circular sediment', 'arena'.

The conceptual structures of two different languages may have networks which are highly compatible, less compatible, or even incompatible. Compatible areas are associated with perceptually salient domains of human cognition (e.g. 'circular piece of jewelry'). Thus, the network representation of concrete nouns has been demonstrated to be highly compatible in many languages. The results obtained in semantic priming (Jin & Fischler 1987, de Groot & Nas 1991) demonstrates that a greater cross-linguistic priming effect is characteristic of concrete words, whereas greater language-specific variations are characteristic of abstract words.

The mapping metaphor represents a link between conceptual structures of a multilingual speaker and helps to explain the activation patterns observed in production. Incongruities resulting from mapping incompatible areas in conceptual structures of a multilingual speaker account for performance deficits in bilingual production, e.g. longer response times, lexical transfer and code-switching.

3. THE NATURE OF IL REPRESENTATION. The notion of the conceptual structure and the mapping metaphor can be used to account for conflicting empirical evidence. Thus, the evidence supporting the definitional ontology can be associated with the areas of greater congruity in the conceptual structures of a multilingual speaker, whereas the evidence supporting the interlingual ontology is largely a product of incongruous mappings. The interlingual ontology constitutes an empirically adequate approach to capture cross-language correspondences, whereas the definitional ontology provides a more theoretically-oriented perspective on the problem of word-knowledge representation. Although the search for a universal logical form might have some advantages in terms of economy of representations, substantial evidence from word-form ambiguity cases suggests that it would be more appropriate to adopt a distributed representation with common abstraction that may give rise to a variety of senses in various contextual frames. Therefore, the IL representation should include information that specifies which subsets of distributed representation are conventionalized in a language.

The structural and the developmental assumptions of the CSM model offer a means to select information essential for IL representations. Traditionally, non-language-specific representations have been associated with concrete nouns, since their conceptual representations were largely determined by perceptual abilities of speakers. However, such representations can not be fully identical due to variability in frames of reference that exist in different socio-pragmatic contexts and across languages in general. Some

examples illustrating frame-of-reference effects on representations were discussed in Paivio and Desrochers (1980) (representation of "church" in English and French), Casad and Langacker (1985) (representation of spatial terms in Cora grammar), and Lakoff 1987) (a cognitive model of "mother").

The CSM model views variability in the sets of frames of reference applicable for a given abstraction as a source for interlingual representation. Since relational organization emerges from extension of the common abstraction to various contextual domains, a degree of specialization and similarity in the sets of possible domains determine whether L2 information is stored as language-independent or as interlingual. For example, both English and Russian demonstrate the same degree of similarity of the sense "strap, girdle" to the common abstraction in the relational organizations of the English lexical item *belt* and its Russian equivalent *poyas.* Therefore, the IL representation of this sense does not require language-specific information. Although the relation between the sense "zone" and the common abstraction of the word *belt* can be established only in a more narrowly defined frame of reference (e.g. geology), both languages use respective lexical items to denote the less prototypical sense "zone."

On the other hand, information about cross-language differences in the frames of reference used for conceptualization should be stored as essentially language-specific information. For example, the metaphorical extension *eye of a needle* can be analyzed in terms of a transfer from the conventionalized domain of a HEAD onto the domain of a NEEDLE. The profile/base relation denoting 'an opening through which you can see' is conceptualized differently when it is imposed on one or the other domain. Metaphorical extensions in L1 and L2 may differ in terms of their profile/base relations.[3] For example, the Russian equivalent of the English metaphorical extension *eye of a needle,* uses a different base/profile relation denoting 'a small opening or hole', which is markedly different from the profile/base relation of the English expression. When this profile/base relation imposed onto the conventionalized domain of a HEAD, the resulting meaning can be translated in English as "an ear". Imposition of the later profile/base relation onto the less conventional domain of a NEEDLE results in the conceptualization that is identical to the English expression *eye of a needle,* but it can be mistakenly translated into English as *ear of a needle* producing a rather unusual, yet comprehensible metaphorical extension.

4. THE RELATION ASSESSMENT EXPERIMENT. The validity of the proposed approach to IL representation is supported by empirical evidence obtained in two relation assessment (RA) experiments. In an RA experiment, word pairs are judged for their semantic relatedness. The RA task was chosen because it can demonstrate prototype effects and degrees of activation spreading arising in the relational organization of the target word stimuli. Prototype effects are generally associated with two things: the senses of a stimulus that exhibit higher perceptual salience or the senses that are most often

[3] Cognitive Grammar posits hierarchies of domains to provide the basis for various concepts. The parts of the domains that a linguistic unit invokes are called the *base.* The notion of a *profile* is used to indicate that some facet of the base is raised to a prominent level (Langacker 1988, pp. 53, 59).

associated with the given lexical forms. Hence, a word pair with closely related prototypical senses should yield a greater number of positive judgments. Among the causes of this is the immediate availability of the target senses upon the activation of the stimulus's relational organization. Conversely, a stimulus pair with related nonprototypical senses is more likely to generate a greater number of negative judgments.

4.1. EXPERIMENT 1. This experiment was conducted to test the hypothesis that the results obtained from bilingual speakers are influenced by both conceptual structures, particularly in judgments provided for distantly related word pairs. The semantic relations between prototypical and nonprototypical senses in distantly related pairs of the target language may not be present in the relational organization of the equivalent lexical items in bilinguals' other language. Consequently, bilinguals with different sets of conceptual structures were expected to demonstrate distinct relatedness judgments.

4.1.1. METHOD. Twelve English monolingual speakers, 13 Spanish-English and 15 Russian-English bilinguals participated in this experiment. The participants were students and visiting scholars at the University of Florida. The fluency of bilingual speakers was at the level that fulfills the English language requirement at the University of Florida, which corresponds to a score of 550 or higher on TOEFL (Test of English as a Foreign Language).

The corpus of stimuli were 51 target and 49 filler English word pairs. The target word pairs comprised three groups. These groups were categorized as closely related, distantly related, and unrelated, with 17 pairs in each group. Closely related word pairs were selected in such a way that the prototypical meanings of the two lexical items were closely related (e.g. ‘fortune’ – ‘wealth’). In distantly related pairs the prototypical meaning of one lexical item was closely related to a non-prototypical meaning of the other lexical item in the pair (e.g. ‘limit’ – ‘ceiling’). In unrelated word pairs none of the senses in the networks of the stimulus lexical items were considered.to be related (e.g. ‘juice’ – ‘sock’).

The experiment was conducted on an IBM compatible notebook computer with a 24 cm color active matrix display. The experiment ran a computer program written in Quickbasic. The instructions and the stimuli were presented in white 0.5 x 0.5 cm letters on blue background, the words constituting a pair were presented consecutively. Stimulus and interstimulus intervals were set automatically at 1 second. Participants were instructed to make judgments of the semantic relatedness between the words. They had to respond as soon as they read and understood the second word in a pair. Response keys marked by “yes” and “no” caps were also color coded, green and red respectively. The “yes” and “no” response keys were located at opposite ends of the computer keyboard to ensure accuracy of responses. Left and right assignment of “yes” and “no” keys was counterbalanced across participants. Participants were instructed to press a white key in the center of the keyboard if they did not know the word(s). Each trial was followed by an automatically set break that allowed the participant to self-pace the experiment.

4.1.2. RESULTS. Figure 1 demonstrates the percentage of positive judgments as a function of network distance for the three groups of speakers. An analyses of variance (ANOVA) were performed on percentage of positive judgments using participants as random factors. The results demonstrated a highly significant main effect of the network distance, $F(2,81)=88.850$, $p<.001$. Although the analysis of positive judgments on word

relatedness demonstrated the effect of language as non-significant, paired sample t-tests demonstrated that the speakers of the three languages provided different judgments about word relatedness in pairs. Thus, the tests demonstrated statistical significance in judgments provided by English monolinguals and Russian-English bilinguals for unrelated and distantly related word pairs *(t* = 1.936, *p= .08,* and *t* = -2.587, *p= .02,* respectively). The responses of Russian-English and Spanish-English speakers revealed marginally significant difference in their judgments for only distantly related word pairs (*t* = 1.622, *p* = .1). The judgments of distantly related words provided by English monolinguals and Spanish-English bilinguals only approached significance at *t* = -1.00, *p* = .1.

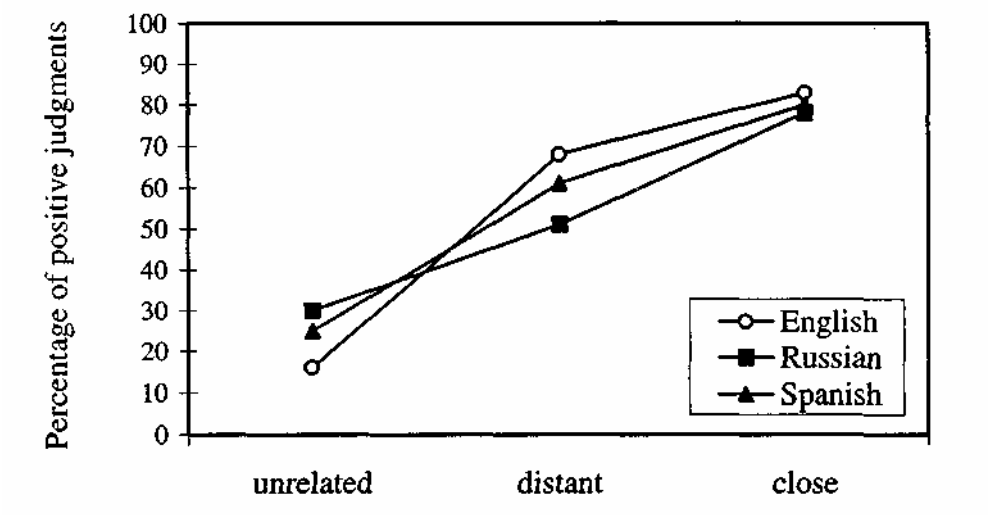

Figure 1. Mean percentage of positive judgments on word meaning relatedness as a function of organizational differences in conceptual structures of bilingual and monolingual speakers. (English = English monolinguals, Russian = Russian-English bilinguals, Spanish = Spanish-English bilinguals)

The absence of a significant difference in the judgments of English monolinguals and Spanish-English bilinguals as compared to the difference observed in the judgments of English monolinguals and Russian-English bilinguals can be a result of greater similarity in the relational organization of the stimulus English lexical items and their Spanish equivalents. The greater differences in responses of English monolinguals and Russian-English bilinguals can also be attributed to less extensive experience with the L2 conceptual structure. Unlike Russian-English bilinguals, Spanish-English monolinguals attended high schools in the US and considered themselves to be equally fluent in both languages. One may argue that the latter may serve as counter-evidence for the hypothesis being tested; that is, the differences in judgments of different language groups reflects the proficiency level of bilingual speakers. However, both bilingual groups produced comparable response latencies (Figure 2), which were significantly longer than the

latencies produced by monolingual speakers. The response times demonstrated a main effect of language in the between-subject condition, F(2,81)= 12.440, p<.01. The reported significance of the language variable was due to a great difference between the response times of bilingual and monolingual speakers. The response latencies of bilingual speakers were approximately 650 ms longer than the response latencies of monolingual speakers. The paired sample t-tests between the response latencies of Russian-English and Spanish-English bilinguals were performed to investigate whether language-specific organization causes differences in the response latencies of bilingual speakers. The tests did not reveal significant differences in response times of the two bilingual groups. This may be due to an overall increase in response times associated with second language processing. Unlike monolingual speakers, bilingual speakers require additional processing time to recognize the differences between the semantic structures of the two languages and to suppress the dominant language in cases where its structure does not coincide with the structure of the language being used.

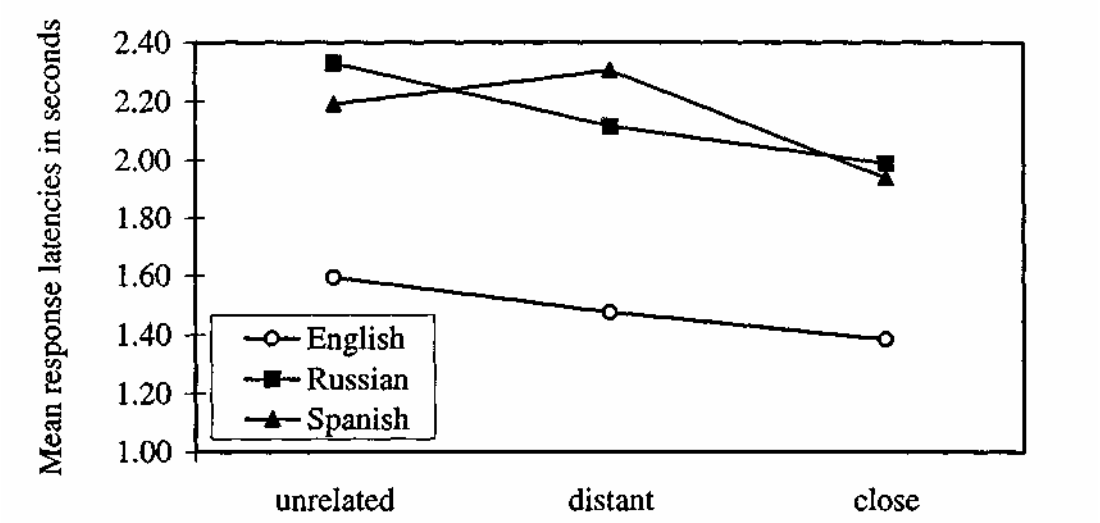

Figure 2. Mean response latencies (in seconds) as a function of organizational differences in conceptual structures of bilingual and monolingual speakers. (English = English monolinguals, Russian = Russian-English bilinguals, Spanish = Spanish-English bilinguals)

The combined evidence suggests that proficiency is only one of the factors affecting bilingual performance. Another factor is distinct relational organization within the conceptual structures of a bilingual's two languages. As predicted, the major differences were demonstrated in the relatedness judgments of the distantly related word pairs. These differences and the marginally significant interaction between language and distance variables ($F(4,81) = 2.382$, $p < .5$) support the assumption that language-specific relational organization influences the performance of bilingual speakers and therefore should be included into IL representations.

4.2. EXPERIMENT 2. In this experiment, word pairs to be judged for their semantic relatedness were presented in contextually-embedded (primed) and isolated (unprimed) conditions. Prior presentation of stimuli in relevant contexts were predicted to increase proportion of positive judgments.

4.2.1. METHOD. A group of nineteen native speakers of American English not fluent in any second language and a group of fifteen native Russian speakers fluent in English were tested in the unprimed condition. A group of twelve American English monolingual speakers and a group of thirteen native Russian speakers fluent in English were tested in the primed condition.

Materials were the same as in Experiment 1. In the primed condition, the sentences used as primes were intended to activate contextual frames, highlighting target conceptual representations. For example, the word pair 'limit' – 'ceiling' was preceded by the sentence "The administration has introduced new ceilings on the value of preferential contracts for minorities." The sentences were selected from authentic English texts available through LEXIS/NEXIS online news service.

In the unprimed condition, the procedure was the same as in Experiment 1. In the primed condition, every trial was preceded by a sentence or two. The sentences comprised less than four lines on a computer screen. Both experimental sessions were preceded by a training session which allowed participants to familiarize themselves with the task.

4.2.2. RESULTS. Figure 3 presents the percentage of positive judgments as a function of network distance and priming for both bilingual and monolingual speakers.

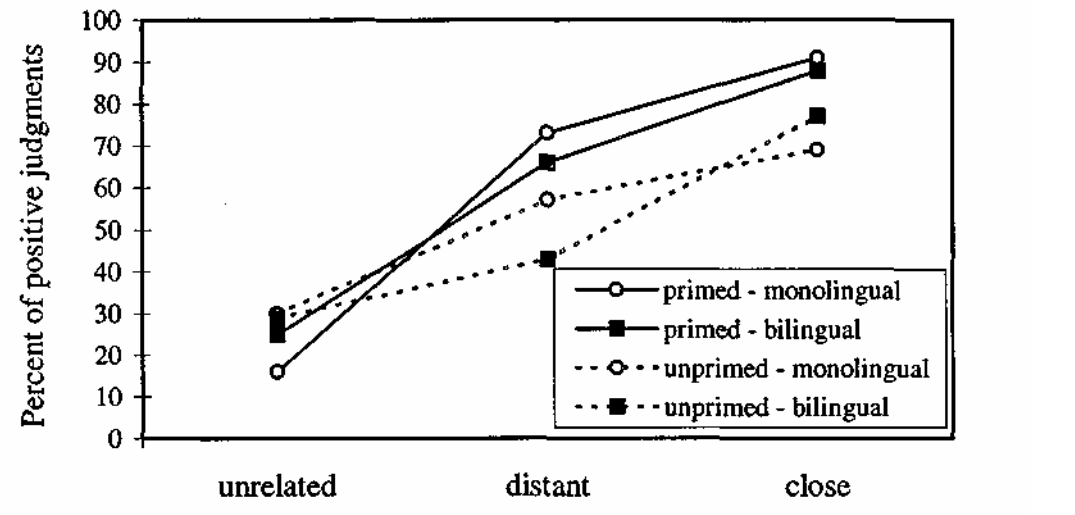

Figure 3. Mean percentage of positive judgments as a function of network distance for bilingual and monolingual speakers in unprimed and primed conditions.

ANOVA were performed on percentage of positive judgments using participants as random factors. The results demonstrate a highly significant main effect of network distance, $F(2,82)=65.377$, $p<.001$. Although the effect of priming was only marginally significant ($F(1,41)=6.519$, $p<.05$), the interaction between network distance and priming was significant, $F(2,82)=5.170$, $p<.008$. Priming made some distant meanings more salient and, as a result, the words in the category of distantly related word pairs were judged as related approximately 20% more often in the primed condition than in the unprimed condition by both monolingual and bilingual groups of speakers.

There was no main effect of the language variable ($F<1$), indicating that the response types provided by monolingual and bilingual speakers were equivalent. Separate ANOVA were performed on bilingual and monolingual data to discover possible differential effects of distance and priming on different groups of speakers. The analysis of the bilingual data revealed main effects of distance and priming, $F(2,54)=86.587$, $p<.01$, and $F(1,54)=7.668$, $p<.001$ respectively, and a significant interaction between distance and priming ($F(2,54)=5.594$, $p<.01$). The analysis of the monolingual data demonstrate only a main effect of distance ($F(2,69)=24.706$, $p<.01$). Although the main effect of language was not significant, the separate analyses demonstrated that relatedness judgments provided by bilinguals were greatly affected by the prior presentation of target lexical items in meaningful contexts in the primed condition. For example, the percent of positive judgments provided by monolingual speakers for the prototypical and nonprototypical meaning in the word pair 'ceiling'- 'limit' increased from 75 to 83 following presentation of the prime sentence "The administration has introduced new ceilings on the value of preferential contracts for minorities," while the percent of positive judgments provided by bilingual speakers increased from 27 to 67 percent.

The activation of a particular meaning relation within a precisely defined contextual frame diminishes the negative lexical transfer that results from straightforward mapping of incompatible representations in the conceptual structures of a bilingual. Relatedness judgments obtained in the experiment were shown to be greatly influenced by the availability of contextual cues. Paired-sample t-tests conducted on the data produced in response to distantly related word pairs demonstrated a significant difference in responses produced by bilingual and monolingual speakers in the unprimed condition, $t = 2.02$, $p = .05$, and a remarkable agreement between the two groups in the primed condition, $p > .1$.

Figure 4 presents the mean response times as a function of the semantic network distance for bilingual and monolingual speakers. As in Experiment 1, the response times demonstrated a main effect of language in the between-subject condition, $F(1,41)=7.282$, $p<.001$. Response time latencies of bilingual speakers were approximately 300 ms longer than response time latencies of monolingual speakers in both conditions. The main effect of the language variable supports the assumption that longer latencies produced by bilingual speakers are conditioned by the processing demands placed on bilingual speakers. Processing L2 lexical material requires operation in the conceptual structure characterized by a higher activation threshold. It also requires the suppression of the dominant conceptual structure, which may access a relational network incompatible with the target conceptual organization. As a result, bilinguals require additional time to process L2 stimuli.

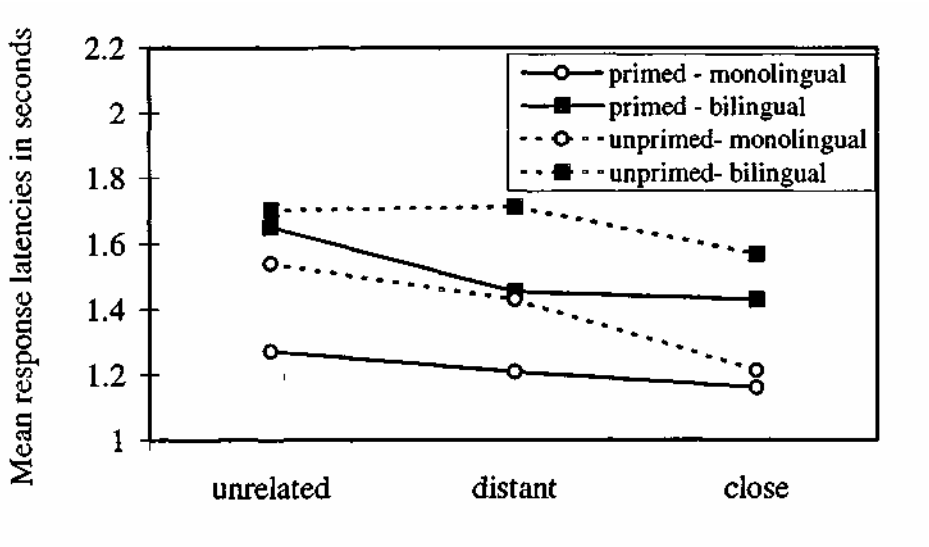

Figure 4. Mean response latencies (in seconds) as a function of network distance for bilingual and monolingual speakers in unprimed and primed conditions.

5. CONCLUSION. The processing differences demonstrated between the group of English monolingual speakers and the group of Russian-English bilingual speakers may have implications for the nature of IL representation. Although the experimental conditions were designed to activate only English conceptual structure, the processing patterns of bilingual speakers in the unprimed condition were largely affected by organizational differences existing in both conceptual structures of a bilingual. The latter provide an evidence for the IL representation. According to the CSM model, effects resulting from the IL representation are most conspicuous when the target lexical items are not accompanied by any information about their relational organization within the target conceptual structure. On the other hand, the data obtained in the primed condition produced rather uniform patterns correlated with the activated knowledge domains. The types of representations that were accessed in the primed conditions were largely defined by the requirements of a single-language context, in which case IL representation was rendered as unnecessary.

The CSM model reviewed here provides a methodological tool for deciding which information should be discarded and which should be retained for the IL representation. It was proposed that IL representations should be associated with the areas of greater incongruity in the relational organization of a lexical item, and with greater variability in the frames of references permitted for a given lexical item.

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